DEPARTMENT OF ECOLOGY
State of Washington

Concise Explanatory Statement: Appendix D

Chapter 173-201A WAC

Water Quality Standards for Surface Waters of the State of Washington

Copies of written comments

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Concise Explanatory Statement: Appendix D

Chapter 173-201A WAC
Water Quality Standards for Surface Waters of the State of Washington

Water Quality Program
Washington State Department of Ecology
Olympia, Washington 98504-7600

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Appendix D: Copies of All Written Comments

Description

Ecology accepted comments on the proposed amendments to Chapter 173-201A WAC between February 1, 2016 and April 22, 2016. This document contains copies of comments we received during the comment period. (RCW 34.05.325(6)(a)(iii)). For details about the rulemaking and Ecology's response to comments refer to the Concise Explanatory Statement (publication no. 16-10-026).

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JAMESTOWN S'KLALLAM TRIBE

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April 21, 2016

Maia Bellon, Director
Washington State Department of Ecology
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ATTN: Water Quality Program, swqs@ecy.wa.gov Becca Conklin

RE: Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon,

As you know, I have been one of the Tribal leaders working on improved water quality standards that will better protect the health of all people in the State of Washington and respect our Tribe's treaty-reserved rights to fish and shellfish. The Department of Ecology has proposed a draft rule for human health criteria and implementation tools. I offer the following comments on the state's proposed rule, issued in February, 2016. First, the proposed state rule once again falls short of the stated goal of protecting people who consume fish and shellfish. Second, the Jamestown S'Klallam Tribe hereby supports, adopts, and incorporates by reference the complete Northwest Indian Fisheries Commission comments submitted to Ecology in April, 2016. Finally, the Jamestown S'Klallam Tribe supports the more protective draft rule for human health criteria applicable to Washington State, issued by the U.S. Environmental Protection Agency on September 14, 2015.

Tribes entered this discussion many years ago with heightened concerns that the existing fish consumption rate (FCR) of 6.5 grams per day greatly under-estimates the amount of fish consumed by Tribal citizens. Fish and shellfish remain staple foods in many Tribal households. The proposed FCR of 175 g/day is low compared to fish consumption rates at many tribes. Public health is impacted by toxic chemicals in the food chain. The rule proposed by the Department of Ecology may greatly diminish the protective benefit of a higher fish consumption rate.

The Department of Ecology's draft rule proposes other human health criteria that do not incorporate best available science and fails to account for other sources of toxic chemicals. Therefore, we recommend adoption of the criteria proposed by the EPA. The Department of Ecology's proposal will allow the criteria for several highly toxic chemicals including PCBs, arsenic, and dioxin to remain at status quo or to get substantially worse. Ecology's proposed implementation tools should be adjusted so that they are directed towards accountability and attainment of water quality standards, and not a set of tools to help dischargers avoid compliance.

Washington State is required to meet the provisions of the Clean Water Act to preserve the beneficial uses of water, including fishing. The public health issues that are determined by these standards affect everyone in Washington who eats fish. On top of this concern, the state must not impair the tribe's treaty-reserved rights to take and consume fish at all their usual and accustomed fishing grounds and stations. The proposed rules by the state of Washington do not meet these requirements.

Sincerely,

W. Ron Allen
CEO/Tribal Chairman

cc
Lorraine Loomis, Chair; Northwest Indian Fisheries Commission
Dennis McLerran, EPA Region 10 Administrator
Dan Opalski, EPA Region 10 Director for the Office of Water and Watersheds

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Federal Water Quality Coalition

April 22, 2016

VIA E-MAIL
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Re: Comments of Federal Water Quality Coalition on Washington Department of Ecology Proposed Water Quality Standards for Protecting Human Health (Chapter 173-201A WAC)

Dear Sir or Madam:

The Federal Water Quality Coalition ("FWQC" or the "Coalition") appreciates the opportunity to file comments with Washington Department of Ecology (the "Department") regarding the Department's proposed rule revising certain water quality standards for Washington State (the "Proposed Standards" or the "Proposal").

The FWQC is a group of industrial companies, municipal entities, agricultural parties, and trade associations that are directly affected, or which have members that are directly affected, by regulatory decisions made by the Federal Government and States under the federal Clean Water Act. The FWQC membership includes entities in the aluminum, agricultural, automobile, chemical, coke and coal chemicals, electric utility, home building, iron and steel, mining, municipal, paper, petroleum, pharmaceutical, rubber, and other sectors. FWQC members, for purposes of these comments, include: Alcoa, Inc; American Chemistry Council; American Coke and Coal Chemicals Institute; American Forest & Paper Association; American Iron and Steel Institute; American Petroleum Institute; Association of Idaho Cities; Auto Industry Water Quality Coalition; Bristol-Myers Squibb; City of Superior (WI); Edison Electric Institute; Eli Lilly and Company; Freeport-McMoRan Copper & Gold; General Electric Company; Hecla Mining Company; Indiana Coal Council; Johnson & Johnson; Kennecott Utah Copper LLC; Mid America CropLife Association; Monsanto Company; National Association of Home Builders; Orange County (CA) Sanitation District; Pfizer Inc.; Rayonier Advanced Materials; Rubber Manufacturers Association; Shell; Utility Water Act Group; Western Coalition of Arid States; Western States Petroleum Association; and Weyerhaeuser Corporation.

FWQC member entities or their members own and operate facilities located in Washington State and elsewhere around the country. Those

Federal Water Quality Coalition

facilities operate pursuant to permits that impose control requirements with respect to wastewater discharges. Many of those permits include effluent limits based on water quality criteria developed for the protection of human health. The criteria being developed by the Department for Washington State will determine the effluent limits in permits for FWQC members in Washington State, and we expect that they will serve as a precedent for how human health criteria issues are addressed in permits for FWQC members in other States. The FWQC therefore has a direct interest in the Proposed Standards that are being developed by the Department.

We believe that in some respects, the Proposed Standards reflect appropriate use of scientific information, and sound policy judgments, and we urge the Department to maintain its decisions on those issues. In other respects, though, we believe that the Department has made decisions that are not appropriate, and we request that you reconsider those aspects of the Proposal. Each of these issues is summarized below.

Bioconcentration Factors: In addressing the issue of food-chain-related increases in contaminant levels, the Department has applied bioconcentration factors (BCFs), instead of using USEPA's preferred bioaccumulation factors (BAFs). We believe that this choice was appropriate, given a number of scientific concerns that exist regarding USEPA's BAF methodology and the national BAF values that USEPA has derived. Those concerns are described in more detail in Appendix A to these comments.

Relative Source Contribution: In addressing the issue of non-water sources of contaminants, the Department has used a Relative Source Contribution (RSC) value of 1.0, rather than using other values that have been provided by USEPA. We believe that the Department's choice is the right one. Applying a lower RSC value is not necessary, given the conservatism already built into other aspects of the standard-setting process,[1] and leads to standards that are more stringent than is scientifically justified. These concerns are detailed further in Appendix B to these comments.

[1] The national criteria guidelines set by EPA, on which the Proposed Standards are based, includes very conservative default values for a variety of inputs. For example, EPA assumes that: (1) the concentration of a pollutant in all waters is always equal to the criterion; (2) the average person drinks 2.4 liters of unfiltered and untreated water from local surface waters, each and every day for 70 years; (3) that average person is eating 22 grams of locally caught fish every day for 70 years, all of which are contaminated at the criteria level; and (4) none of the pollutants in the fish were lost due to preparation or cooking. The "compounded conservatism" that results from use of these assumptions leads to criteria that are substantially more stringent than necessary.

Federal Water Quality Coalition

Fish Consumption Rate: The Department has calculated its new standards based on a fish consumption rate of 175 grams per day. Applying that value on a State-wide basis is improper. That high fish consumption rate is based on studies of groups that eat much more fish on a daily basis than the general population. In developing State-wide standards, the Department should focus on ensuring that consumers of fish in the general population are not exposed to unacceptable risks. By instead using the fish consumption rate of a sub-group that eats considerably more fish, the Department is deriving State-wide standards that are far more stringent than necessary.

Risk Level: Initially, the Department had developed standards based on an incremental risk level of 10^{-5}. However, USEPA objected, and issued its own proposed standards for Washington State that reflected an incremental risk level of 10^{-6}. The FWQC filed comments on the USEPA proposal, raising concerns about use of that lower risk level. (A copy of those comments is attached as Appendix C to these comments.) Now, the Department, in the Proposed Standards, has changed its approach, using the 10^{-6} risk level recommended by USEPA. We continue to believe that the Department's original choice of a 10^{-5} risk level was appropriate, and that the change to a 10^{-6} risk level will provide no measurable improvement in protection of human health, with a substantial increase in cost to regulated parties and the public. Therefore, we recommend that the Department return to its original approach, and revise the Proposed Standards to reflect a 10^{-5} risk level.

The FWQC appreciates the opportunity to submit these comments concerning the development by the Department of water quality standards for the protection of human health in Washington State. Please feel free to call or e-mail if you have any questions, or if you would like any additional information concerning the issues raised in these comments.

Fredric P. Andes
Coordinator

FWQC COMMENTS ON WASHINGTON PROPOSED STANDARDS APPENDIX A

Washington's proposed use of bioconcentration factors (BCFs) represents sound science policy, because it recognizes the scientific limitations of the bioaccumulation assumptions made by USEPA when developing the 2015 national human health water quality criteria.

Washington is proposing to use bioconcentration factors (BCFs) rather than bioaccumulation factors (BAFs) to estimate the accumulation of chemicals from surface water into tissue. In developing its proposed approach, Washington has correctly recognized the following concerns about the BAF approach:

(1) when developing the bioaccumulation methodology used to derive its 2015 national human health water quality criteria, USEPA did not provide a methodology to allow states to develop state-specific BAFs (USEPA 2015a, USEPA 2016);

(2) USEPA's pre-2015 BCFs are better vetted and more transparent than the BCFs and BAFs used by USEPA in its 2015 criteria; and

(3) Even with USEPA's release of a supplemental Technical Support Document in January 2016 (USEPA 2016), the scientific basis for the BCFs/BAFs used in several of USEPA's 2015 criteria are either not fully explained or are incorrect, and their use leads to water quality criteria whose scientific basis is unclear at this time.

For all of the above reasons – described in more detail below - Washington's decision to develop its proposed human health standards based on the approach and BCFs that USEPA and most states have employed for the past two decades is a sound science policy decision.

) **USEPA has not provided a methodology to allow states to develop state-specific BAFs.**

In developing the 2015 criteria, USEPA indicates that, for a given chemical, a single set of assumptions and BAFs can be used to represent bioaccumulation in all the waters of the United States. USEPA has further proposed that for chemicals without measured BAFs, if the octanol water partition coefficient (K_{ow}) of a chemical is known, a single set of assumptions about aquatic food webs and fish physiology (e.g., assimilation, metabolism) can be used to estimate a single set of BAFs for surface waters throughout the United States. USEPA's approach is inconsistent with certain well-recognized principles: fish accumulate chemicals from their diet as well as from water, and the degree of uptake from the diet depends upon a range of waterbody-specific characteristics, such as the composition of the food web. The effect of waterbody-specific characteristics on BAFs precludes the USEPA's use of a single set of assumptions to develop BAFs for chemicals in all waters of the United States.

Bioaccumulation of the same chemical will vary across water bodies. While it may be possible to demonstrate that once differences in K_{ow} of a chemical are accounted for, variation of BAFs across all waters of the United States is expected to be small and have little consequence on criteria, USEPA has not made such a demonstration to this point. Absent such a demonstration, USEPA needs either to provide BAFs on a regional geographic basis or provide the tools by which states can develop state-specific BAFs using state-specific inputs.

Additionally, there are questions about the scientific basis for some of the USEPA BAFs. The Agency (USEPA 2016) provides a single table of foodchain multipliers (FCMs) by which to estimate BAFs for different trophic levels, assuming that the K_{ow} of a chemical is known. USEPA applies FCMs from the table to chemicals that USEPA has classified as "high metabolism" (e.g., benzo(a)pyrene, USEPA 2015b) and also to chemicals that the Agency has classified as "low metabolism" (USEPA 2003). However, it is generally accepted that high versus low metabolism affects the potential for a chemical to accumulate in higher trophic levels of food web. USEPA's use of a single table of FCMs that does not account for differences in metabolism raises significant uncertainty about the validity of BAFs derived using the FCM approach presented in USEPA 2016 and used to derive the 2015 criteria. Until greater certainty exists about how well the BAFs and BCFs used by USEPA in the 2015 criteria represent accumulation in fish living in surface waters in Washington, the State's decision to continue to use pre-2015 BCFs represents a sound science policy choice.

- **The BCFs that Washington is proposing to use are better vetted and more transparent than USEPA's 2015 BAFs.**

USEPA has not provided an opportunity for the scientific community to adequately evaluate and comment on the BAFs and BCFs used to derive the 2015 criteria. The 2015 BAFs differ from the pre-2015 BCFs by orders of magnitude in several cases (Figure 1). Given the effect that such alternate BAFs can have on criteria and the potential implications for states and dischargers that may result, USEPA needs to allow for substantive comment on the technical merits of its choice of national default values and on the appropriateness of using such national default values in deriving criteria for specific states and waterbodies. While USEPA, in January 2016, did finally release background information as to how it developed the 2015 BAFs and BCFs (USEPA 2016), there has not been sufficient time (in the three months since the release) for an adequate review of that information, to evaluate its scientific merits or its applicability to surface waters in Washington or any other State.

- **The scientific basis for the BCFs and BAFs used by USEPA to derive the 2015 criteria is either unclear or incorrect for some chemicals.**

We have not had time to review the basis of all the BCFs or BAFs used by USEPA for the 94 chemicals for which criteria were updated in 2015. However, we have had the chance to review the basis of the BAFs for a few chemicals, and we have found that the scientific basis for USEPA's BAF is insufficient for some chemicals. The national BAF of 3,900 liter per kilogram (L/kg) that USEPA has proposed for benzo(a)pyrene (BaP) is an example. This compound is particularly appropriate to review, given its widespread presence in the environment, the substantial knowledge of its fate and transport within the scientific community, and its use by USEPA as a surrogate for the BAFs of other potentially carcinogenic polynuclear aromatic hydrocarbons (PAHs). (The BaP BCF is used by USEPA to derive the revised criteria for six other PAHs - benzo(a) anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.)

To derive the 2015 criteria for BaP, USEPA used a BAF of 3,900 L/kg. That BAF is 130 times higher than the BCF of 30 L/kg used in the previous EPA criteria. Our review found that the new calculations were inconsistent with the methodology prescribed for national BAFs (USEPA, 2003).

Fish and crustaceans are known to be able to metabolize and eliminate PAHs (ATSDR, 1995). Biomagnification (the systematic increase in tissue concentrations moving up a food chain) has not been reported for PAHs, because of the tendency of many aquatic organisms to eliminate these compounds rapidly. In general, decreasing PAH concentrations are associated with increasing trophic level (ATSDR, 1995). EPA acknowledged this characteristic by classifying BaP as having "high metabolism" (USEPA, 2015b) and indicating that "Procedure #2" (USEPA, 2003) was used to select a method to evaluate BaP. In the absence of field measured BAFs or BSAFs, Procedure #2 should have led to the selection of "Method 3", using lab measured BCFs *without* food chain multipliers (see Figure 3-1 of USEPA, 2003; also Figure 6 of WADEC, 2016)).

In the 2015 BaP criteria support document (USEPA 2015b), the Agency states:

> EPA was not able to locate peer-reviewed, field-measured BAFs, BSAFs, or lab-measured BCFs for all three [trophic levels (TLs)] (2, 3, and 4). Therefore, EPA used the BCF method estimate for the reported TLs by calculating the geometric mean of the TL2 and TL3 BCF values available for benzo(a)pyrene (Arnot and Gobas 2006; Environment Canada 2006) to derive the national BAF value of 3,900 L/kg for this chemical.

Upon review of the supplemental information on BAF calculation that was released in January 2016 (*Development of National Bioaccumulation Factors: Supplemental Information for EPA's 2015 Human Health Criteria*), it is clear that USEPA did not follow Procedure #2, and instead applied a food chain multiplier (10.216) to the BCFs measured in TL3 fish, thereby increasing the BAF by 10-fold. Furthermore, the TL2 BAFs used in the calculation were based primarily on species not consumed by humans (i.e. zebra mussel, amphipod, mayfly, water flea, small crustacean) and varied by an order of magnitude, adding large uncertainty to the overall BAF calculation.

Another inconsistency was found regarding the conversions of the study BCFs for BaP to baseline BAFs. The equation includes a fraction lipid and fraction dissolved term (see equation 5-12 in USEPA, 2003). The freely dissolved concentration is determined from the particulate organic carbon (POC) and dissolved organic carbon (DOC) concentrations from the study (see Equation 4-6 of USEPA 2003). USEPA guidance (USEPA 2003) clearly states that study values for POC and DOC should be used in the equation and that it is not appropriate to use default values. However, upon review of the EPA January 2016 Supplemental Information document, it appears that USEPA used national surface water default values, because the DOC, POC, and dissolved fraction values in the supplemental calculation tables are identical for all five studies. It would be very unusual for five different studies to have the exact same POC, DOC, and freely dissolved fraction.

Based on the information USEPA has provided to date, it is unclear why USEPA, in developing the BAF for BaP, deviated from the flowchart for derivation of BAFs this is contained in its 2003 guidance. Moreover, we see no basis for use of an FCM of greater than 10 to extrapolate a BAF from BCFs for a chemical that is widely recognized as being metabolized by fish. That approach leads to estimates of bioaccumulation that are higher than predicted by USEPA's own bioaccumulation models (see Section 8 of USEPA 2015b). Until USEPA addresses each of these concerns, these BAFs should not be used. These issues provide additional justification for Washington's decision to not use USEPA's 2015 BAFs and BCFs when developing its proposed human health standards.

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USEPA. 2015a. Human Health Ambient Water Quality Criteria: 2015 Update. Office of Water. EPA 820-F-15-001. June 2015.

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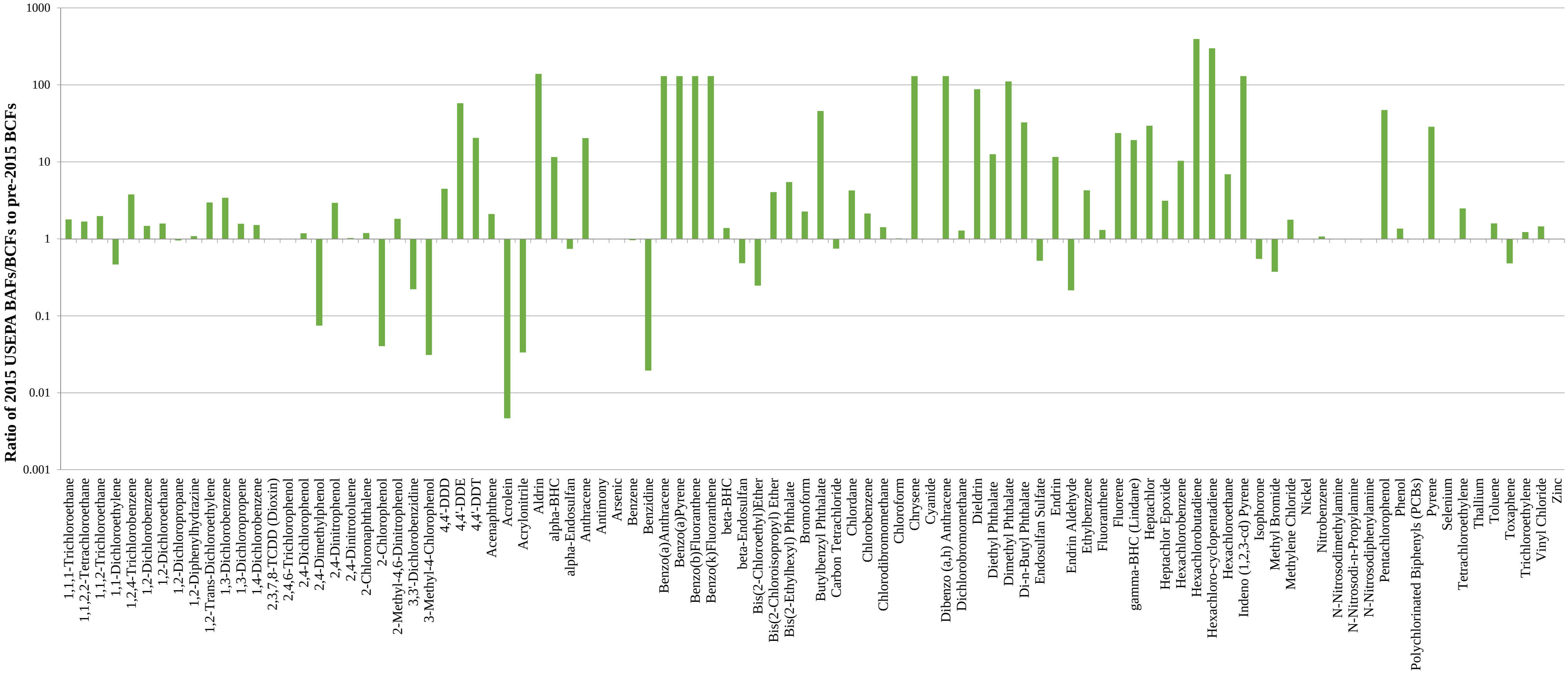

Figure 1. Chemical-by-Chemical Comparison of 2015 USEPA BAFs/BCFs to pre-2015 BCFs Used to Derive National HHWQC

Note:
A ratio greater than 1 indicates that the 2015 BAFs/BCFs are higher than the pre-2015 BCFs (e.g., a ratio of 10 would indicate the 2015 BAFs/BCFs are 10 times higher). A ratio below 1 indicates that the 2015 BAFs/BCFs are lower than the pre-2015 BCFs (e.g., a ratio of 0.1 would indicate the 2015 BAFs/BCFs are 10 times lower).

FWQC COMMENTS ON WASHINGTON PROPOSED STANDARDS APPENDIX B

Washington's proposed use of a Relative Source Contribution Factor (RSC) of 1.0 results in protective human health standards and recognizes that selection of an RSC is a risk management decision.

To derive updated human health water quality standards, Washington is proposing to use a Relative Source Contribution (RSC) factor of 1 for all chemicals. In making this risk management decision, Washington correctly recognizes that employing an RSC in the derivation of standards, and choosing a specific RSC value, are science policy decisions rather than technical decisions. As identified below, several factors support Washington's decision to use an RSC of 1.0.

- **Employing an RSC in the derivation of numeric criteria is a policy choice: Criteria can be derived without use of an RSC.**

The equations used to derive numeric criteria contain several parameters. Some of these are essential: criteria cannot be derived without them, no matter what is the environmental media to which the criteria apply (e.g., air, surface water, drinking water). For example, one must select a body weight to derive a numeric criterion. Similarly, one must select a contact rate, whether that is a fish consumption rate, an inhalation rate, or a drinking water rate. These parameters are essential to the equations used to derive numeric criteria. Other factors are not necessarily required, but can be used. For example, the loss of a chemical during preparation of fish (often referred to as cooking loss) can be included in the derivation of human health water quality criteria, but is not essential: criteria can be derived with or without assessing cooking loss. Similarly, the Relative Source Contribution (RSC) is not essential to the derivation of numeric criteria: criteria can be derived with or without an RSC, as evidenced by the absence of the RSC parameter in USEPA's equation to derive water quality criteria prior to 2000 (USEPA 1994). USEPA uses an RSC when deriving drinking water standards, and in 2015 began using RSCs when deriving national water quality criteria, but does not use RSCs when deriving air quality standards for air toxics.

- **The decision to use an RSC should consider the overall protectiveness of human health water quality standards.**

The risk management decision to use an RSC should take into account the overall protectiveness of the proposed standards, based on the conservativeness of the toxicity and exposure assumptions used to derive the proposed standards. By selecting a default RSC of 0.2 in most of the 2015 national criteria for the non-cancer endpoint, USEPA is effectively using the RSC as an additional safety factor of 5. National criteria are based on numerous conservative assumptions (such as fish consumption rates that overstate consumption for most people, an upper bound drinking water consumption rate, the assumption that all drinking water is untreated, the use of toxicity reference values that incorporate numerous uncertainty factors). When combined, these assumptions greatly overstate exposure and toxicity. Additionally, Washington's proposed standards use a fish a consumption rate (i.e., 175 grams/day) that is nearly ten times higher than the fish consumption rate (22.5 grams/day) used by USEPA in the 2015 national criteria. Given the level of conservatism embodied in Washington's proposed standards, it is not necessary to add another safety factor (of 5) to derive protective standards. The standards are already protective.

- **EPA's data requirements for States to derive State-specific RSCs impose an unfair burden.**

USEPA's data requirements for a state to develop State-specific RSCs are exceptionally burdensome (USEPA 2000). That USEPA guidance has an extended discussion in Section 4.2.2.2 on data adequacy, which virtually assures that most States will not have State-specific data on all of the relevant exposure pathways. Further, given USEPA's data adequacy requirements, it is also likely that most States will not have the resources available to develop what USEPA would consider adequate data. Moreover, in several instances (for example, in Idaho and Florida), States have made scientifically sound and conservative decisions about potential exposures using data from other sources (i.e., not specific to that State), and USEPA has rejected those State decisions, because data specific to those States were not used. In some of these situations, the estimated RSCs were substantially greater than the default of 0.2 that USEPA has used in its 2015 national criteria (FDEP 2014). The resource implications of USEPA's data adequacy requirements, combined with the evidence that RSCs are generally substantially greater than USEPA's default of 0.2, all support Washington's risk management decision to employ a uniform RSC of 1.0 for the non-cancer endpoint.

- **Use of a uniform default RSC of less than 1.0 for all chemicals is inappropriate, particularly for bioaccumulative chemicals when standards are based on high fish consumption rates.**

The majority of exposure to chemicals that are bioaccumulative (e.g., chlorinated pesticides, mercury, PCBs) is through the diet – in particular, through animal-based sources of protein that accumulate such chemicals from the environment (e.g., fish, beef, poultry). Water quality criteria that assume a high rate of fish consumption, such as Washington's proposed standards that are based on a fish consumption rate of 175 grams/day, effectively assume that a large portion of a person's daily source of protein is fish. That also means that the majority of exposure to bioaccumulative chemicals will be from fish, rather than from other dietary protein sources. That then has implications for the application of RSCs. Ideally, default RSCs should vary depending upon the tendency of a chemical to bioaccumulate and the magnitude of the fish consumption rate used to develop the water quality criterion. Because Washington's proposed standards use a fish consumption rate that is nearly ten times higher than that used to derive USEPA's 2015 national criteria, application of USEPA's default RSC of 0.2 (which USEPA used for most of its 2015 national criteria) is inappropriate. Given the conservative nature of the assumptions that Washington used to derive the proposed standards, the use of a uniform RSC of 1.0 for all chemicals will be protective of high consumers (for whom most exposure is assumed to come from fish) as well as average consumers (for whom a majority of exposure may be from other sources, but for whom exposure from water is greatly overestimated because of the conservative assumptions used in the proposed standards). Therefore, use of an RSC of 1.0 represents a sound risk management decision.

REFERENCES

USEPA. 1994. Water Quality Standards Handbook. Chapter 3: Water Quality Criteria. Office of Water. EPA 823-B-94-005a. August 1994.

USEPA. 2000. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000). Office of Water Science and Technology. USEPA. EPA-822-B-00-004. October 2000.

WADEC. 2016. Washington State Water Quality Standards: Human health criteria and implementation tools. Overview of key decisions in the rule amendment. Publication no. 16-10-006. January 2016.

Commenter ID: 3

Commenter Name: Robert B. Barnes

Commenter Association: Citizen

Comment received via online comment form

Comment:

I totally agree with the Tribes that the State should adopt higher standards, at east as high as the EPA. The State's track record is dismal. They allowed dams to be built without fish passage which was a law since Washington was a territory. The Department of Transportation has delayed, delayed, delayed on culvert replacement which is a minimum to what they should be doing. Many of their current outfalls go untreated, poisoning the Salish Sea with hydrocarbons and contaminants from the roadway. I was a commercial fisherman in Alaska for 40 years, and I am afraid to eat the fish coming from the Salish Sea. We should be leading, not trailing the EPA for water quality standards. We all live downstream, and our children and grand children expect and deserve better. Thank God for the EPA, the Clean Water Act, the Clean Air Act, the Environmental Impact Statement Process, and the Bolt decision that made Northwest Treaty Tribes co-managers of the fish and shellfish we all consume. We can and should do better!

April 21, 2016

Via email to: swqs@ecy.wa.gov

Cheryl Niemi
Water Quality Program
Washington Department of Ecology

RE: Proposed Rule Amendment to Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC)

The Northwest Food Processors Association (NWFPA) submits the following comments on the *Proposed Rule Amendment to Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC)*. In addition, NWFPA endorses the comment package submitted by Northwest Pulp and Paper Association and other co-signers.[11]

NWFPA represents food processing companies in Washington regulated by permits under the National Pollutant Discharge Elimination System (NPDES). The human health criteria adopted as part of the Water Quality Standards are of direct interest to food processors' operations in the State of Washington.

Fish Consumption Rate

The proposed rule sets a fish consumption rate at 175 grams per day and is based on local "highly exposed populations" rather than the general population. The methods used and the decisions made by the Department of Ecology result in a rate that represents a value of nearly the 95th percentile of the highest consumers in the state. This consumption rate represents a policy decision rather than a current state-wide survey of fish consumption or current survey of highly-exposed populations.[2] NWFPA is concerned about the data used to determine the fish consumption rate—the quality of surveys, age of surveys, as well as the assumption that short-term dietary surveys reflect long-term dietary behaviors. In 2012, JR Simplot Company submitted to Ecology a review of the fish consumption rates technical Support Document by Arcadis, identifying concerns with the fish consumption studies being used to assess fish consumption.[3]

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[1] "Northwest Pulp & Paper Association Comments on Draft Human Health Water Quality Criteria for the State of Washington," submitted by Chris McCabe, April 22, 2016.
[2] *Washington State Water Quality Standards: Human health criteria and implementation tools—Overview of key decisions in rule amendment* at 20 (January 2016). The January 2015 version of this document at page 16 indicates that the decision is based on input from Governor Inslee. Both documents reference the Governor's news release.
[3] Arcadis U.S., Inc., *Review of Fish Consumption Surveys for Ambient Water Quality Criteria Rulemaking in Idaho*, prepared for J.R. Simplot Company (November 2012).

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NWFPA does not support the inclusion of all fish and shellfish--regardless of sources and including anadromous fish. A foundational assumption in this rulemaking is that Washington's water quality standards influence the contaminant levels in water and fish. When considering the different sources of fish consumed by Washington residents, questions arise as to where these fish acquire contaminants and can Washington rules change the levels of contaminants in these fish.

Ecology has chosen to include "all fish and shellfish (which includes the additional protective step of including local and non-local sources, such as salmon, restaurant, locally caught, imported, and from other sources)." Washington's regulations will have no effect on contaminant levels in some of these fish and shellfish and minimal impact to fish such as salmon. Salmon species spend months to a year in freshwater and three to five years in saltwater habitats. Studies by Cullon et al. indicate that 97% to 99% of the body burdens of several persistent bioaccumulative toxins were acquired during the time at sea.[4] While there is clearly consumer exposure to contaminants from market and non-resident fish, including them in the fish consumption rate (with the resulting toxics substances criteria) places the burden of contaminants in these fish on Washington dischargers. This would expand the scope of what the Clean Water Act is expected to control.

Risk Level

The choice of risk level is a policy decision of the state. However, NWFPA believes that the proposed 10^{-6} risk level, and application to an average fish consumption rate for highly exposed populations instead of the general population, is over-protective and not consistent with EPA guidance or evidence in the record. In its 2000 guidance, EPA states that it believes that both 10^{-6} and 10^{-5} may be acceptable risk levels for the general population and that highly exposed populations should not exceed a 10^{-4} risk level.[5]

When the proposed risk level is applied to the proposed fish consumption rate, the resulting numeric criteria are significantly more stringent than the current National Toxic Rule criteria and exceed the levels necessary to protect public health. These levels are, however, more stringent than the allowable risk levels EPA uses in its safe drinking water regulations. It is also extremely conservative when applied to the general population of Washington State, who most likely consume much less than 175 grams per day and would be protected at a level of about 10^{-8}.

The concept of 10^{-6} was originally developed by the U.S. Food and Drug Administration as a screening level of "essentially zero," or *de minimus* risk—in other words, a level of risk considered below regulatory concern. At some point, a level of risk that was considered to be "essentially zero" has come to be identified for many as a maximum level of acceptable risk.[6]

Arcadis has pointed out in its comments to the state of Idaho (that "in general, the range of allowable risks for the general population typically used to set AWQC (i.e., 10^{-6} and 10^{-5}) are much smaller than the

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[4] Cullon, D.L., Yunker, M.B., Alleyne, C., Dangerfield, N.J., O'Neill, S., Whitcar, M.J., and Ross, P.S. *Persistent organic pollutants in Chinook salmon (Oncorrhynchus tshawytscha): Implications for resident killer whales of British Columbia and adjacent waters.* Environmental Toxicology and Chemistry 28(1):148-161. (2009).
[5] U.S. Environmental Protection Agency. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.* (2000)
[6] State of Idaho Department of Environmental Quality, *Idaho Fish Consumption Rate and Human Health Water Quality Criteria—Discussion Paper #7*. (December 2014).

daily risks we encounter simply by being alive (such as the daily risk of dying from an unnatural cause such as a fall or other accident) or activities we partake in on a regular basis (e.g., walking, driving a car, running)". Arcadis presents data on these other risks and conclude that "these comparisons support the notion that the risks of 1 x 10^{-6} and 1x 10^{-5} and even greater can be considered acceptable for the general population". [7]

Relative Source Contribution

NWFPA agrees with Ecology's proposed use of an RSC of 1.0. The scope of the Clean Water Act is to address potential exposures from NPDES. Use of an RSC less than 1.0 would expand this scope.

Intake Credits

NWFPA supports inclusion of intake credits to provide regulatory relief to dischargers who are subject to background pollutants.

Variances

NWFPA supports inclusion of a specific process for obtaining and maintaining a variance to comply with the Clean Water Act. We are concerned about the resource burdens these new regulations may pose to NPDES permittees. However given the stringency of the new criteria, variances may be a necessary implementation tool for many permittees.

Thank you for the opportunities you have provided to stakeholders to participate in the public process and to comment on the proposed rule.

Sincerely,

Pamela Barrow
Vice President, Energy, Environmental & Sustainability

[7] Arcadis U.S., Inc., *White Paper Responding to the Idaho Fish Consumption Rate and Human Water Quality Criteria—Discussion Paper #7: Risk Management and Protection of Human Health.* (January 20, 2015). IACI comments to Idaho Department of Environmental Quality on Idaho's Revised Human Health Toxic Criteria, (November 6, 2015) indicate the following lifetime risk of death: lightning 10^{-6} – 10^{-5}; cataclysmic storm 10^{-4}; homicide 10^{-3} – 10^{-2}; flu 10^{-2}; all accidents 10^{-2} – 10^{-1}; cancer or heart disease 10^{-1}.

Oral Comments on WDOE Proposed Fish Consumption Rule – April 6, 2016

The following comments are made with regards to the proposed Washington Department of Ecology Fish Consumption Rule. These comments were prepared by the Spokane Riverkeeper and read by myself, Alli Beard on behalf of the Spokane Riverkeeper. The Spokane Riverkeeper is a project of the Center for Justice, and we are an affiliated member of the Waterkeeper Alliance. We work to protect and restore the world's waters so that they are healthy and usable by communities that interact with them. As such, the Spokane Riverkeeper's stated mission is keeping the Spokane River Fishable and Swimmable.

The rule change that the Washington Department of Ecology (Ecology) has proposed takes several steps in the right direction, but falls short in helping us keep our Spokane River "Fishable" for the public.

1. Ecology's proposed rule has improved the fish consumption formula over the existing rule. The formula assumes a more realistic consumption rate of 175g of fish per/day while keeping the acceptable human health risk at 1 case of cancer in a million fish-eating residents. These standards would make Washington's waters cleaner and its fish safer to eat. We commend Ecology for listening to the public and changing their proposed rules to be more realistic and more protective of human health.
2. However, we encourage Ecology to review and revise their rule with regards to Mercury, PCBs and Arsenic. The proposed rule is not strong enough with regards to these toxins. All of these toxins bio-accumulate and bio-magnify in the food chain in such a way that makes Spokane River fish problematic to consume. In some cases, fish in the Spokane River are edible under the specific amounts and frequencies recommended in Dept of Health fish advisories. But depending on the age, species and river reach, many other types of fish are too toxic to eat. The standards for PCBs are still exceeded in some fish and statewide mercury advisory remains in place making their consumption extremely problematic for pregnant women, children and folks who for cultural and economic reasons consume far more than the recommended allowance. Currently, the

Environmental Protection Agency (EPA) has put forward PCB standards that are more protective and more up to date. We feel strongly that The EPA guidelines should be followed.

3. Additionally, we feel that the EPA standards for both arsenic and methyl mercury should be adopted. We understand that these toxins are tough to capture, but feel strongly that inaction is not a solution. Using the older National Toxics Rule criteria is not adequate and leaves the public vulnerable to higher levels of these toxins over time.

1. The proposed rule Increases timeframes for Compliance Schedules which is unacceptable. Using the language "as soon as possible" when refereeing to must meeting water quality standards is too idealistic and vague. There rule should require concrete time-limits for dischargers to meet state standards to ensure accountability that our waters are clean.
2. The increased availability and/or potential use of **Variances** in the proposed rule is unacceptable. Ecology policy should be pushing dischargers to lower their output of dangerous chemicals at the end of pipe, precisely because of the nature and amount of pollution in a water body can be excessive and challenging. Ecology should not be providing off-ramps from meeting existing standards or providing the designated, attainable uses.
3. Do not provide intake credits. Incentives should be developed to capture all pollutants coming through the systems that end up in our waters. Please construct policies that create net decreases in pollutants leaving the end-of-pipes in order to encourage dischargers to work towards cleaning up Washington's waters.

These comments are made with the idea that we should be working towards the ultimate elimination of discharge to the nation's rivers. Ecology's proposed rule-making should help us get there. Please do not provide provisions that stall our progress, or avoid the tough work of getting our public waters fishable and swimmable. Thanks for the opportunity to comment.

Spokane Riverkeeper.

NORTHWEST ENVIRONMENTAL ADVOCATES

April 20, 2016

Washington State Department of Ecology
Water Quality Program
Attn: Becca Conklin, Water Quality Standards Coordinator
P.O. Box 47600
Olympia, WA 98504-7600 *Via email only*: swqs@ecy.wa.gov

Re: **Proposed Amendments to Water Quality Standards for Surface Waters of the State of Washington**

Dear Ms. Conklin:

Please accept these comments from Northwest Environmental Advocates ("NWEA"). We hereby incorporate by reference and attachment the full comments NWEA submitted to Ecology on March 23, 2015 to the extent that they remain applicable given changes in U.S. Environmental Protection Agency ("EPA") regulations and changes in Ecology's proposed rule language.

We noted at the outset that the first attempted rulemaking—that linked a higher risk of cancer to a sought-after legislative effort to reduce toxics—was based on an odd and false premise, namely that an attempt to reduce pollution from currently un- or under-regulated sources should be linked to less protection for human health and less stringent regulation of currently-regulated sources. While we agree with Governor Inslee's underlying point—that new criteria do not necessarily result in any pollution reductions absent an effort to control pollution by regulatory agencies—many of the approaches to real implementation of pollution controls already exist if Ecology, and other state agencies, have the political will to put them to use. Therefore, we consider Ecology's approach of ignoring real implementation tools for non-NPDES sources to be a major gap in its multi-year effort to partially update the water quality standards. This is certainly highlighted by Ecology's keen interest in calling exemptions for NPDES sources "implementation tools" when they are more correctly referred to as non-implementation tools. Frankly our view is that if Ecology chooses not to improve its regulation of un- and under-regulated sources, it should double its efforts to properly and fully regulate those sources that it currently is compelled to regulate under the Clean Water Act. Anything less is a violation of the federal statute, *see e.g.*, 40 C.F.R. § 122.44(d)(1)(ii), and will render Ecology's overall efforts to protect water quality inadequate.

Non-Priority Pollutants

Ecology asserts that its proposal to not adopt numeric criteria for any non-priority pollutants at this time is based on the fact that:

> Ecology will use a narrative statement to protect designated uses from effects of

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> chemicals that do not have numeric criteria. If monitoring or other information indicates that non-priority pollutant sources or concentrations are a concern, Ecology will use the narrative statement to protect designated uses from regulated sources. The ongoing triennial review process for the water quality standards will be used to determine whether there is a need to adopt numeric criteria for additional pollutants in future revisions to the water quality standards.[1]

This is disingenuous in the extreme. As Ecology is well aware, its staff ignores its narrative criteria in nearly all regulatory actions, regardless of their legal status as water quality standards. Therefore suggesting that Ecology will actually be using its narratives is simply misleading. Obviously this statement of Ecology's begs the question of how Ecology will determine that sources or concentrations are " a concern," and where the monitoring data will come from if Ecology doesn't have numeric criteria to prompt either data collection or concern. Nor does Ecology explain to the public it represents how it will determine the need for such criteria in future rule revisions. We have no doubt that Ecology simply intends to regulate as few pollutants as possible.

Equation Variables for Priority Pollutants

NWEA fully supports the use of the 175 grams/day fish consumption rate and the one-in-a-million cancer rate. The earlier proposal to adopt the first and then moot its effects on protecting public health by adopting a higher cancer rate was a cynical ploy best abandoned and not worthy of Ecology.

However, we strongly oppose Ecology's 'thinking on its own' with regard to the relative source contribution ("RSC"). As explained by the agency,

> An inherent assumption in how the RSC for HHC is developed is that all other sources of the contaminant are required to be accounted for in the exposure scenario, and the HHC get the remainder of the reference dose or allowable daily exposure that is assumed to come from sources under the authority of the Clean Water Act. The resulting situation seems contradictory: as the contribution of a contaminant from water sources becomes smaller, the HHC becomes more stringent and in effect becomes a larger driver for more restrictive limits.[2]

We do not see the EPA approach to be contradictory in the least. By focusing on the water pollution sources that are controlled under the Clean Water Act, this approach ensures that the mere fact that people are being exposed otherwise is not used to avoid their full protection. Ecology just does not like the use of the RSC in this fashion because it increases regulation of its pollution sources and Ecology views its job as protecting these polluters from the ravages of the public good known as the Clean Water Act. The agency's failure to update these criteria over many years, the cynical ploys embodied in its first approach to rulemaking, and its failure to use the water quality standards and other authorities to actually clean up pollution over many decades all point to its fundamental misunderstanding of its role. Its first obligation is to the

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1 WAC 173-201A Decision Document at 11.

2 *Id.* at 25.

public and the environment, not to the polluters.

As far as its other excuses, first, the Safe Drinking Water Act ("SDWA"), cited by Ecology as an example of when one can factor in the cost of treatment, addresses a beneficial use that can be protected by treatment, so there is a connection between the two, unlike water quality in a stream. Second, the decision to allow such factors to be taken into account was established by Congress, not the EPA and not Ecology. Third, it is unclear why Ecology thinks that what it terms "direct regulatory levels that are enforced" is wrong as a method of protecting human health other than it undermines Ecology's protectiveness of entities that pollute public waters and jeopardize the health of fish and water consumers. Moreover, given Ecology's poor regulation of these pollution sources and its employment of mixing zones as a method of undercutting the so-called "direct regulatory levels that are enforced" it is unclear what Ecology is complaining about.

Finally, Ecology is not limited to the authorities of the Clean Water Act to clean up water pollution from other than NPDES-regulated sources, as it implies.[3] Ecology has plenty of authority granted to it by state water pollution laws. Moreover, to imply that atmospheric deposition is not under Ecology's control is misleading. See, for example, the Willamette River TMDL developed by the Oregon Department of Ecology.[4] While it is not actually a TMDL in that it does not contain certain legally-required elements of a TMDL, it does contain an evaluation of mercury sources to this major river basin. For example, it concludes that 41.8 percent of the total mercury load to the basin is from "runoff of atmospherically deposited mercury [to land]" and 47.8 percent is from "erosion of mercury containing [native] soils." Together the runoff and erosion result in nearly 90 percent of the total mercury loading to the mainstem Willamette River. Runoff and erosion are, as Ecology is well aware, sources of pollution that can be controlled by state legal authorities. This example demonstrates why Ecology's whining about the limitations of the Clean Water Act as a basis for not properly establishing its water quality standards rings hollow.

So-Called "Challenging Chemicals"

Ecology proposes to adopt the same PCB criteria as the National Toxics Rule ("NTR"), to adopt the SDWA maximum contaminant level ("MCL") for arsenic, and to not update its mercury criteria. These are "challenging" precisely because they are some of the biggest threats to public health, the reason that they should be fully and properly limited. For example, it should be noted that when EPA conducted a risk assessment for Columbia River tribes's fish consumption, it concluded:

> For both resident and anadromous species, the major contributors to the hazard indices were <u>PCBs</u> (Aroclors) and <u>mercury</u>. DDT and its structural analogs were also important contributors for some resident species. The chemicals and or chemical classes that contributed the most to cancer risk for most of the resident

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[3] *Id*. at 26 ("Given the limited ability of the Clean Water Act to control sources outside its jurisdiction . . .")

[4] Oregon DEQ, *Willamette Basin TMDL: Mercury* (September 2006), *available at* http://www. deq.state.or.us/WQ/TMDLs/docs/willamettebasin/willamette/chpt3mercury.pdf.

> fish were PCBs (Aroclors and dioxin-like PCBs), chlorinated dioxins and furans, and a limited number of pesticides. For most of the anadromous fish, the chemicals that contributed the most to cancer risk were PCBs (Aroclors and dioxin-like PCBs), chlorinated dioxins and furans, and arsenic.[5]

These conclusions make Ecology's choices particularly questionable.

For PCBs, Ecology's proposal is to continue to regulate this pollutant on the basis of standards that are over a decade and a half old and to completely ignore the facts on fish consumption. After explaining how PCBs are—like most toxics—difficult to measure, control, and clean up, Ecology engages in a twisted manipulation designed to produce an outcome that is identical to the currently-applicable criteria. Clearly this risk level did not come out of thin air; it was identified through back-calculation to produce the end result. As such it does not represent a sound evaluation of the policy choices but, instead, the lengths to which Ecology will go to maintain the status quo.

With regard to arsenic, Ecology states that the use of the SDWA MCL is "based on scientific information." It is not. The MCL, as Ecology itself admits, factors in the cost of treatment, not allowed under the Clean Water Act. The fact that EPA has—contrary to its own guidance[6] —approved other states' standards' using the MCL is no reason to do so. As Ecology is no doubt aware, NWEA has sued EPA for approving Idaho's use of the MCL.[7]

What is really pathetic in Ecology's proposal is its so-called "pollution minimization requirements." In our earlier comments, perhaps we were too subtle about what was wrong here:

> We are concerned, however, that the way that Ecology has drafted this language will be treated by EPA as not a water quality standard because it is written as a rule that affects dischargers. In addition, while Oregon's rule focused exclusively on waters used for domestic water supply that was because Oregon had up to that point publicly and incorrectly claimed that arsenic was only a human health concern when consumed as drinking water, not as contaminated fish, Ecology has no such justification. Specifically, Ecology has not misled the public into thinking that only drinking water is a concern so why is Ecology restricting the discharge of arsenic from direct and indirect industrial sources to only waters because of that designated use. This is nonsensical. If Ecology is going to copy Oregon, it

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5 EPA, *Columbia River Basin Fish Contaminant Survey 1996-1998*, EPA 910-R-02-006 at E-7, *available at* https://www.epa.gov/sites/production/files/documents/columbia_fish_contaminant_survey_1996-1998.pdf (emphasis added).

6 EPA, Notice of Availability of Water Quality Criteria Documents, 45 Fed. Reg. 79,318, 79,320 (Nov. 28, 1980); EPA Memorandum from Martha G. Prothro to Water Management Division Directors, Regions I-X, Re: Compliance with CWA Section 303(c)(2)(B) (June 19, 1989); EPA, Revisions to the Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health, 65 Fed. Reg. 66,444 (Nov. 3, 2000).

7 *Nw. Envtl Advocates v. EPA,* Case No. 3:15-cv-01151-HZ.

should at least understand what it's doing.[8]

Specifically, when the narrative language was drafted as part of the advisory committee process in Oregon, the Oregon Department of Environmental Quality ("DEQ") had been consistently asserting that arsenic was only a concern in drinking water, not in fish consumption. This assertion was not true. However, it was the basis for Oregon's including the narrative because the narrative was intended to guard against the unintended consequence of setting the arsenic criteria high in order to avoid regulatory consequences (e.g., widespread 303(d) listings and the need for TMDLs). The unintended consequences were, specifically, the possibility, if not the likelihood, that the high criteria would result in a failure by the state to regulate anthropogenic arsenic sources. In other words, to prevent throwing out the baby (anthropogenic sources of arsenic) with the bath water (accommodations for much arsenic being of natural origin), the language was added to ensure that the baby remained regulated even whilst being below the numeric criteria because arsenic is dangerous to public health.

After the language was agreed to, Oregon DEQ went out to public comment. It was during the comment period that NWEA discovered that Oregon DEQ had, as we say in polite terms, misled the advisory committee. As a result of this, Oregon DEQ was forced to withdraw the proposed rule and try again. Bizarrely, although its next proposal was based on a reversal of its position that fish contaminated with arsenic posed no public health threat, it retained the narrow drinking-water-only narrative that had been negotiated while the advisory committee was still active and being told that only drinking water posed a threat. The language was then, and remains now, utterly illogical as a solution to the baby-in-the-bath-water problem described above. It certainly is no solution to the problem of high arsenic levels in fish tissue caused by anthropogenic sources of arsenic.

Here, Ecology has not engaged in the utter fiction that arsenic is not dangerous to consumers of fish (aside from its unwillingness to adopt protective arsenic criteria). Therefore it is, as we said before, nonsensical for it to adopt some narrative protections that are focused solely on drinking water protection. Sometimes it makes sense to copy someone else, such as when they do something smart. When they do something that is patently idiotic—as Oregon DEQ did with the arsenic narrative—it makes no sense at all to copy. If it were a test, Ecology would flunk because it copied the results of the dumbest person in the class.

Please tell us this: On what basis has Ecology limited the AKART requirement from any direct or indirect industrial discharge to surface waters that is adding arsenic to only waters that are designated for domestic water supply?

With regard to mercury, Ecology's regulatory cowardice is demonstrated in full form, which is really all that needs to be said.

So-Called "Implementation Tools"

Please see our previously submitted comments which we incorporate by reference and

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[8] Letter from Nina Bell, NWEA, to Cheryl Niemi, Ecology Re: Chapter 173-201A WAC, Water Quality Standards for Surface Waters of the State of Washington (March 23, 2015) at 4 (emphasis added).

attachment to these comments. In addition we note:

- The proposed definition of "compliance schedule" should reference the federal regulations.
- In proposed WAC 173-201A-420(6)(c) it is unclear why Ecology is including "unpermitted dischargers" as being covered by a variance. There is no need for the variance to apply to any pollution source without an NPDES permit and, in fact, applying the variance to unpermitted dischargers could well undermine the ability of Ecology to take the actions necessary to achieving water quality that does not require a variance.
- In proposed WAC 173-201A-420(7) for monitoring and reporting requirements, language should be included that requires the monitoring be sufficient to ensure the usefulness of the mandatory interim review in (8). Otherwise the requirements of both (7) and (8) are pointless.

Sincerely,

Nina Bell
Executive Director

Attachments:

Letter from Nina Bell, NWEA, to Cheryl Niemi, Ecology Re: Chapter 173-201A WAC, Water Quality Standards for Surface Waters of the State of Washington (March 23, 2015)

Oregon DEQ, Willamette Basin TMDL: Mercury (September 2006)

EPA, Columbia River Basin Fish Contaminant Survey 1996-1998, EPA 910-R-02-006

Nw. Envtl Advocates v. EPA, Case No. 3:15-cv-01151-HZ

EPA Memorandum from Martha G. Prothro to Water Management Division Directors, Regions I-X, Re: Compliance with CWA Section 303(c)(2)(B) (June 19, 1989)

NORTHWEST ENVIRONMENTAL ADVOCATES

March 23, 2015

Cheryl Niemi
Water Quality Program
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600 *via email only*: swqs@ecy.wa.gov

Re: **Chapter 173-201A WAC, Water Quality Standards for Surface Waters of the State of Washington**

Dear Ms. Niemi:

Washington's proposed changes to its water quality standards are a huge disappointment and represent an overall decrease in protection for public health and protection of the environment due to the emphasis on so-called "implementation tools," which are not tools for implementing but, rather, tools for *not* implementing Washington's new toxic criteria. Ecology's use of this doublespeak— copied from Oregon— makes a mockery of the agency's huge emphasis on the public process behind this proposal.

I. New Human Health Numeric Criteria

It has been and remains disheartening in the extreme to see Ecology increase the fish consumption rate and increase the cancer risk rate at the same time so as to placate polluters. That is the long and short of what Ecology has done. In this context it is difficult to stand up and cheer because Ecology managed to move the state into the *last century*, namely from 6.5 grams per day of fish consumption to 17.5 grams/day, once one takes the change in cancer risk rate into account. There is no justification for this increase in cancer risk rate; instead, it is a blatant give-away to those who pollute, at the cost of protecting those who do not pollute but merely seek to use the public waters that Ecology is charged with protecting.

A. Narrative Revisions

Proposed WAC 173-201A-240(4) is unclear. Is this language the equivalent of saying that where Washington has not explicitly adopted numeric criteria consistent with EPA's recommended 302(a) criteria that it does so by reference, along with "other relevant information as appropriate"? If so, it would improve the rule to make that explicit. "Concentrations ... shall be determined" is unclear. Likewise, subsection (3) is not entirely clear. Does it mean that where EPA has revised a 304(a) recommended criterion that the new revision "shall be used in the use and interpretation of the [numeric] values" in these standards? Or does it pertain to only those criteria documents that exist at the time Ecology adopts the numeric criteria?

We believe that the units of measurement would be more appropriately located with the tables

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rather than in WAC 173-201A-240(5). The language in WAC 173-201A-240(5)(a) is inconsistent with the Clean Water Act. The Act requires that "[w]henever a State reviews water quality standards, ... such State *shall adopt criteria for all toxic pollutants listed pursuant to section 1317(a)(1) of this title for which criteria have been published* under section 1314(a) of this title[.]" CWA § 303(c)(2)(B). Ecology's rule states that the department "may revise ... as needed," which is contrary to the clear language of the statute. "As needed" should be defined by, *inter alia*, EPA's revisions of recommended criteria, in which case the correct word would be "shall," not "may." In addition, there is a tension between the language of subsection (5)(a), "[t]he department shall formally adopt any appropriate revised criteria as part of this chapter" and the language in subsection (4), which states that Ecology's toxic criteria are "determined in consideration of USEPA Quality Criteria for Water," a determination that takes place outside the formal adoption of numeric criteria through rulemaking. In fact, it is not the least bit obvious why a procedural rule about adopting criteria has been placed within the standards and criteria section itself, particularly when it is not consistent with the Clean Water Act.

Proposed WAC 173-201A-240(5)(b) is consistent with the requirements of 40 C.F.R. § 131.10(b) that requires protection of downstream waters. It is not, however, as clear as it could be. In June 2014, EPA issued guidance on how states could clarify the downstream protection afforded by their standards. *See* EPA, Protection of Downstream Waters in Water Quality Standards: Frequently Asked Questions, EPA-820-F-14-001 (June 2014). In this guidance, EPA urges states to take a number of actions whilst revising their standards in order to clarify how downstream protection provisions will work. Without reiterating the content of that guidance, suffice it to say that Ecology has ignored it completely. One improvement that is obvious is making more explicit the proposed language in subsection (5)(b) that Washington's numeric criteria "shall maintain a level of water quality when entering downstream waters that provides for the attainment and maintenance of the water quality standards of those downstream waters, including the waters of another state." Specifically, the waters of another state are Oregon's, which has far more stringent criteria for the protection of human health from pollutants, many of which are bioaccumulative and persistent. The rule should state which waters in Washington must meet Oregon's more stringent human health criteria.

In addition, this language has been added to the human health narrative but does not currently exist in the aquatic life criteria narrative, which could suggest to many readers that the distinction is intended. Presumably it is not, as that would be contrary to the federal statute and regulations. It is true that WAC 173-201A-260(3)(b) states that "[u]pstream actions must be conducted in manners that meet downstream water body criteria," and that that language applies to all criteria. However, that language is limited, among other ways, to criteria rather than standards. Federal regulations require protection of downstream standards, including designated uses, criteria, and antidegradation requirements. Because this provision is wholly inadequate, subsection (5)(a) should be amended to include protection for downstream standards for the protection of aquatic life. In addition, as discussed immediately above, Ecology should make explicit that Oregon's far more up-to-date aquatic life criteria must be met by pollution sources upstream in Washington State and should clarify specifically which waters.

Bizarrely, Ecology includes a statement in subsection (5)(b) that the human health criteria are calculated on the basis of 175 grams/day of fish consumption but fails to state that these new criteria are also based on a cancer risk rate of one in 100,000. If basic information is going to be included in the rules, Ecology should include all of it, not just the parts that make it look as if it's being protective of the human health of its citizens. Instead current subsection (6) that establishes that fact has been deleted, not moved. While this piece of information may reside in a small-print footnote, it is not clear why Ecology would bury that, whilst including the fish consumption rate in the text.

B. Numeric Criteria for the Protection of Human Health

Ecology has chosen to use variables in deriving its human health criteria that are intended to the maximum extent possible to keep toxic levels in Washington's waters high. One key example is its use of the relative source contribution (RSC), where Ecology proposes to continue to use a RSC of 1 despite EPA's recommendation that states should take into account the fact that toxic contamination ingested by the public comes from more than just fish or fish and water. Ecology discusses EPA's recommendations, summarized as follows:

> In the simplest terms, EPA's latest RSC guidance recommends two conservative default approaches:
>
> - If sources of exposure to a chemical are not known, then a default RSC of 0.2 is included in the equation.
> - If sources of exposure to a chemical are well known and documented, then a calculated RSC is included in the equation. This calculated RSC gives the HHC the remainder of the reference dose or allowable daily exposure that is not accounted for by other non-CWA sources. EPA guidance suggests that the RSC value cannot be greater than 0.8.

Ecology, Washington State Water Quality Standards: Human health criteria and implementation tools: Overview of key decisions in rule amendment (Jan. 2015) at 22. Nonetheless, Ecology explains how its criteria would be more protective of public health if it followed EPA's recommendations and then proceeds to state that it is a "prudent decision" to reject the federal view. *Id.* at 23. It justifies this entirely arbitrary and important decision in literally one sentence: "Because the geographic and regulatory scope of the CWA addresses contaminant discharge directly to waters of the state (not other sources or areas), Ecology is making a risk management decision that this draft rule continue to use a relative source contribution of one (RSC = 1)." In other words it does not explain its decision but merely tags it a "risk management decision," as if that alone insulates its choice from the need to provide a "sound scientific rationale." 40 C.F.R. § 131.11(a)(1). Instead its rationale is a muddle of such observations that the Safe Drinking Water act allows cost considerations to provide less protection.

C. Arsenic

Washington's proposed arsenic criteria of 10 µg/l is based on the maximum contaminant level (MCL) developed pursuant to the Safe Drinking Water Act. The SDWA allows for the consideration of treatment costs in establishing MCLs. In contrast, the CWA does not. Federal regulations do not mention that cost may be a factor in setting water quality criteria. Instead, water quality criteria "must be based on sound scientific rationale" and "support the most sensitive use." 40 C.F.R. § 131.11(a)(1). Criteria for toxic pollutants must be "sufficient to protect the designated use." *Id*. at 131.11(2). Ecology's proposed use of the SDWA MCL does not meet requirements of the Clean Water Act. Moreover, Ecology's choice to use such an unprotective criterion flies in the face of EPA studies demonstrating that arsenic is a major contributor to the human health risk of tribal fish consumers.

We are pleased to see that Ecology has proposed language to address arsenic discharges from industrial sources, both direct and indirect, as Northwest Environmental Advocates was instrumental in obtaining some similar, albeit not entirely useful, language in the Oregon rules. We are concerned, however, that the way that Ecology has drafted this language will be treated by EPA as not a water quality standard because it is written as a rule that affects dischargers. In addition, while Oregon's rule focused exclusively on waters used for domestic water supply that was *because Oregon had up to that point publicly and incorrectly* claimed that arsenic was only a human health concern when consumed as drinking water, not as contaminated fish, Ecology has no such justification. Specifically, Ecology has not misled the public into thinking that only drinking water is a concern so why is Ecology restricting the discharge of arsenic from direct and indirect industrial sources to only waters because of that designated use. This is nonsensical. If Ecology is going to copy Oregon, it should at least understand what it's doing.

D. Methylmercury

Washington also copied Oregon in not acting to revise its water quality criteria for the protection of human health from mercury. While Oregon did that when it revised its aquatic life criteria but explicitly left out mercury so as to avoid promulgating standards for a pollutant known to have effects on species protected under the Endangered Species Act, Washington is now proposing to do that for mercury and human health. Ecology takes this approach notwithstanding the fact that EPA has provided significant guidance to states on adopting its new 304(a) recommended methylmercury criterion and that states have managed to revise their standards based on EPA's recommended criteria. As with arsenic and PCBs, discussed immediately below, mercury is a driver in the public health risk associated with consuming fish which apparently is a rationale for Ecology's inaction. Not only is this illogical unless Ecology is seeking to protect polluters but it is contrary to the Clean Water Act, as discussed below.

E. PCBs

Washington copied Oregon once again in its proposal for PCBs by using pollutant-specific random numbers to get the results it wanted. While applying its "policy overlay" rule of thumb to ensure that many pollutants' criteria would not become less protective than the NTR to pollutants that are likely not often found to impair waters and therefore unlikely to be controlled in NPDES permits, for PCBs, which are a known problem for dischargers, Ecology cooked up a different method to set its criteria. This is precisely what Oregon did when it used a higher cancer risk rate solely for arsenic. This approach is very obviously just monkeying around with the equations to get the results the states want so that regulation of those pollutants will be at a minimum. Here, Ecology created a cancer risk rate of 4 in 100,000 in order to establish a standard that was no change from the current unprotective PCB criteria for Washington.

II. <u>So-Called Implementation Tools</u>

As stated above, none of these so-called implementation tools has anything to do with implementing Washington's new and revised criteria; to the contrary, it's all about not implementing them. In our opinion, these provisions are poorly written and provide very little assurance that the regulatory relief they will provide polluters will be as minimal as possible, which should be their goal.

A. Variances

It is unclear why Ecology cannot manage to revise certain key criteria— e.g., for the major drivers of public health impacts of pollution—nor can it manage to update its ancient aquatic life criteria—see discussion below—but it can manage to revise its variance rules to apply to all pollutants and all criteria. Not only does it do that but it asserts that in some cases Ecology may adopt the variances itself, "on its own initiative," without application by specific pollution sources. In other words, Ecology is rushing to embrace the idea that after all of its efforts it is willing to go even further out of its way to ensure that the Clean Water Act doesn't stop any polluters from contributing to Washington's toxic waters. This it calls an "implementation tool."

The variance procedure outlined in the proposed rule is extremely thin on both content and process. There are, for example, quite a few key concepts, such as "reasonable progress," that are completely undefined. After all these years working on this proposed rule, there is nothing in the rule that defines the specific findings that Ecology will make. There is nothing that will help the public or Ecology determine when a variance is more appropriate than a compliance schedule or when a variance should be used to lead up to a compliance schedule. In our opinion, this effort is just slipshod.

Proposed WAC 173-201A-420(1)(a) says that a variance may be considered where the "attainable use cannot be reliably determined." It is unclear what Ecology means by this statement. Why does the rule not explain what that means? And why does it not establish that the only issue is not attainability but whether the use is an existing use protected under Tier I of the antidegradation policy? Where will Ecology draw the line between an attainable use that can be or cannot be "reliably determined"? With any use there are always a myriad questions about precisely what, when, where. As a matter of policy, Ecology should establish that its use designations mean something. Yet this language opens the door for variances based on questions about science that plague every undertaking and implies that Ecology will be handing variances out like cookies.

Given that the federal regulations do not specifically cite to variances, although we agree they pertain to variances, merely citing the federal regulations is not particularly helpful. Worse, the basis for maintaining a variance and obtaining a variance renewal is "reasonable progress" which is not defined anywhere. If, in fact, reasonable progress must be made during the variance period, as required by proposed subsection (1)(d), that implies that if reasonable progress is not being made, Ecology will withdraw the variance. The only problem is that the rules do not contemplate such an action. While Ecology has included a "mandatory interim review" every five years in proposed subjection (8), there is no requirement to obtain data to ensure that the review has enough information with which to make findings and specifically whether it will have any information to determine whether the polluters covered by the variance will have made any reasonable progress. Without requiring the collection of data, both aspects of this rule will fail to be anything than an empty and meaningless exercise in bureaucracy. Will the variance itself establish how to measure "reasonable progress," so that the polluters and the public know what to hold polluters to at the time of the interim review? If not, how is anybody to determine that variances are not merely methods of maintaining the status quo of unsafe pollution levels? How will Ecology make a determination that a variance can be renewed under subsection (8)(e) that is other than an entirely arbitrary, and likely political, finding?

Proposed WAC 173-201A-420 is unclear on what a variance is varying from. It starts in subsection (1) discussing criteria, notes that it applies to specific parameters in subsection (1)(b), but talks about variances to "standards" in subsection (2) and "uses and parameters-specific change[s] to the standard(s)." Changing the criteria on a purportedly temporary basis is one thing but in subsection (2) Ecology is talking about changing the designated uses as well. Yet Ecology makes no mention of the requirements of 40 C.F.R. §§ 131.10(g) and (h)(1) which prohibit the removal of a designated use that is an existing use. Not only should this prohibition be made explicit if Ecology is going to include language in its variance rule about removing designated uses, it must provide a meaningful process by which existing uses will be identified. The rest of the rule, including for example subsection (6) regarding the required contents of a variance, is completely silent on the matter of existing uses. There is no discussion in the rules about how Ecology will determine existing uses considering that it requires looking backwards in time to 1975. There are certainly no assurances that Ecology will take this federal requirement seriously. There are multiple references to designated uses in the variance section; we have not cited them all but our comments apply to all of them.

Subsection (3)(b) refers to the feasibility of attainment without establishing how Ecology will make that determination. This rule merely states that "one or more of the conditions found in 10 C.F.R. 131.10" can be the basis, presumably in reference to 40 C.F.R. § 131.10(g)(1)-(6). But that statement does not illuminate Washington citizenry with regard to how Ecology will make feasibility findings. For example, with regard to attainability, 40 C.F.R. 131.10(d) states that uses are attainable if they can be achieved through effluent limits issued pursuant to CWA § 301(b) and "reasonable best management practices for nonpoint source control." This does not explain how Ecology will determine what nonpoint BMPs are "reasonable" and which ones are not reasonable. The rules do not explain how long variances can continue on the basis of purported infeasibility when uses are, actually, attainable. At what point in time does the exception become the rule? There is no guidance established in Ecology's variance rule on how it will determine the length of time for variances. There is no guidance on how Ecology will determine that treatment options are not economically feasible or to what degree Ecology will check the assertions made by polluters that treatment options are not technically feasible.

Subsection (3)(d) refers to "[s]ufficient water quality data and analyses to characterize receiving water and discharge water pollutant concentrations," but leaves much—too much—to the imagination. What is "sufficient" other than in the mind of beholder? How will Ecology determine was is sufficient? How does this sufficiency finding pertain to the designated and existing uses, the criteria, the quality of the discharge, seasonal variability, other sources of the same pollutant, the effect of multiple pollutants, downstream effects, downstream uses affected by sources found far upstream, bioaccumulation that can only be measured in tissue or lipid bags, sediment deposition, quantitation limits, etc.? There are a myriad of issues that relate to the sufficiency of gathered data and nothing in these rules gives the least bit of a hint as to how Ecology will address any of them. In addition, it is wholly unclear what Ecology means by the sufficiency of "analyses" that are required in this proposed rule. Or what it means by "receiving water" and if that is incorrectly limited to the immediate area of a given discharge. And how sufficiency is or is not tied to determinations of reasonable potential.

Proposed subsection (3)(e) refers to the submission of "a schedule for the development and implementation of a pollutant minimization plan," which itself is a multi-part process: (1) a schedule (2) to develop a plan and (3) to implement a plan. Why is the plan development not part of the submission of the variance proposal? Why is there a delay in offering up what little a polluter is going to do during the variance if approved? Why does the public not get to see that plan when it is commenting on the variance proposal and why does EPA not see it when it is determining whether the variance should be approved as a temporary change to standards? Why is the schedule of implementation of the plan not before both the public and EPA?

Proposed subsection (4)(a) does not explain how its consultation process with downstream states will ensure that the result of a variance is consistent with the requirements of 40 C.F.R. 131.10(b), which requires that a state's standards "provide for the attainment and maintenance of the water quality standards of downstream waters." Simply consulting is not the same as compliance with basic standards-setting rules.

Proposed subsection (5) purports to establish the period during which the variance would be in effect but instead, says nothing other than it is "temporary," and that it will be for the "minimum time estimated to meet the original standard." This says nothing about how Ecology will determine what this minimum time will be or even whether Ecology, rather than the polluters, will propose the minimum time period. For example, if the basis is the economic difficulties associated with using treatment to meet the standard, on what basis will Ecology determine those economic difficulties will cease? Providing no cap whatsoever on the length of a variance is inconsistent with the statute and EPA regulations and guidance.

EPA has consistently defined variances as lasting for three years, sometimes up to five.[1] Where it has allowed variances to exceed three years, EPA has not allowed them to be longer than five years.[2] Where a variance is allowed to go beyond three years, a three-year review from the date of the last triennial review submission to EPA is required.[3] The reason for this is simple; it

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[1] *See, e.g.*, EPA, Guidance: Coordinating CSO Long Term Planning with Water Quality Standards Reviews, EPA-833-R-01-002, July 31, 2001 [hereinafter "CSO Guidance"] at 34; EPA, Guidance for State Implementation of Water Quality Standards for CWA Section 303(C)(2)(B), December 1988 [hereinafter "Guidance for Implementation"] at 6; EPA, Memorandum from Kenneth M. MacKenthun, EPA Re: Definition of Water Quality Standards Terms, July 3, 1979 [hereinafter "Definition"] at 1; EPA, National Assessment of State Variance Procedures, November 1990 [hereinafter "National Assessment"] at 1; EPA NPDES Permit Writers' Manual, EPA-833-B-96-003, December 1996 at 177. In its Guidance for Implementation, EPA noted that "[w]ithout a short term variance procedure, there is a danger that permits may contain excessively long compliance dates which don't force the attainment of water quality standards." *Id.* at 6. Here EPA is speaking specifically about attainment of standards for toxic contaminants and expressing concern that use of compliance schedules –which are perceived by permittees as more onerous than variances – will allow the passage of too much time before point sources comply with toxic criteria.

[2] *See e.g.*, Great Lakes Initiative [hereinafter "GLI"] Pt. 132, App F, Procedure 2 §B; CSO Guidance at 34.

[3] 40 C.F.R. § 131.20(a); GLI Pt. 132, App F, Procedure 2 §B; CSO Guidance at 34; EPA Water Quality Standards Handbook, 1985 [hereinafter "Handbook"] at 5.3; GLI Supplementary Information Document, EPA-820-B-95-001, March 1995 [hereinafter "GLI SID"] Sec. VIII.B.2.c; Water Quality Standards Regulation Proposed Rule, Advance Notice of Proposed Rulemaking, 63 Fed. Reg. 36741, July 7, 1998 [hereinafter "ANPRM"] at 36759; EPA Memorandum from Patrick Tobin, EPA, to Regional Water Division Directors Re: Three-Year

corresponds to EPA's requirement that water quality standards that do not support the Act's uses must be reviewed every three years.[4] Where five year variances have been allowed, such as the Great Lakes Initiative (GLI) rules, EPA has additionally required a re-opener clause in associated NPDES permits to ensure that the triennial review is meaningful.[5] Likewise, for the same reason, the variance holder should be required to obtain information that can be used in that review, as discussed further in the "reasonable progress" discussion below. So, for example, EPA's policy on conditions of a variance for CSO-affected waters emphasizes the importance of obtaining new information.[6] In a similar vein, the GLI also explicitly notes that a renewal of a variance is subject to all of the same findings and procedures as an original variance.[7] In this way, the GLI rules ensure that more, rather than less, information is the basis upon which any extensions to variances will be allowed.

Here, Ecology proposes no cap, let alone three or five years. It does include a five year review, which it refers to as "mandatory," but as there are no consequences for Ecology's failure to conduct a five-year review, there is nothing mandatory about it. (Clearly the consequences of a failure to conduct such a review should be the automatic sunsetting of the variance.) The review focuses on whether a permittee has been in compliance with the conditions of a variance and also "to evaluate whether the variance is still necessary." How will Ecology define "necessary." This ambiguity should be removed to ensure that the findings—also missing from the review—are consistent with federal regulations and the original premise of the variance.

Ecology also fails to ensure through its proposed rule language that this review will be meaningful. There is nothing to ensure that sufficient data are collected and analyzed to determine if pollutant loads have increased or decreased, any changes in the status and population health of designated uses, nothing at all with regard to threatened and endangered species or candidate or sensitive species, nothing to account for any changes in EPA's recommended criteria for the pollutants at issue that could cast doubt on assumptions made in the issuance of the original variance, etc. In short there is no reason to believe that this review will be anything but an exercise in paperwork, intended to preserve the status quo of pollution in Washington's waters rather than to ensure that new criteria for toxics are met.

Water Quality Standards Reviews, September 6, 1983 [hereinafter "Three-year Reviews"] at 1; EPA Memorandum from Catherine A. Winer to Dale Vodehnal Re: Request for Views on Allowable Duration of Water Quality Standards Variances, January 24, 1992, [hereinafter "Request for Views"] at 2.

[4] "The State shall from time to time, but at least once every three years, hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards. *Any water body segment with water quality standards that do not include the uses specified in 101(a)(2) of the Act shall be re-examined every three years* to determine if any new information has become available." 40 C.F.R. § 131.20(a) (emphasis added).

[5] GLI Pt. 132, App F, Procedure 2 §F.4, GLI SID" Sec. VIII.B.2.c.

[6] CSO Guidance at 34.

[7] GLI Pt. 132, App F, Procedure 2 §H; ANPRM at 36759.

Subsection (8)(a)(i) states that the review "shall be coordinated" with the public process for issuing an NPDES permit. It does not clearly state that the process will also be separate so that members of the public not interested in reviewing the permit, realize that the interim review of the variance is contemplated. It does not address how the timing of the review may not coordinate with the issuance of a new NPDES permit, rendering the word "mandatory" with regard to the review and "shall" with regard to the coordination in conflict.

Subsection (8)(a)(i) does not explain why any variance would be issued that is not being "implemented in a permit." Likewise, the contents of the variance, as subsection(6)(c) includes a "description of the permitted and unpermitted dischargers covered by the variance." Why would Ecology be issuing a variance for an unpermitted discharge? And how is this consistent with the language in subsection (2)(a) and (b), which refer to permitted dischargers? Why does the review process for a waterbody variance include a review of information that would suggest the timeframe for the variance could be shortened but a review of a variance for an individual discharger is not subject to the same evaluation? If there is no review of the timeframe for the variance, what is the point of the review? If in fact the terms of the variance have been made into enforceable permit conditions, those should be directly enforceable and the review of such a variance is rather pointless. Ecology has not articulated a rationale for its curtailed view of the review for an individual discharger variance. Moreover, subsection (8)(c)(ii), which calls for shortening the term of a variance after a review, is not the logical outcome of the process in (8)(a) because that process does not even consider the issue.

Rather than the proposed subsection (7)(c) provision that "allow[s]" Ecology to reopen and modify permits on the basis of the interim review, the rule should include a provision that *requires* Ecology to reopen such permits on this basis. *See, e.g.*, GLI Pt. 132, App F, Procedure 2 §F.4. What it the point of having a mandatory review but no mandatory reopener? Subsection (2)(a) refers to a variance as applying "at the point(s) of compliance for the individual facility." We suggest that this point of compliance should be the end-of-pipe, without a mixing zone. As the variance will be tailor-made for the specific discharger, no mixing zone is needed, and dispensing with the concept of mixing will allow much more clear evaluation of the impacts of the discharge, the pollution reduction results over time, and any revision to the variance over time.

Subsection (3) contains the requirements for submission to obtain a variance. The rule does not, however, contain any requirements pertaining to how Ecology will make a decision whether to issue a variance and what conditions will be included. There is no requirement, for example, for Ecology to make findings, based on the required submissions. Taking one point at random, while the applicant must show that treatment is not technically, economically or otherwise feasible, Ecology is not required to find that treatment is not technically, economically or otherwise feasible in order to issue a variance. This makes no sense at all and leaves the issuance of variances more at the whim of the agency than not. There is no indication of the level of protection that Ecology will seek to provide even when it issues a variance that will allow a level of protection nor normally allowed or desirable for permanent standards. We suggest that the proposed variance rules should include a requirement that the permittee characterize the extent of any increased risk to human health and the environment from granting the variance compared to the underlying water quality standards, *see* GLI Pt. 132, App F, Procedure 2 §C.2.b), and a requirement that the State conclude that such an increased risk is consistent with protection of public health, safety, and welfare, *see* GLI Pt. 132, App F, Procedure 2§C.2.b. These provisions will ensure against the granting of variances that undo what little Ecology has managed to accomplish in these new proposed criteria.

Subsection (6) describes what a variance will include. What it will not include under Ecology's proposal is a replacement criterion, rendering this rule inconsistent with requirements that apply to the establishment of water quality standards. Because a variance is a change to water quality standards, it follows that a criterion cannot simply be removed but must be replaced. In fact, it is contrary to the requirements of sections 301(b)(1)(C) and 402(a)(1) of the CWA to issue a variance to an effluent limit, necessitating the change to the criteria. This is true of both the individual and multiple source variances. For example, in Michigan, EPA settled a lawsuit challenging EPA's approval of a multi-source variance for mercury with an agreement the state would establish the waste load allocations for permit holders on an individual basis. *See Nat'l Wildlife Fed'n v. Johnson*, No. 06-12423 (E.D. Mi. Nov. 30, 2007) (consent decree). Ecology must not only provide for a replacement criterion, it must explain how it will derive replacement criteria where there are multiple polluters covered by one variance and how it will evaluate those criteria during the review process (all sources may not have the same outcome).

Subsection (6) is inconsistent with subsection (2). The first states that variances can pertain to "geographic area[s]" whereas the latter states that variances can pertain to individual sources discharging to individual waters, multiple dischargers to "any water body," and a "stretch of water." It is unclear why the variance need only specify a geographic area. Subsection (6) hints at the notion that there might be "measurable milestones" but does not require any measurable milestones by the use of the word "any," thereby eliminating any assurance that a variance will, in fact, lead to any change in the status quo. A failure to ensure change renders the idea that a variance is a "temporary" change to water quality standards null and void.

This section of the rules is also extremely unclear. It states that "[d]ischargers are required to use adaptive management to fine tune and update actions, schedules, and milestones[.]" First, the milestones may or may not be required, as discussed above, so how can a discharger be required to fine tune and update them? Second, if the variance is not defined to include required steps that constitute "fine tun[ing] and updat[ing]," how can the discharger be "required" to do so? Likewise, the variance does not make mandatory the inclusion of such requirements in any permits that are written to meet a variance. There is no outside body of law that establishes these so-called requirements of subsection (6)(d). Third, what does "adaptive management" mean in this context? Generally, effective adaptive management requires the gathering of information, its analysis, and a decision-making process that is based on the data and analysis. If these steps are not required as part of an NPDES permit that is aimed at meeting a variance, a discharger will not, in fact, be "required to use adaptive management," as this rule claims. Instead, another section of rules must be written to explain what is required in an NPDES permit written to meet a variance and placed in Ecology's permitting rules and cited here. Fourth, the words "fine tune and update" are ambiguous language. Fifth, it is unclear what precise "actions" must be fine tuned and updated. Sixth, what precisely is a discharger's requirement to update "actions, schedules, and milestones," if these items are established by Ecology in the contents of a variance? It is Ecology's job to change a variance, not a discharger's. If a discharger is required to "fine tune and update" some of the provisions of a variance, what is Ecology's job to respond to those fine tunings and updatings? Seventh, what is intended by "required actions and a schedule"? How will Ecology determine what actions to include and what schedule to put them on? The rule provides no guidance to determine how Ecology will establish variances.

We urge that Ecology include a requirement that all conditions related to an approved variance be incorporated into the permit of the applicant seeking the variance. *See*, *e.g.*, GLI Pt. 132, App F, Procedure 2 §G. Subsection (7) of the proposed rules states that Ecology must include "all conditions necessary to implement and enforce an approved variance" but that is inconsistent with its proposed subsection (3)(e) for the reasons explained in the discussion, namely that it allows for the creation of a pollutant minimization plan and a schedule for its implementation to be postponed to an indefinite time. Rendering expectations into requirements is always a good idea and even more so when a permittee is being allowed to discharge pollution at levels that Ecology has already deemed are not protective. Since the subsections of (7) do not include anything related to implementation of that plan it is quite clear that Ecology is poised to consider the plan as outside the permit requirements. Instead, subsection (7) requires only that effluent limits that represent the status quo are required, without any requirement to do anything else on any schedule. That means that the rules will not support public comments on draft permits that propose to ignore the purported requirements of a variance.

Subsection (7) is troubling for other reasons. It allows "effluent limits that are sufficient to meet the original water quality standard upon expiration of the variance" but fails to explain why the establishment of such an effluent condition would not instead be subject to a compliance schedule, the correct tool for any circumstance where a permittee know precisely how and when it can meet the standards. It also states that Ecology may use "achievable effluent conditions" without any explanation of what findings Ecology must make to determine this outcome. Without requiring such findings and simply stating that Ecology may use something that requires work or something that represents the status quo, the likely outcome will be the result that requires no work: the status quo versus the more stringent reductions that are achievable. There is no reason that the rules should avoid setting a hierarchy of outcomes in terms of permit conditions. We agree that monitoring and reporting requirements must be included in the permit conditions but in the absence of anything specific about what level of monitoring is required, this will likely be subject to huge abuse in the negotiated dance engaged in by permit writers and permittees.

We are pleased to see references to nonpoint sources, to the extent that these are included in the phrase "unpermitted dischargers," namely that a variance is defined to include Ecology's revision to "BMP requirements for unpermitted dsichargers" at subsection (6)(e). However, it is unclear to what Ecology refers. Likewise the submission of a request for a variance requires that the entity provide information on both "[a]ll cost-effective and reasonable best management practices for permitted sources that address the pollutant the variance is based upon," and "[b]est management practices for nonpermitted sources that meet the requirements of chapter 90.48 RCW," at proposed subsection (3)(f)(ii) and (iii). If Ecology takes provision (3)(f)(iii) seriously, it will make the variance process significantly more meaningful. However, there is nothing that follows on from subsection (3)(f)(iii) in subsection (6) regarding the actual contents of a variance. There is, instead, merely a "description of ... unpermitted dischargers," and a reference to Ecology's authority to "revise BMP requirements for unpermitted dischargers" as a result of the mandatory review. There is no statement that an initial variance will include BMP requirements for unpermitted dischargers or even a statement of what BMPs Ecology is expecting nonpoint sources to use when it issues the variance and makes assumptions about the impacts of the point sources covered by the variance. There is no clarity that the "nonpermitted sources" described in the application are the same as the "unpermitted dischargers" in the variance itself and, if they are not the same, what an "unpermitted discharge" actually is. In addition, in the mandatory review, the proposed rules state that the review will "be focused" on the discharger's compliance with the variance and there is no reference whatsoever to any other polluters' contributions to the pollution problem. This missing piece seems to suggest that the discussions of unpermitted and nonpermitted sources are merely window dressing and that Ecology intends to take no actions to ensure that pollution sources together negate the ongoing need for a variance.

Ecology has not proposed a rule that is consistent with federal regulations. As temporary changes to water quality standards, variances are issued pursuant to the provisions in EPA's rules that apply to removing or altering use designations. 40 C.F.R. § 131.10. While these designated use removal provisions require the use of "all cost-effective and reasonable nonpoint source controls," *id*. at § 131.10(h)(2), Ecology's rules do not. Yet, EPA has stated repeatedly that variances are subject to the "same substantive and procedural requirements as removing a designated use." Handbook at 5.3; 14 EPA Interim Economic Guidance Workbook, EPA-823-B-95-002; March 1995 [hereinafter "Economic Guidance"] at 1-3; *see also* CSO Guidance at 34. This use provision applies to issuance of a variance as a temporary removal of designated uses governed by the same EPA regulations. ANPRM at 36760. The BMP requirements of 40 C.F.R. §131.10(h)(2) apply to all nonpoint sources in the consideration of a variance application. EPA has supported this position by noting that in issuing variances, the economic impacts that can be considered are only those that result from treatment beyond that required by technology-based regulations. This includes both technology-based limits on point source discharges *as well as BMPs to nonpoint sources*.[8]

In addition, as mentioned above, the proposed Ecology rules do not ensure protection of existing uses, as required. We urge Ecology to note that EPA has written quite a bit about the need to ensure protection of existing uses in the issuance of variances. The requirement to protect existing uses in the issuance of variances derives from several sources. First, existing use protection is the "floor" of water quality, below which State standards may not go. *See* Handbook; EPA Questions & Answers on Antidegradation, August 1985 [hereinafter "Questions and Answers"]; 48 Fed. Reg. 51402 (November 8, 1983). Because variances are changes to water quality standards they too may not go below that floor. This is encoded in the requirement to classify existing uses, 40 C.F.R. § 131.10, as well as the antidegradation provisions to protect those uses, 40 C.F.R. § 131.12, which must be read together. *See* ANPRM at 36752. Existing use protection is specifically noted – twice – in EPA regulations concerning the removal of designated uses, the same provision that is used for variances. 40 C.F.R. §§ 131.10(g) & (h)(1). EPA notes that the protection of existing uses is a site-specific exercise, which is wholly consistent with the issuance of variances. ANPRM at 36752. EPA considers protection of existing uses as essential in issuing variances. *See* CSO Guidance at 34, citing 40 C.F.R. §

[8] Economic Guidance at 1-1. ("This workbook provides guidance for those seeking to . . . obtain a variance based on economic considerations, or to lower water quality in a high-quality water. In addition, it provides guidance to States and EPA regions responsible for reviewing requests for variances and modifications to designated uses, and for approval of antidegradation analyses.

. . .

The economic impacts considered are those that result from treatment beyond that required by technology-based regulations. Since water quality cannot be lower than that resulting from technology-based limits applied to direct and indirect point source discharges and reasonable Best Management Practices (BMP) applied to nonpoint sources, these are considered to be the baseline.")

131.10(h)(1); ANPRM at 36759, 36760. EPA notes that it is the necessity of preserving existing uses, as well as making reasonable progress towards ultimate attainment, that requires the conditions of a variance to be set as close as possible to the designated uses and "always retained at the level needed to preserve the existing use." CSO Guidance at 34. These conditions include various prohibitions, control requirements, monitoring, and evaluation. *Id*. at 35. The requirement to protect existing uses pursuant to the antidegradation policy applies during triennial reviews and water quality standards revisions, of which a variance is one, see Questions and Answers, as well as the issuance of NPDES permits, see Handbook. Last, the six factors of 40 C.F.R. § 131.10(g) cannot be read outside the context of the text of 40 C.F.R. § 131.10(g), of § 131.10(h), and of the antidegradation policy, all of which specify the protection of existing uses. Similarly, the GLI rules explicitly require that in addition to the six factors governing use attainability, the variance seeker show the antidegradation requirements have been met. *See* GLI Pt. 132, App F, Procedure 2 §C.2.a; GLI SID Sec. VIII.B.3.c. Consistent with these policies, EPA has also held that permits issued pursuant to variances must still comply with antidegradation requirements, including existing use protection. Guidance for Implementation at 6. A variance applies to the applicable criterion and does not modify the application of the existing use and designated use provisions of the water quality standard. *See* EPA Memorandum, from Kenneth Mackenthun to Regional WQS Coordinators, Re: Definition of WQS Terms, July 3 1979 at 1.

B. Compliance Schedules

This section is very messy and it is unclear what Ecology is attempting to accomplish with its proposed language. The starting point of compliance schedule rules in state standards should be consistency with the federal regulations yet Ecology's proposal hints at some federal requirements, adopts some portions of the requirements, and ignores some. This simply leaves everybody in the dark as to how Ecology views the intersection between its own proposed rules and binding federal regulations. It also raises questions about what distinctions Ecology is attempting to draw.

The proposed rule includes a definition of "compliance schedule" as follows:

> a schedule of remedial measures included in a permit or an order, including an enforceable sequence of interim requirements (for example, actions, operations, or milestone events) leading to compliance with an effluent limit, other prohibition, or standard.

Proposed WAC 173-201A-020. This definition is not consistent with federal regulations and therefore it is not adequate to support the use of compliance schedules for NPDES permits. *See* 40 C.F.R. § 122.47. We suggest that Ecology not attempt to reinvent the definition of compliance schedules and, instead, follow the federal regulations. For example, a compliance schedule must be a part of an NPDES permit, *id*. at § 122.47(a), and cannot be in an unenforceable "order" (or an order enforceable only by Ecology). (The error is repeated in proposed WAC 173-201A-510(4)(a).) Federal regulations contain specific requirements related to the "sequence of interim requirements," namely that a compliance schedule in excess of one year must include interim requirements and dates for their achievement, *id*. at § 122.47(a)(3), and that the time between interim dates shall not exceed one year, with exceptions, *id*. at 12247(a)(3)(i).

Proposed WAC 173-201A-510(4)(a) introduces unnecessary detail with its addition of (i) and (ii) unless there is something in the universe of aquatic life and everything other than aquatic life that Ecology has in mind to not make subject to compliance schedules.

Proposed WAC 173-201A-510(b)(iv), related to completion of "necessary water quality studies related to implementation of permit requirements," is unclear. If the studies are part of a compliance schedule that leads to compliance with effluent limits it would be consistent with the requirements of WAC 173-201A-510(a) and 40 C.F.R. § 122.47(a). This example, however, does not clearly establish that the compliance schedule for studies will have that result. It appears possible that Ecology might issue a compliance schedule for a study that does not result in compliance with a related effluent limit. In addition, it is unclear how Ecology will identify an effluent limit and a compliance schedule to meet such an effluent limit in the absence of completed studies.

Proposed WAC 173-201A-510(d) implies an extra step in the development of compliance schedules that is not included in federal requirements: "Prior to establishing a schedule of compliance, the department shall require the discharger to evaluate the possibility of achieving water quality standards via nonconstruction changes (e.g., facility operation, pollution prevention)." The rule should be amended to require that Ecology make a finding that is based on that requirement for dischargers and to provide those findings in the required fact sheet for NPDES renewal. Likewise, Ecology's determination that a period longer than the permit term is needed should be in the required fact sheet.

It is unclear why Ecology uses the phrase "as soon as practicable" in subsection (d) as opposed to "as soon as possible" found in subsection (e) and in 40 C.F.R. § 122.47(a)(1). If the word is intended to suggest something less stringent than federal regulations, it is inconsistent and should be changed. If it has no separate meaning, the language should be consistent so as to not imply there is a difference.

The intent of WAC 173-201A-510(e) is unclear. First, what does it mean by "a longer period of time"? The word "longer" must modify something but it is unclear what it is modifying unless it means longer than the day after a revised permit is issued. Second, why are there additional rules that pertain to dischargers discharging to waters subject to a TMDL? And is there something embedded in this subsection that establishes policy differences between compliance schedules to implement effluent limits consistent with wasteload allocations versus other water quality-based effluent limits? Third, what is the purpose of the distinction between WAC 173-201A-510(e)(i) and (e)(iv), the first of which refers to wasteload allocations and the second of which refers to achieving water quality standards. Fourth, is the intent of this to address an NPDES permit prior to renewal when the TMDL is approved prior to that point? If so, it is not clear. Fifth, is there a distinction between subsection (d)'s requirement that a permittee first demonstrate it cannot meet effluent limits (standards) without construction and subsection (e)(i)'s requirement that a permittee cannot meet its wasteload allocation without construction? And why is the demonstration made by the permittee in subsection (d) but made by Ecology in subsection (e)(i)?

Sixth, why is a permittee only entitled to seek a compliance schedule if it has "made significant progress to reduce pollutant loading during the term of the permit"? If the permit in question has no requirements to reduce pollutant loading and the wasteload allocation was not yet in place, it is unclear why a permittee would be penalized for not making reductions. Likewise, it is unclear what Ecology means by stating that a compliance schedule may be authorized if a permittee is "meeting all of its requirements under the TMDL as soon as possible." Proposed WAC 173-201A-510(e)(iii). Generally speaking, the requirements of a TMDL as they apply to point sources are wasteload allocations. If this rule language is intended to ensure that wasteload allocations that are being met pursuant to a compliance schedule are met as soon as possible, it presumably is redundant to the requirement in subsection (d), which requires compliance as soon as practicable. The word "EPA-" should precede the word "approved" to eliminate ambiguity.

As this section is a mess, we urge Ecology to make explicit reference to the federal regulations on the issuance of compliance schedules for NPDES permits.

III. Clean Water Section 303(d) and NPDES Permits

It its narrative, Rule Implementation Plan Water Quality Standards for Surface Waters of the State of Washington; Amendments to Chapter 173-201A WAC (Draft Jan. 2015), Ecology sets out some internal rules for when it will use its new criteria. Some of these observations are simply unlawful. For example, once EPA has formally approved a TMDL to achieve an outdated and less stringent standard, Ecology cannot retain the waterbody in category 4a for completed TMDLs. Instead, those waters must be relisted. In addition, while the chart is silent on the relationship between completed TMDLs' wasteload allocations and new or revised permits, permit writers may not continue to rely on wasteload allocations without reference to the new criteria, once EPA has approved them. In addition, NPDES permits cannot be put out for public comment using no-longer-applicable criteria.

IV. Ecology Proposes to Violate the Clean Water Act

The Clean Water Act requires that "[w]henever a State reviews water quality standards, ... such State *shall adopt criteria for all toxic pollutants listed pursuant to section 1317(a)(1) of this title for which criteria have been published* under section 1314(a) of this title[.]" CWA § 303(c)(2)(B). Ecology is reviewing its water quality standards in this proposed rulemaking yet it is failing entirely to consider, let alone "adopt criteria" for all toxic pollutants for which criteria have been published. Ecology has failed to adopt aquatic life criteria since it first did so on November 25, 1992, with the exception of ammonia, chronic marine copper, and chronic marine cyanide. At a minimum, EPA has revised its recommended criteria for aquatic life for the following pollutants: acrolein, ammonia, arsenic, carbaryl, cadmium, chromium (III), chromium (VI), copper, diazinon, dieldrin, endrein, gamma-BHC (Lindane), mercury, nickel, nonylphenol, parathion, pentachlorophenol, selenium, tributyltin, and zinc. These revised criteria obligate Ecology to update its aquatic life criteria accordingly.

We hereby incorporate the attached Petition for Rulemaking Under the Clean Water Act, Water Quality Criteria for Toxics in the State of Washington.

Sincerely,

Nina Bell
Executive Director

Attachment: NWEA, Petition for Rulemaking Under the Clean Water Act, Water Quality Criteria for Toxics in the State of Washington (Oct. 28, 2013).

CHAPTER 3: WILLAMETTE BASIN MERCURY TMDL

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OVERVIEW

The bioaccumulation of mercury in fish is a well recognized environmental problem throughout much of the United States. The number of states that have issued fish consumption advisories pertaining to mercury has risen steadily from 27 in 1993 to 45 in 2002 (USEPA, 2003). The Oregon Department of Human Services (DHS) has issued multiple fish consumption advisories for mercury in the Willamette Basin (DHS, 1993, 1997a, 1997b, 2001, 2004a, 2004b) advising consumers of fish of the health risks associated with eating fish caught from the Willamette River and the Dorena and Cottage Grove Reservoirs. These fish consumption advisories represent an impairment of the beneficial use of fishing in the Willamette Basin and demonstrate that mercury is bioaccumulating in fish tissue to levels that adversely affect public health. The TMDL for mercury, described below, is designed to restore the beneficial use of fish consumption to the Willamette River and its tributaries.

One of the primary goals of this TMDL is to establish an interim water column guidance value deemed to be protective of the beneficial use of fish consumption in the Willamette Basin. This interim guidance value, when attained, should eventually reduce the concentrations of mercury in fish tissue to levels that no longer pose an unacceptable health risk to consumers of the fish. This TMDL document describes the methodology utilized in establishing the interim water column guidance value as well as the sector-specific load reductions necessary for the eventual attainment of the guidance value concentration. The corresponding Water Quality Management Plan (WQMP) outlines the implementation strategy that will promote mercury reductions throughout the Basin, the eventual attainment of the established water-column guidance values and, ultimately, the restoration of the beneficial use of fish consumption. The goals and objectives of this TMDL are consistent with the requirements of the federal Clean Water Act, Oregon's Administrative Rules, and ODEQ's Mercury Reduction Strategy (ODEQ, 2003a).

ODEQ acknowledges the current limitations to our understanding of the fate, transport, bioaccumulation, loading and sources of mercury in the Willamette Basin. These limitations have the potential to influence the estimates of the loading of mercury in the Willamette system, the sector-specific source contributions, the water column guidance values, as well as the estimated reductions necessary to restore the beneficial use of fish consumption. For this reason, ODEQ is establishing *interim* water column guidance values and sector-specific allocations at this time, based on the collected body of information currently available. The preliminary sector-specific allocations will not be translated into numeric water quality based effluent limits for individual point sources at this time. The interim targets and allocations will be used to define the extent of the problem and to identify the level of effort needed to address the bioaccumulation of mercury in fish. ODEQ intends to require specified domestic and industrial point sources in the Willamette Basin to monitor their effluent for mercury and to submit their data to ODEQ. Mercury minimization plans will also be required from select sources and sectors. These minimization plans will serve as the primary vehicle for implementing mercury reduction activities within the point source sector. Nonpoint sources will also be expected to incorporate mercury concerns into the established mechanisms for TMDL implementation pertaining to agriculture, forestry, and urban land use activities. This incremental approach for the mercury TMDL is warranted due to the assumptions and limitations of the currently available information. ODEQ believes that the interim approach described in this chapter is consistent with State and Federal law and meets the specific requirements of TMDLs as presented in Table 3.1.

ODEQ plans to develop *revised* estimates of the water column guidance values and allocations by 2011. At that time, ODEQ will have the opportunity to translate the revised allocations into water quality based effluent limits for wastewater point sources. In the interim, ODEQ will develop a comprehensive conceptual framework for assessing mercury behavior in the Basin, along with the methodological and modeling tools needed to calibrate and validate this framework. To provide data for this purpose, ODEQ will: (1) conduct three years of water quality monitoring to collect additional information on ambient mercury and methyl mercury concentrations and (2) perform additional source characterization work to help refine the estimates of sector-specific source contributions. ODEQ looks forward to working with stakeholders during the next incremental phase of this effort to obtain the resources and the funding necessary to undertake this work in a timely and efficient manner. The availability of the expanded data set will help reduce uncertainties and enable the development of more refined estimates of the appropriate water column guidance values and sector-specific load and wasteload allocations. ODEQ also commits to the further evaluation of the methodological and modeling tools employed in this study (as presented in detail below). In the event new information suggests improved alternative methods for establishing water column guidance values and/or load allocations, this information will be incorporated into the 2011 revisions as part of the iterative adaptive management framework.

Over the course of the past four years ODEQ has been working with a group of stakeholders to discuss key policy issues related to the development of the mercury TMDL. This group, known as the Willamette River TMDLs Council has met approximately every other month since March, 2001. The sectors and entities represented by this Council include industry, U.S. Army Corps of Engineers (USACE), environmental groups, the Association of Clean Water Agencies, forestry, agriculture, developers, recreational and commercial fishermen, public utilities, and the Tribes. The group was facilitated by an independent facilitator and staffed by ODEQ. Agendas and meeting summaries for this group can be found on ODEQ's website: http://www.deq.state.or.us/wq/willamette/WRBHome.htm . The Council provided valuable input to ODEQ on key issues such as: the use of the food web model to determine interim water column guidance values; the establishment of guidance values in units of total mercury as opposed to methyl mercury; the choice of fish species utilized in the establishment of water column guidance values; the methodology to assess the load and sources of mercury within the Willamette Basin; the determination of data adequacy for the development of interim mercury allocations; and the elaboration of the 'path forward' to address continued monitoring and model development needs. Each of these issues will be discussed in detail within the text of this chapter. Whereas the Council was a valuable sounding board for ODEQ on these key issues, providing much valuable information and reactions, the group did not often reach consensus. The feedback from the group, however, significantly aided ODEQ in reaching complex technical and policy decisions. The TMDL for mercury reflects significant input from Council members and their constituent groups and ODEQ is grateful to members of this group for their participation. The policy decisions outlined in this TMDL, however, do not necessarily represent endorsement by the Willamette River TMDLs Council.

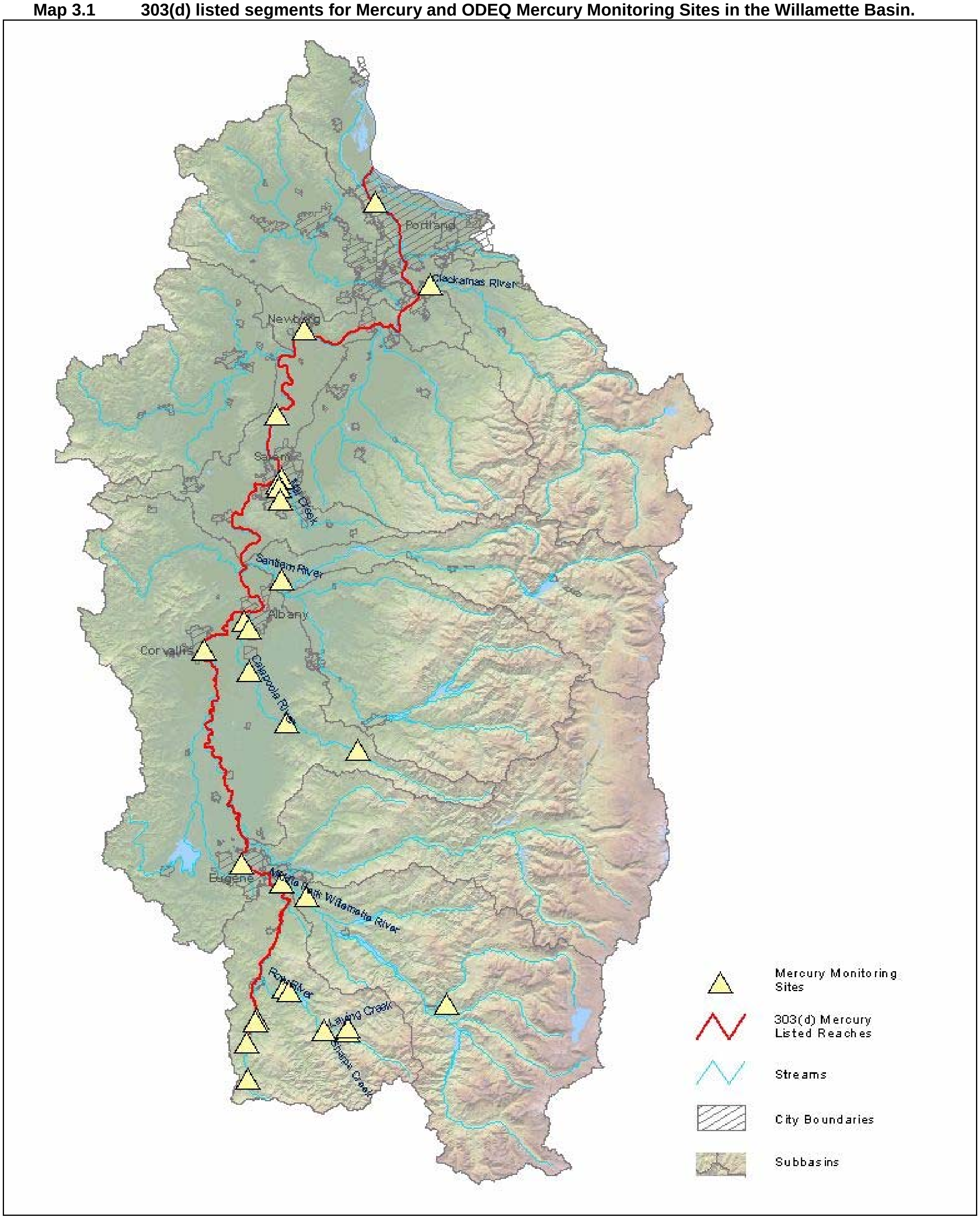
This mercury TMDL is being developed for the entire Willamette Basin which includes the Clackamas, Coast Fork Willamette, Lower Willamette, McKenzie, Middle Fork Willamette, Middle Willamette, Molalla-Pudding, North Santiam, South Santiam, Tualatin, Upper Willamette, and Yamhill Subbasins. The area affected by this TMDL for mercury is different from the area covered by the temperature and bacteria TMDLs. The bacteria and temperature TMDLs presented in this document cover a smaller geographical area since they do not address waterbodies in the Molalla-Pudding, Tualatin, and Yamhill Subbasins.

Table 3. 1 Mercury TMDL Components.

Waterbodies ***OAR 340-042-0040-4(a)***	This TMDL covers all tributaries to the Willamette River Basin (Hydrologic Unit Code (HUC) 170900). Water quality-limited stream segments for mercury include the entire mainstem Willamette River (from the mouth to the confluence of the Middle Fork and Coast Fork Willamette Rivers), the Coast Fork Willamette (HUC 17090002) from the mouth to the Cottage Grove Reservoir, and the Dorena and Cottage Grove Reservoirs (in the Coast Fork Willamette Subbasin).
Pollutant Identification ***OAR 340-042-0040-4(b)***	Anthropogenic increases in instream mercury concentrations.
Beneficial Uses ***OAR 340-042-0040-4(c)*** ***OAR 340-041-0340***	Fishing is one of the designated beneficial uses of the Willamette Basin (as indicated in Table 340A). This TMDL focuses on the restoration of the beneficial use of fish consumption in the Willamette Basin.
Criteria Identification ***CWA §303(d)(1)*** ***OAR 340-042-0040-4(c)***	**OAR 340-041-0340:** Water quality in the Willamette Basin must be managed to protect a range of beneficial uses including fishing. **OAR 340-041-0033:** (1) Toxic substances may not be introduced above natural background levels in waters of the state in amounts, concentrations, or combinations that may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediments or bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare or aquatic life, wildlife, or other designated beneficial uses. (2) Levels of toxic substances in waters of the state may not exceed the applicable criteria listed in Tables 20, 33A, and 33B. Tables 33A and 33B, adopted on May 20, 2004, update Table 20 as described in this section. (a) Each value for criteria in Table 20 is effective until the corresponding value in Tables 33A or 33B becomes effective. (A) Each value in Table 33A is effective on February 15, 2005, unless USEPA has disapproved the value before that date. If a value is subsequently disapproved, any corresponding value in Table 20 becomes effective immediately. Values that are the same in Tables 20 and 33A remain in effect. *[Note that to date, USEPA has neither approved nor disapproved Oregon's revised toxics criteria.]* (B) Each value in Table 33B is effective upon USEPA approval. (b) The department will note the effective date for each value in Tables 20, 33A, and 33B as described in this section. (3) To establish permit or other regulatory limits for toxic substances for which criteria are not included in Tables 20, 33A, or 33B, the department may use the guidance values in Table 33C, public health advisories, and other published scientific literature. The department may also require or conduct bio-assessment studies to monitor the toxicity to aquatic life of complex effluents, other suspected discharges, or chemical substances without numeric criteria.
Existing Sources ***CWA §303(d)(1)*** ***OAR 340-042-0040-4(f)***	Source categories considered in this TMDL include: legacy mines, industrial and municipal point sources, sediment resuspension, native soil erosion, stormwater runoff, and the atmospheric deposition from point, area, mobile and global sources.
Seasonal Variation ***CWA §303(d)(1)*** ***OAR 340-042-0040-4(j)***	There are considerable seasonal variations in the mass loads and concentrations of the various forms of mercury present in the Willamette Basin. Mass loads of total mercury were highest during the winter months due primarily to seasonal variations in flow rate. During high flow events, increases in soil erosion and resuspension of bed sediments combine to produce elevated total mercury concentrations. Concentrations of methyl mercury, on the other hand, were typically lowest during the winter months (at or near method reporting and detection levels) when the total mercury concentrations were highest. Seasonal variations in methyl mercury concentrations are due in part to the influence of temperature, sunlight and other parameters that affect the rate of mercury methylation and demethylation.
TMDL Loading Capacity and Allocations ***40 CFR 130.2(f)*** ***40 CFR 130.2(g)*** ***40 CFR 130.2(h)*** ***OAR 340-042-0040-4(d), 4(e), 4(g), 4(h)***	The interim loading capacity of 94.6 kg/yr represents the total annual load of mercury (as calculated at the mouth of the Willamette River) associated with the water column guidance value concentration deemed to be protective of the beneficial use of fish consumption. The interim loading capacities for the Dorena and Cottage Grove watersheds are 1.46 and 1.01 kg/yr respectively. For the mainstem Willamette River, Wasteload Allocations (WLA) for Point Sources total 3.7 kg/yr and Load Allocations (LA) for Nonpoint Sources total 90.1 kg/yr. There are no significant point sources of mercury above the Dorena and Cottage Grove Reservoirs. For this reason, the LAs for nonpoint sources are equal to the loading capacities of each of the two systems (1.46 and 1.01 kg/yr) for the Dorena and Cottage Grove watersheds, respectively.

Surrogate Measures ***40 CFR 130.2(i)*** ***OAR 340-042-0040-5(b)***	Surrogate measures are developed to translate the point source wasteload allocations and the nonpoint source load allocations into terms of the percent reductions needed to achieve the interim water column guidance value. These surrogate measures effectively translate average annual loads of mercury into more applicable measures of performance. The estimated percent reductions needed to attain the interim water column guidance value are 26.4%, 29.8%, and 67.8% for the mainstem Willamette River system, the Dorena Watershed and the Cottage Grove Watershed, respectively.
Margins of Safety ***CWA §303(d)(1)*** ***OAR 340-042-0040-4(i)***	The Food Web Model employed in this TMDL utilizes a fish tissue criterion of 0.3 mg/kg in establishing an interim water column guidance value. Oregon's fish consumption advisories are issued by the DHS when the average fish tissue concentrations of mercury exceed the threshold of 0.35 mg/kg. The use of 0.3 mg/kg in our analysis, as opposed to 0.35 mg/kg, represents a conservative margin of safety on the order of fifteen percent and is consistent with recently developed guidance from the USEPA. The utilization of the northern pikeminnow in the development of the interim water column guidance value also has an inherent degree of conservatism due to the fact that the northern pikeminnow is the most efficient bioaccumulator of mercury considered in our analysis. It is recognized that this particular fish species is not targeted by commercial fishermen in the Willamette Basin. The northern pikeminnow, however, may be caught and consumed on an occasional basis by recreational and or subsistence fishermen. In selecting a guidance value based on the northern pikeminnow, we have chosen one that would also be protective of the consumers of other fish species found in the Willamette which may be more readily targeted for human consumption.
Reserve Capacity ***OAR 340-042-0040-4(k)***	A small reserve capacity of 0.8 kg/yr (0.6% of the total load) has been incorporated into this TMDL to allow a growing municipality or a new source to discharge effluent containing low levels of mercury. The establishment of this reserve capacity would allow growth and expansion to occur in the Basin. This small allocation set aside as a reserve capacity is warranted due to the significant reductions in mercury loading which have and are currently occurring throughout the Basin and the low likelihood of new future releases.
Water Quality Management Plan **OAR 340-042-0040(4)(l)**	The Water Quality Management Plan (WQMP) provides the framework of management strategies to attain and maintain water quality standards. The WQMP is designed to complement the detailed plans and analyses provided in specific implementation plans. See Chapter 14.

Map 3.1 303(d) listed segments for Mercury and ODEQ Mercury Monitoring Sites in the Willamette Basin.



Mercury in the Environment

Mercury is a naturally occurring element found in cinnabar deposits and areas of geothermal activity. In Oregon, mercury was mined commercially and used extensively in gold and silver amalgamation (Brooks, 1971; Park and Curtis, 1997). Mercury has been used historically in fungicide formulations and can still be found in many commercial products including fluorescent lights, thermometers, automobile switches and dental amalgam. Mercury is also naturally present in trees and fossil fuels such as coal, natural gas, diesel fuel and heating oil. The mercury present in these fuel sources is released into the atmosphere upon combustion. This atmospheric mercury can be transported great distances and is known to be deposited on the landscape via either wet or dry deposition (Sweet *et al*., 1999, 2003).

Mercury can be present in various physical and chemical forms in the environment (Ullrich *et al.,* 2001; USEPA, 2001b). The majority of the mercury found in the environment is in the form of inorganic or elemental mercury but these forms of mercury can be converted to organic or methyl mercury by sulfate-reducing bacteria. Methyl mercury production is affected by a host of physical and chemical factors including temperature, redox potential, dissolved oxygen levels, organic carbon, sediment particle size, alkalinity, sulfate concentration and pH. Methyl mercury, once formed, represents the most bioaccumulative form of mercury in fish tissue and the most toxic form of mercury for human consumers (USEPA, 2001a).

Methyl mercury is a potent neurotoxin that has the potential to cause permanent damage to the brain, kidney, and developing fetus (ATSDR, 1999). Effects on brain functioning may cause irritability, shyness, tremors, changes in vision or hearing and memory problems. Children are known to be more sensitive than adults to mercury intoxication. The mercury present in the mother's body may pass to the fetus and accumulate there. It can also pass to a nursing infant through breast milk. Mercury's harmful effects to children include brain damage, mental retardation, incoordination, blindness, seizures and inability to speak. The primary route of human exposure to mercury is via the consumption of fish or seafood containing elevated levels of mercury (USEPA, 2001a).

Summary of Mercury TMDL Development and Approach

The stated objective of this TMDL is to reduce average fish tissue mercury concentrations in the Willamette River so that the fish are safe for human consumption. The multiple fish consumption advisories for mercury in the Willamette Basin and the numerous 303(d) listings indicate that this beneficial use is not currently being met. ODEQ acknowledges that it may take many years, perhaps even decades, to ultimately achieve the desired reduction in fish tissue concentrations of mercury. In establishing interim water quality guidance values, ODEQ has considered the criteria and thresholds utilized by the DHS when issuing fish consumption advisories. This TMDL analysis is *not* designed to reevaluate the levels of mercury deemed safe for human consumption or to revisit the basic assumptions inherent in DHS's risk assessment analysis for mercury (see Appendix B for a complete description of the methodology employed by DHS when issuing fish consumption advisories pertaining to mercury). The proposed TMDL outlined in this document is also not explicitly structured to address ecological receptors, as the focus of this effort has been on the human health concerns pertaining to the multiple fish consumption advisories. If, at some point in the future, data from the Willamette Basin indicate that other sensitive ecological species are being adversely affected by mercury contamination (leading to additional 303(d) listings), then ODEQ would most likely address this impairment through a future TMDL. The TMDL is also not designed to address the drinking water criterion for mercury as that numeric criterion (0.002 mg/l) has not been exceeded.

ODEQ's approach to the mercury TMDL is based on two fundamental methodological components: a Basin-Specific Aquatic Food Web Biomagnification Model for the Estimation of Mercury Target Levels; and an independent Revised Estimate of a Mercury Mass Balance for the Willamette River Basin. A basin-wide mercury monitoring program was also implemented to support the development of the food web model and to estimate mercury mass loads and sources. The discussion below contains a more detailed technical presentation of the analytical tools utilized in the development of this mercury TMDL.

Food Web Biomagnification Model (FWM)

A basin-specific aquatic Food Web Model (FWM) was employed to establish a range of interim guidance values for total mercury in surface water that are linked to the protection of the beneficial use of fish consumption (see Appendix B). The estimation of target water concentrations requires a biomagnification factor and a fish tissue criterion deemed to be protective of human health. The USEPA recommends that for a particular area of concern, biomagnification factors derived from data collected within the area of study are more preferable than the utilization of standardized default values (USEPA, 2001b). They also suggest inclusion of site-specific considerations when calculating surface water guidance value levels. ODEQ's model for the Willamette Basin was employed to bring regional specificity to estimates of biomagnification factors and mercury guidance values. The FWM focused on resident fish species identified as species of concern in the DHS Fish Consumption Advisories, those occupying critical niches in the aquatic food web, or those species of particular concern to stakeholders in the Basin. The FWM was calibrated with basin-specific fish tissue and water quality data.

The FWM simulates mercury accumulation in fish, via a basin-specific food web, considering chemical mass balances for aquatic biota. The model was calibrated with fish tissue, sediment and surface water mercury data from the Willamette Basin. The model developed for this study considers the direct uptake of the chemical from water, uptake through feeding, loss of the chemical due to elimination, and dilution as a function of age. The FWM addresses the potential for bioconcentration, bioaccumulation, and biomagnification. In order to predict tissue levels in fish destined for human consumption, the model is repeatedly applied to organisms at each trophic level to simulate mercury transfer from primary and secondary producers, through a variety of intermediate fish species, to top level predacious fish. Probabilistic (Monte Carlo) techniques were used to propagate stochastic variability and incertitude throughout the model to provide a range of estimates for the mercury guidance values. Empirical data from the Willamette Basin was used to estimate the relative ratio of dissolved methyl mercury to total mercury in the water column. This translator was used to establish water column guidance values based on units of total mercury, recognizing that it is the methylated form of mercury that is actually prone to bioaccumulation. The empirically-derived translators utilized in this study were consistent with default values proposed by the

USEPA (USEPA, 2001b). Several mercury guidance values were generated for each fish species varying in their probability of affording human health protection relative to the USEPA's established fish tissue criterion of 0.3 mg/kg. The FWM developed for the Willamette Basin has been peer reviewed and published in *Environmental Toxicology and Chemistry* (Hope, 2003).

Estimate of Mass Loads and Sources

The mercury mass balance analysis compares the estimated mass of total mercury discharged from the Basin as fluvial load (output) to the sum of estimated contributions from a variety of potential mercury sources (inputs) either internal or external to the Basin. The fluvial load (output) was estimated by first developing a relationship between flow and river mile (RM). This relationship was then used to estimate the flow at locations lacking recent U.S. Geological Survey (USGS) flow data. Ultra low-detection mercury concentration data from the ODEQ and various municipalities in the Willamette Basin were then matched (both spatially and temporally) with flow data to form a relationship between flow and concentration. Finally, using a distribution of daily flow rates developed with USGS data, the average annual mass of mercury leaving the Basin at the confluence (river mile 0) was estimated as a function of flow and concentration. Available data and informed assumptions were used to identify and quantify possible sources of mercury with respect to the Basin. Mean estimates of relative mass contributions were developed for each of the following source categories: erosion of mercury-containing soils, runoff of atmospherically deposited mercury, landfill emissions, historical mining activities, municipal and industrial point sources, stormwater, and sediment resuspension. The results of the mass balance analysis (Appendix B) helped inform ODEQ's proposed framework for allocations and reductions presented below.

Significant data gaps and assumptions limit our ability to accurately estimate the magnitude of source-specific mercury contributions. Emission and effluent data from air and water point sources are still limited, as are specific data on total and methylmercury concentrations from municipal and industrial sources in the Willamette Basin. Limited data exist for municipal point sources but many of these data lack the required analytical precision (i.e., use of low detection limit methods for total mercury and methylmercury) necessary to make an accurate estimate of the magnitude of their contributions. There is also limited site-specific information on sediment resuspension, the degree of runoff of mercury associated with various land use categories, and the extent of wet and dry atmospheric deposition. Data gaps hindering this mass balance analysis were bridged with values taken from the literature and with plausible assumptions regarding the behavior of mercury in the Willamette Basin system. The activities and commitments outlined in the WQMP will help generate additional information for the further refinement of these initial estimates of mercury loading and sector-specific source contributions during the next incremental phase of this effort.

Ambient Mercury Monitoring Program

The Willamette River is a large and diverse system that has many potential sources of mercury and a range of habitats differentially affecting methyl mercury production and bioaccumulation in fish. River morphology can affect many of the physical-chemical characteristics that influence methyl mercury production. The river morphology changes from a high-energy stream in the headwaters to a tidally influenced river near the mouth. Therefore, a basin-wide mercury monitoring program was implemented to support the development of the food web model and to estimate mercury mass loads and sources (ODEQ, 2002). The monitoring for both total and methyl mercury in the water column and sediment, as well as total mercury in fish, was made possible by a grant from USEPA. USEPA also provided considerable 'in-kind' services over the course of this project by offering technical assistance and by conducting the analytical analyses required for the measurement of mercury and other parameters in water, sediment and fish tissue.

Eighteen sites in the Willamette Basin were monitored on a quarterly basis for methyl mercury and total mercury in the water column during 2002 and 2003 (Map 3.2 and Table 3.2). Sediment samples were also collected and analyzed for mercury and methyl mercury. In addition, fish were collected from selected sites in the Willamette River (and the two reservoirs) and were submitted to the USEPA laboratory for mercury analysis. A reference site on the Middle Fork Willamette River above the Hills Creek Reservoir was selected as a background site for the basin. This site consistently recorded low levels of mercury (both total mercury and methyl mercury) in the water column. Data presented in Appendix B were used to calibrate and validate the FWM, calculate the average loads of mercury in the mainstem Willamette River, and estimate source contributions by sector.

Map 3.2 Mercury Monitoring Sites in the Willamette Basin

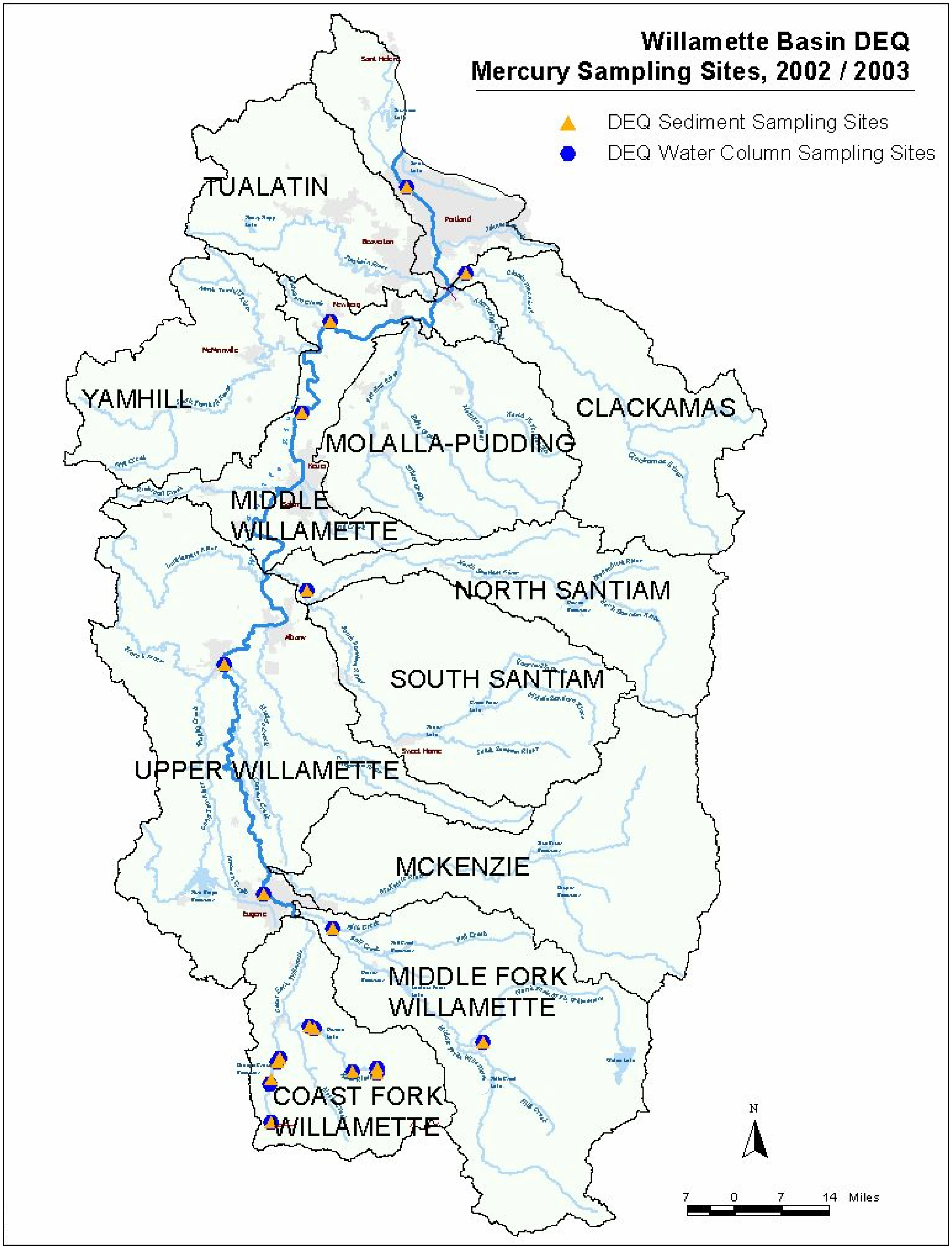


Table 3. 2 Mercury Monitoring Sites in the Willamette Basin.

LASAR #	ID	Site Name	River Mile	LAT (DEC)	LON (DEC)	Water Samples	Fish tissue samples	Sediment Samples
10332	1	Willamette River (lower) – SP&S RR Bridge, Portland[a]	7.0	45.5779	-122.7475	4X/year	1X/study	1X/study
26339	2	Willamette River (Newberg Pool) – Rogers Landing	50.1	45.2857	-122.9658	4X/year	1X/study	1X/study
10344	3	Willamette River (middle) – u/s of Wheatland Ferry	71.9	45.0906	-123.0443	4X/year	1X/study	1X/study
29043	4	Willamette River (upper) – Willamette Park, Corvallis	132.9	44.5518	-123.2519	4X/year	1X/study	1X/study
29044	5	Willamette River (upper) – at Greenway Footbridge[b]	180.0	44.0674	-123.1119	4X/year	1X/study	1X/study
29045	6	Clackamas River - at Riverside Park	3.2	45.3961	-122.5618	4X/year		1X/study
10775	7	Santiam River at Jefferson	9.7	44.7154	-123.0129	4X/year		1X/study
10386	8	Middle Fork Willamette – at Jasper	8.0	43.9982	-122.9053	4X/year		
28614	9	Coast Fork above Cottage Grove Res. – Raisor Rd	32.5	43.6638	-123.0778	4X/year		1X/study
11278	10	Coast Fork below Cottage Grove Res.	29.5	43.7180	-123.0490	4X/year		1X/study
13750	11	Cottage Grove Reservoir		43.7114	-123.0556	4X/year	1X/study	1X/study
10993	12	Row River above Dorena Reservoir- at Sharps Crk Rd	16.9	43.6959	-122.8369	4X/year		1X/study
10991	13	Row River below Dorena Reservoir–at Government Rd	6.7	43.7891	-122.9675	4X/year		1X/study
13769	14	Dorena Reservoir		43.7833	-122.9500	4X/year	1X/study	1X/study
29047	15	Dennis Creek (downstream of Black Butte mine)	0.1	43.5816	-123.0713	4X/year		1X/study
29048	16	Brice Creek (downstream of Bohemia Mining Dist.) – at RM 0.75	.8	43.6940	-122.7620	4X/year		1X/study
29049	17	Layng Creek (Background) – at RM 0.4	.4	43.7045	-122.7634	4X/year		1X/study
27986	18	Middle Fork Willamette above Hills Creek (Bkg.) – at USGS Gage	52.9	43.7639	-122.4550	4X/year		1X/study
29232	19	Middle Fork Willamette at Springfield Wellfield[c]	1.9	44.0280	-122.9828			1X/study

(a) Due to the depth and difficulty of collecting fish at this particular site, additional fish were collected at the 'Willamette River at Willamette Park, Portland' site to complete the complement of fish from the Lower Willamette reach.

(b) Fish were collected at the 'Willamette River upstream of McKenzie River and below Beltline Drive' site in lieu of this site due to the fact that ODEQ could not get the fish shocking boat to this particular site.

(c) This site was just sampled once for sediment.

WILLAMETTE MERCURY TMDL

Sensitive Beneficial Use Identification

According to Oregon Administrative Rules (OAR) 340-041-0340, water quality in the Willamette Basin must be managed to protect a range of beneficial uses including fishing (see Table 340A; November 2003). The beneficial use of fishing applies to the entire mainstem Willamette River and its tributaries. The multiple fish consumption advisories issued for the Willamette Basin by the DHS indicate that this beneficial use is not currently being attained. The TMDL for mercury is designed to restore the beneficial use of fishing to the Willamette River and its tributaries.

Fish consumption advisories for mercury are currently in place for the Dorena (DHS, 2004a) and Cottage Grove Reservoirs (DHS, 2004b) as well as the entire mainstem Willamette River and the Coast Fork Willamette up to the Cottage Grove Reservoir (DHS, 1997a). The initial fish consumption advisory for the mainstem Willamette River, dated February 13, 1997, advised the public of elevated mercury levels in the edible fish tissue of bass and northern pikeminnow (squawfish) and recommended specific limits for consumers who eat these fish caught anywhere in the mainstem river system (from the mouth of the river upstream to the Cottage Grove Reservoir). The average level of mercury found in bass and northern pikeminnow was 0.63 mg/kg. The DHS issues fish consumption advisories when average mercury levels reach or exceed 0.35 mg/kg in edible tissue (see Appendix B for a description of the DHS methodology for issuing fish consumption advisories for mercury). The multiple fish consumption advisories for mercury led to a total of ten listings for mercury on the State's 2002 303(d) list of impaired waterbodies. It should be noted that in November, 2001 the DHS issued a 'consolidated' advisory for the Willamette River advising that *all species* of resident fish in the mainstem of the Willamette River should be eaten in only moderate amounts (DHS, 2001). This consolidated listing also considered pollutants other than mercury.

Water Quality Standard Identification

ODEQ recently proposed a fish tissue methyl mercury criterion of 0.3 mg/kg in lieu of establishing specific water column criteria that are protective of 'water and fish ingestion' or 'fish consumption' only (ODEQ, 2003b). This proposed criterion was approved by Oregon's Environmental Quality Commission in May, 2004 and was submitted to the USEPA for approval. The overwhelming majority (>90%) of the mercury found in fish tissue is in the methylated form (Ullrich et al., 2001). The average fish tissue concentration for mercury in a number of fish species in the Willamette Basin currently exceeds the 0.3 mg/kg criterion. The current freshwater 'acute' criterion for mercury is 2.4 micrograms/liter and the freshwater 'chronic' criterion is 0.012 micrograms/liter (as presented in the Table 33A Water Quality Criteria Summary; OAR 340-041-0033). It is important to note that the Willamette River currently attains the current numeric criteria for the protection of aquatic life. The average annual concentration of mercury in the mainstem Willamette is approximately 1.3 ng/l (or 0.0013 micrograms/liter; see below).

In addition to the OARs pertaining to the maintenance of sensitive beneficial uses, there are also narrative standards that apply to the release of toxic chemicals in the Willamette Basin. The applicable standards presented below have been excerpted from OAR 340-041-0033.

(1) Toxic substances may not be introduced above natural background levels in waters of the state in amounts, concentrations, or combinations that may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediments or bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare or aquatic life, wildlife, or other designated beneficial uses.

(2) Levels of toxic substances in waters of the state may not exceed the applicable criteria listed in Tables 20, 33A, and 33B. Tables 33A and 33B, adopted on May 20, 2004, update Table 20 as described in this section.

(a) Each value for criteria in Table 20 is effective until the corresponding value in Tables 33A or 33B becomes effective.

(A) Each value in Table 33A is effective on February 15, 2005, unless EPA has disapproved the value before that date. If a value is subsequently disapproved, any corresponding value in Table 20 becomes effective immediately. Values that are the same in Tables 20 and 33A remain in effect.

[Note that to date, the USEPA has neither approved nor disapproved Oregon's revised toxics criteria.]

(B) Each value in Table 33B is effective upon EPA approval.

(b) The department will note the effective date for each value in Tables 20, 33A, and 33B as described in this section.

(3) To establish permit or other regulatory limits for toxic substances for which criteria are not included in Tables 20, 33A, or 33B, the department may use the guidance values in Table 33C, public health advisories, and other published scientific literature. The department may also require or conduct bio-assessment studies to monitor the toxicity to aquatic life of complex effluents, other suspected discharges, or chemical substances without numeric criteria.

Pollutant and Target Identification

This TMDL focuses on the bioaccumulation of mercury in edible fish tissue. As stated before, mercury may be present in various physical and chemical forms in the environment (Ullrich *et al.,* 2001; USEPA, 2001b). The form of mercury most prone to bioaccumulation, however, is methyl mercury (USEPA, 2001a). Unfortunately, methyl mercury monitoring is quite expensive and difficult due to the ultra-clean sampling procedures and sophisticated laboratory equipment required to quantify the extremely low concentrations found in Willamette River water and sediment. Due in part to these practical limitations, there were limited methyl mercury data available from the Willamette River, its tributaries, and the various mercury sources present in the Willamette Basin prior to this study.

The interim guidance values developed in this study represent numeric targets that are protective of the beneficial use of fish consumption. In essence, the TMDL is calculating the concentration of mercury in water that will not bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare. The interim guidance values established in this TMDL are *not* considered to be site-specific numeric criteria (standards) but rather system-wide average annual concentrations that will allow us to restore the beneficial use of fish consumption and the protection of public health. All proposed changes to the water quality standards (including the establishment of site-specific numeric criteria) must go through a separate public review process and, ultimately, submittal to USEPA for approval before a change can take place.

In interpreting the narrative standard, ODEQ does not expect each and every source of mercury to discharge below the interim guidance values established in this TMDL. The goal of this TMDL is to implement broad, cross-sector mercury reductions which will eventually bring water column concentrations of mercury in the Willamette Basin down to the guidance values. If this goal were to be achieved in the Willamette, then, according to our analysis, the beneficial use of fish consumption would eventually be restored. ODEQ commits to the continued monitoring and analysis for mercury as part of the iterative adaptive management framework. It is likely that the interim guidance values presented in this TMDL will change as more data and information are incorporated into the analysis.

The focus of this TMDL effort has been on addressing the multiple 303(d) listings pertaining to the human health fish consumption advisories for mercury. If, at some point in the future, the Willamette Basin is listed on the State's 303(d) list for water quality limitations and/or beneficial use impairments associated with ecological or other endpoints, then the TMDL will be revisited with the goal of addressing these additional concerns.

This TMDL establishes interim guidance values and allocations based on units of *total* mercury, as opposed to methyl mercury. The decision to develop guidance values based on units of total mercury was necessitated by the paucity of ambient and source-specific methyl mercury data, the expense and difficulty associated with low-level methyl mercury analysis, and the fact that significant methyl mercury bioaccumulation has been observed at concentrations at or near the method detection limit. Whereas methyl mercury is the form of mercury most prone to bioaccumulation, establishing guidance values in units of total mercury allows us to utilize the more readily available total mercury data to provide information on source loading, relative contributions, and to monitor the effectiveness of control strategies. This approach is consistent with USEPA guidance on the implementation of the methyl mercury water q+uality criterion (USEPA, 2001b).

There are several ways to develop a translator. ODEQ chose to use an empirical method to develop a translator which was consistent with established methods and the available data set. Ambient monitoring data gathered over the course of this study allowed us to empirically estimate the relative ratio (as a percentage) of dissolved methyl mercury (DMeHg) to total mercury (THg) in the water column of the Willamette River. This DMeHg:THg translator (also known as omega) was used to establish water column guidance values based on units of total mercury, recognizing that it is the methylated form of mercury that is actually prone to bioaccumulation. ODEQ acknowledges that a translator determined in this manner reflects only observed conditions and not what is theoretically occurring in the watershed and does not shed any light on underlying mechanisms of methylmercury production or cycling or the linearity or non-linearity of the total mercury - methylmercury relationship.

Translator (Omega) = Dissolved Methyl mercury (DMeHg) : Total Mercury (THg)

The estimate of this translator was based on empirical data from the Willamette Basin mercury study. Data from four quarterly sampling events (as presented in Appendix B) were used to develop the estimate of the average annual translator value used in this TMDL analysis. Seasonal variations caused the cumulative translator distributions to shift as samples from each quarter were added to the dataset (as demonstrated in Figure 3.1). The distribution of site-specific translator ratios from the Willamette Basin mercury study presented in Figure 3.2 represents the cumulative dataset from four quarters of sampling. The median of the distribution of translator values from all four quarters is 0.03, the mean is 0.05 and the 90th percentile range is 0.01-0.18 (see Figures 3.1 and 3.2). In other words, on an average annual basis, approximately five percent of the total mercury measured in the water column is found in the methylated form.

It is important to note that these empirically-derived site-specific translator values from the Willamette (presented in Figures 3.1 and 3.2) are consistent with USEPA proposed default values especially those presented for lakes (USEPA, 2001b). Several explanations for the convergence of translator values with those for lakes and reservoirs are possible: (1) coincidence, (2) data from reservoirs, tributaries, and the mainstem Willamette River were combined to make this estimate, obscuring the effects of flowing water, or (3) the mainstem Willamette, because of its size and regulation, behaves more like a large, slow lake than a fast moving river.

Figure 3.1 Cumulative Translator (Omega) Distributions from the Willamette Basin Mercury Study

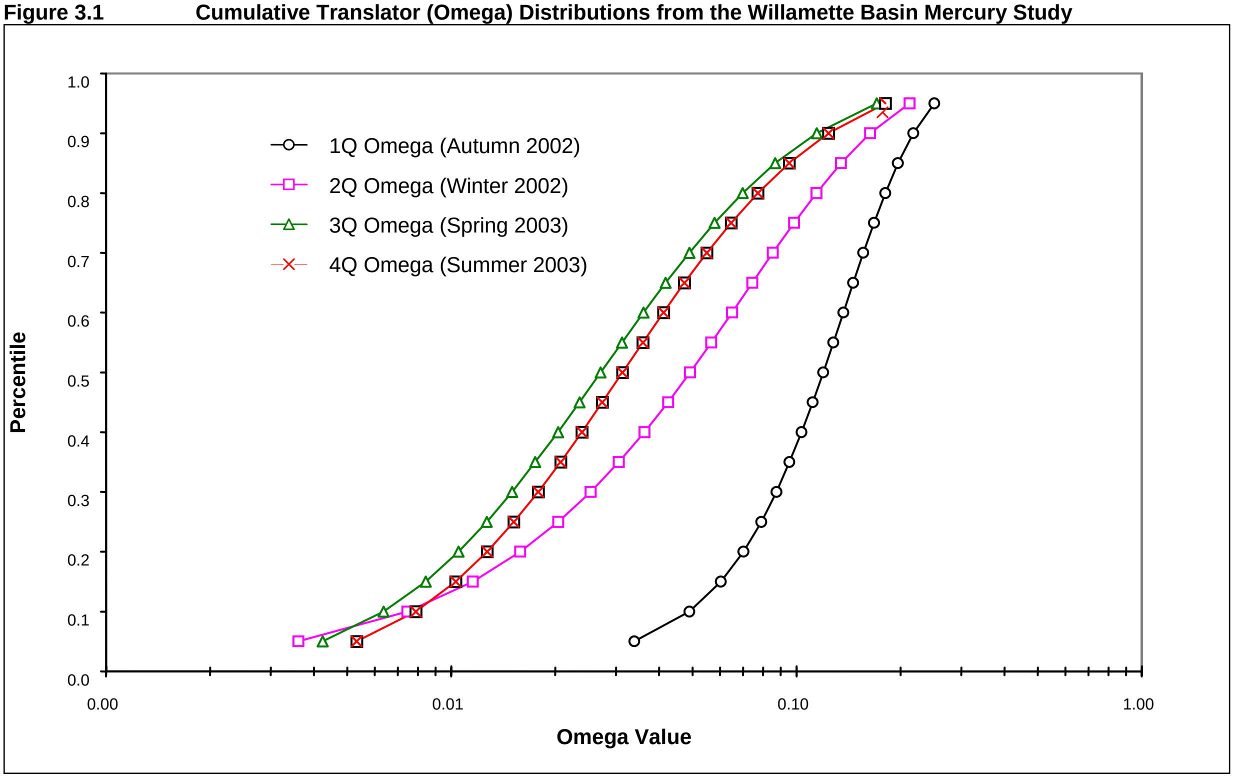
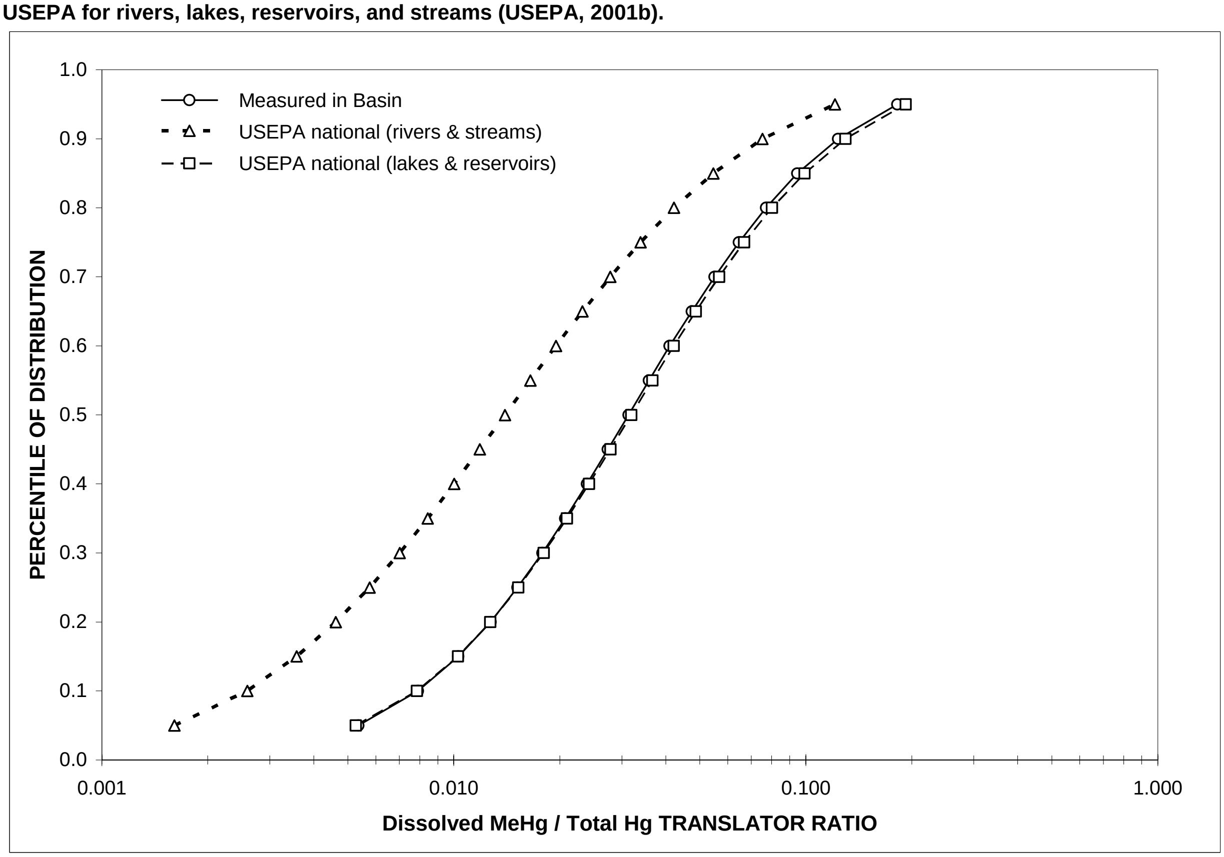


Figure 3.2 Comparison of MeHg - THg translator ratios measured in the Willamette Basin to ratios estimated by the USEPA for rivers, lakes, reservoirs, and streams (USEPA, 2001b).



Interim guidance values are presented in units of total mercury for each of the fish species considered in the model (Table 3.3). The FWM calculates a range of water column guidance values for each fish species considered varying in their degree of protectiveness for human consumers. There are three guidance values presented in Table 3.3 for each of the resident fish species considered in the FWM. These three values correspond to the 5th, 50th and 95th percentiles. At the median level (the 50th percentile) there is a fifty percent likelihood that a given fish species would have a fish tissue concentration at or below the USEPA fish tissue criterion for methyl mercury (0.3 ppm). Interim guidance values for selected fish species are also presented in units of dissolved methyl mercury (Table 3.4).

As mentioned before, the methodology for establishing water column guidance values in units of total mercury, as opposed to methyl mercury, is consistent with guidance from USEPA (USEPA, 2001b). One of the basic assumptions inherent in the methodology presented by USEPA (and utilized in this TMDL) is that there is a direct association between the loading of total mercury to waters of the Willamette and the formation of methyl mercury. As more total mercury, bound to sediments and organic matter, enters the Willamette, more methyl mercury can eventually be produced by bacteria. The validity of this assumption will be addressed by future studies as a component of the adaptive management process.

Table 3. 3 Interim Species-Specific Water Column Guidance Values for Total Mercury in the Willamette Basin, Based on a Post-Calibration Model

Fish Species	Model Estimate (ng/L) [a]		
	5th-%tile [b]	50th-%tile [c]	95th-%tile [d]
Northern pikeminnow	10.03	0.92	0.07
Largemouth bass	15.16	1.27	0.11
Smallmouth bass	38.42	2.82	0.20
Rainbow trout	54.72	4.78	0.31
Bluegill	37.56	3.65	0.40
Largescale sucker	28.97	2.75	0.22
Carp	34.96	3.25	0.21
Cutthroat trout	73.40	6.02	0.50

a) Calculated using Equation {12} and 1-D MC methods (see Appendix B), with biomagnification factor and Ω as distributions.
b) Total mercury concentration that would achieve the USEPA tissue criterion in 5 percent of individuals.
c) Total mercury concentration that would achieve the USEPA tissue criterion in 50 percent of individuals.
d) Total mercury concentration that would achieve the USEPA tissue criterion in 95 percent of individuals.

Table 3. 4 Interim Water Column Guidance Values for Dissolved Methyl Mercury for Selected Fish Species in the Willamette Basin, Based on a Post-Calibration Model

Fish Species	Model Estimate (ng/L) [a]		
	5th-%tile [b]	50th-%tile [c]	95th-%tile [d]
Northern pikeminnow	0.137	0.029	< 0.02
Largemouth bass	0.200	0.037	< 0.02
Smallmouth bass	0.614	0.087	< 0.02

a) Calculated using Equation {12} and 1-D MC methods (see Appendix B)
b) Dissolved methyl mercury concentration that would achieve the USEPA tissue criterion in 5 percent of individuals.
c) Dissolved methyl mercury concentration that would achieve the USEPA tissue criterion in 50 percent of individuals.
d) Dissolved methyl mercury concentration that would achieve the USEPA tissue criterion in 95 percent of individuals.

Confidence in estimates of water column guidance values is moderate due to limitations imposed by characterizing a large watershed with limited data. The choice of translator value, representing the percentage of total mercury in the methylated form, can influence the development of water column guidance values. After four sampling events, the translator values stabilized at a mean of approximately 5%. The range of ambient methyl mercury concentrations used in the FWM represents another critical variable with the potential to influence the development of water column guidance values. Methyl mercury concentrations, however, fluctuated to a significantly lesser extent than total (unfiltered) mercury concentrations and remained essentially constant throughout the year. The current estimates of both the translator value and the range of ambient methyl mercury concentrations in the mainstem Willamette are based on quarterly sampling data from a single year. Additional ambient monitoring over the course of the next three years will help establish better long-term estimates of the translator value and ambient conditions in the Basin. This new information will allow us to refine our estimates of the appropriate water column guidance values and the necessary percent reductions as a component of the iterative adaptive management framework. The policy decision to pursue the interim approach outlined in this TMDL was based in part on significant input from members of the Willamette Basin TMDLs Council.

Estimates of Mercury Mass Loads and Sources

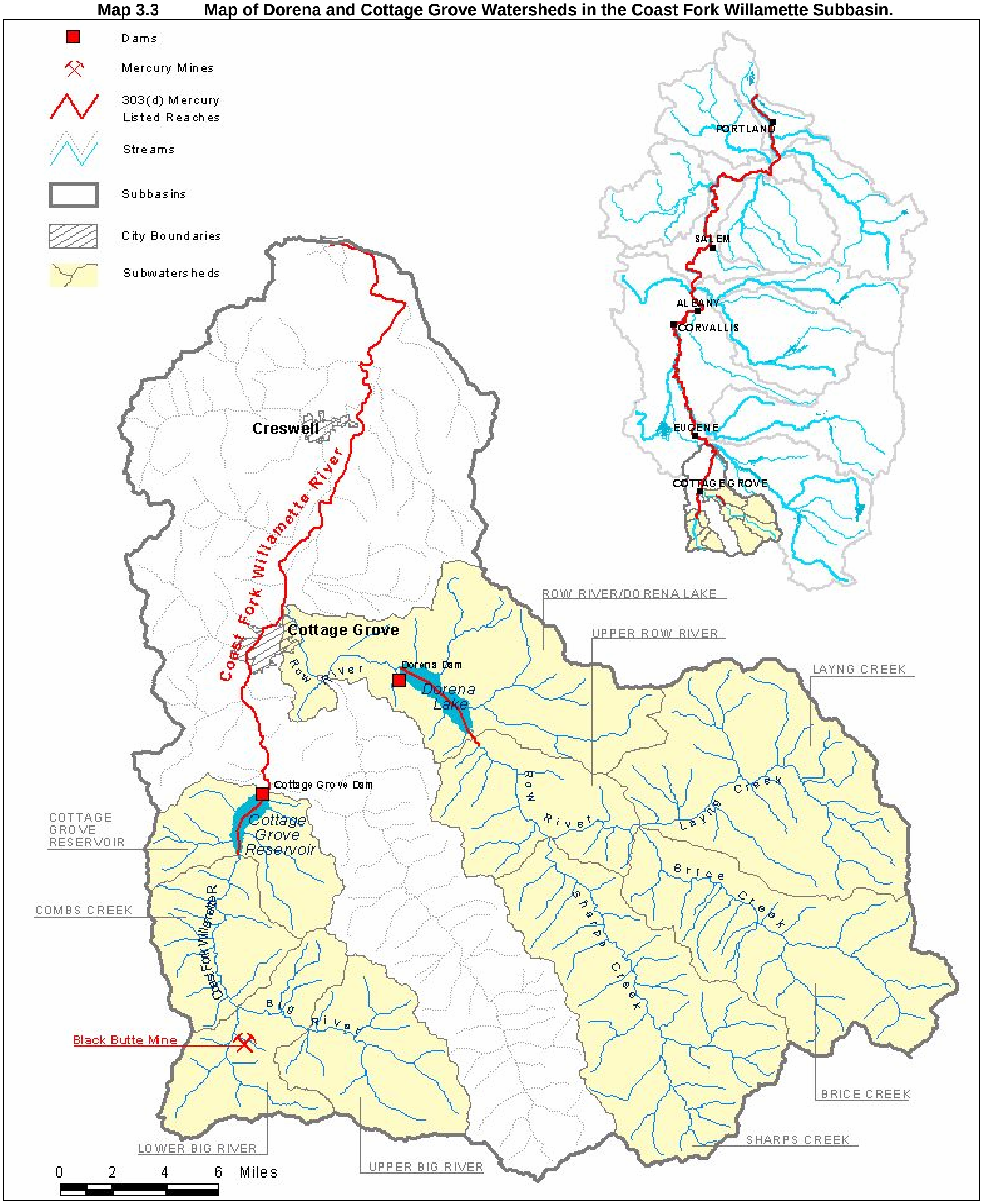
Data Review and Analysis

The TMDL for mercury is required to evaluate, to the extent existing data allow, the difference between the actual pollutant load in a waterbody and the loading capacity of that waterbody. The loading capacity for this analysis is defined as the load of total mercury (estimated in kg/yr) associated with the interim water column guidance value. The water column guidance value represents the mercury concentration in water that is correlated with an acceptable fish tissue criterion (as predicted by the Food Web Model). Attainment of this water column guidance value should, over time, allow for the restoration of the beneficial use of fish consumption.

The TMDL must also identify the various sources of the pollutant and estimate, to the extent existing data allow, the amount of actual pollutant loading from each of these sources. These estimates of mercury mass loads and sources in the Willamette Basin have been conducted and are presented in Appendix B. It should be noted that the effort to estimate mercury mass loads and sources in the Willamette Basin has been an iterative process with significant stakeholder involvement and discussion via the Willamette River TMDLs Council.

The data reviewed and generated by ODEQ support conducting a *system-wide* TMDL for mercury in the mainstem Willamette River system and then separate subbasin-level analyses for the Cottage Grove and Dorena watersheds (Map 3.3). These two watersheds in the Coast Fork Willamette Subbasin are downstream of areas known to be associated with mercury mining and mercury use in gold and silver amalgamation. The Black Butte abandoned mine site, located in the headwaters of the Coast Fork Willamette River above the Cottage Grove Reservoir, represents a likely source of mercury to downstream waterbodies particularly the Cottage Grove Reservoir. The Black Butte abandoned mine site is characterized by exposed tailing piles and elevated mercury concentrations in soils resulting from an inefficient mercury extraction and recovery processes. Mercury was used historically in the Bohemia Mining District (along Sharps and Brice Creeks upstream of the Dorena Reservoir) to enhance the recovery of gold. This historical use of mercury represents an additional legacy mining source with the potential to impact downstream waterbodies. These downstream impacts are most likely to be observed in the reservoirs immediately below the legacy mining areas since the reservoirs represent barriers to the transport of particle-bound mercury to the lower watershed and most likely create conditions favorable for the production of methyl mercury. Therefore, separate analyses have been conducted to determine the mass loading and relative source contributions in each of these two watersheds (Appendix B). Whereas legacy mining sources appear to represent relatively minor sources of mercury to the mainstem Willamette River system and the Dorena Reservoir, these sources have the potential to significantly impact the Cottage Grove Reservoir. The entire Coast Fork Willamette Subbasin has still been considered in the mainstem mercury analysis as a potential input of mercury.

Map 3.3 Map of Dorena and Cottage Grove Watersheds in the Coast Fork Willamette Subbasin.



Still there are many unknowns about mercury loads and sources in the Willamette Basin due to the sheer scale of the area considered, the seasonal variation in mercury concentrations, and the limited dataset available particularly pertaining to source load contributions. This TMDL attempts to utilize the information available while acknowledging the various data gaps that still exist. The intent in developing interim guidance values and allocations is to provide information supporting the interpretation of the numeric and narrative standards and to guide the development of future studies (monitoring and analysis) that will provide useful information and additional data on mercury loads and sources. This new information will help us further refine the guidance values and the allocations established in this TMDL as part of the adaptive management process (see below).

Mercury Mass Loads

The estimated mass of total mercury discharged from the Basin as fluvial load was estimated as a function of river flow rate at the confluence (river mile 0) and mercury concentration in unfiltered surface water samples. USGS flow data were available from five gauging stations along the mainstem of the Willamette River (USGS, 2003). An empirical relationship was developed between river flow rate and river mile by pairing measured daily mean flow rates with river mile. This relationship was then used to estimate the daily mean flow rate at sampling locations along the mainstem where daily mean flow rate data were not available for the period between 1997 and 2003. During 2002 and 2003, ODEQ conducted quarterly mercury sampling at 18 sampling stations in the Willamette Basin (Map 3.2 and Table 3.2). ODEQ samples were analyzed using ultra-low detection methods (USEPA Method 1631E) and combined with those from periodic sampling performed by the Cities of Portland, Wilsonville, Corvallis, and Eugene between 1997 and 2003. An empirical relationship was then formed between daily mean flow at RM 0 and the concentration of total mercury in the mainstem. There is a moderate positive correlation between concentration and flow for total mercury; a correlation consistent with the seasonal mobilization of fine-grained particulates in the river sediment and runoff (erosion) with which mercury is associated.

The estimated average annual mass load of total (unfiltered) mercury was estimated at the confluence (RM 0) as a function of concentration and flow rate. The annual output from the Basin was thus defined as the mercury discharge rate in units of kg/yr at RM 0. An average of 126.8 kg of total mercury is estimated to be discharged by the Willamette into the Columbia River each year. The estimated inputs of mercury to the Basin (128.6 kg/yr; see Source Identification section below) slightly exceed the mercury mass leaving the Basin as fluvial load, suggesting that a portion of the mercury is deposited in the river bottom. An analogous process was employed to estimate the mass loading of mercury into the Dorena and Cottage Grove watersheds. Estimates of total mercury mass loads into the Dorena and Cottage Grove Reservoirs are 2.08 and 3.13 kg/yr, respectively.

Source Identification

As described in Appendix B, a combination of available data and informed assumptions were used to identify and quantify the sources contributing to the mass load of total mercury in the Mainstem Willamette River and the Coast Fork tributaries. Source categories considered in this analysis include: atmospheric deposition (from both local and far-field sources); erosion of native soils; historical mining activity; sediment resuspension; and municipal and industrial water discharges. Data from ODEQ were combined with the available information from municipal and industrial sources to generate the estimates presented below. The various data sources and informed assumptions employed in the source characterization analyses are presented in detail in the technical appendix.

Limitations in the available dataset create hindrances to our understanding of the nature and extent of mercury loading from the various sources present in the Basin. For example, there is little Basin-specific information on the actual erosion rates of native soils from various land use categories. In this analysis, literature rates for soil erosion were utilized in lieu of actual monitoring data. There is also little information available on the actual mercury concentrations found in effluent and stack emissions from key industrial sectors. Default values from the USEPA and emission factors (for the air sources) were employed in the source characterization study to bridge this significant data gap. Estimates from industrial sectors were also considered. We have only recently begun to collect atmospheric deposition data within the Basin through the placement (by the USGS in 2003) of two atmospheric deposition collectors at its northern and southern ends. These collectors have become part of the National Atmospheric Deposition Program/Mercury Deposition Network (MDN). Data from MDN sites, as well as monitoring data from planned point source studies, will be incorporated into future iterations of this TMDL. The additional work outlined in the WQMP is absolutely essential for refining the preliminary source characterization estimates presented below.

A summary balance of mercury inputs and outputs for the mainstem Willamette River is presented in Table 3.5. A preliminary mass balance for mercury is achieved by matching the estimated Basin output (as fluvial load at RM 0) to the sum of the estimated Basin inputs (from the source characterization analysis). Air deposition supplies a total of 61.3 kg/yr to the river, of which 7.6 kg/yr comes from direct deposition to water, and 6.4, 10.0, 14.7, and 22.5 kg/yr result from runoff (overland flow) from urban, mixed, forest, and agricultural land, respectively. Erosion of native soil contributes an additional 61.4 kg/yr of mercury to the river. The total load from all nonpoint sources is 123.5 kg/yr. The estimated load from all known and currently quantified point sources is 5.0 kg/yr, for a total annual average input of 128.5 kg/yr to the river. Since annual average output (at the confluence of the river) is 126.8 kg/yr, achieving a mass balance requires the assumption that approximately 1.7 kg/yr is removed (on long-term average) from the water column through deposition on the river's bottom. Evidence suggests that significant depositional segments include the Newberg Pool and the lower Willamette River, the reach from below Willamette Falls to the confluence. It is estimated that the amount of mercury available for re-suspension will decrease over time as cross-sector measures to address mercury loading (described in detail in Chapter 14) are implemented.

Table 3. 5 A Summary of the Adjusted Balance of Mercury Inputs and Outputs for the Mainstem Willamette River System.

Description of Input or Output	Report Section (see Appendix B)	Annual Mean Rate (kg/yr)	Percent Contribution of total load (128.5 kg/yr)
Average annual cumulative output	2.0	126.8	
Average annual inputs			
Nonpoint Sources			
Runoff of atmospherically deposited mercury	3.1	53.7[(a)]	41.8
Direct deposition to open water	3.1	7.6	5.9
Erosion of mercury containing soils	3.2	61.4[(a)]	47.8
Legacy mine discharges	3.4	0.8[(b)]	0.6
Sediment re-suspension (input to water column)	3.8	0.0 [(c)]	0.0
Point Sources			
POTW Discharges	3.5	3.5	2.7
Industrial Discharges	3.6	1.5	1.2
Total Inputs		128.5	100
Sediment Deposition (output from water column)		-1.7 [(d)]	

(a) The estimate of the total mercury load for this source category includes a component attributable to stormwater discharges from urbanized areas. These stormwater inputs may originate in either Municipal Separate Storm Sewer System (MS4) communities or non-MS4 communities and includes the overland flow of mercury directly into impacted waterbodies. In certain situations these loadings may be considered to be point sources, as in the case of MS4 discharges, but for the purpose of this analysis, the stormwater component is contained within the 'runoff of atmospherically deposited mercury' and 'erosion of mercury containing soils' categories and is accounted for here as a nonpoint source category.

(b) The contribution from legacy mines is considered to be a nonpoint source input due to the reasons outlined in the text of this document.

(c) Seasonal average value, expected to be significantly higher during the wet (high flow) season.

(d) Estimated indirectly as Output minus Total Inputs (126.8 - 128.5 = -1.7). Seasonal average value, expected to be zero during the wet (high flow) season.

Annual mean estimates of the relative source load contributions for the mainstem Willamette River are presented in Figures 3.3 and 3.4. These figures show the relative contributions of the various inputs of mercury to the total inputs, based on the values presented in Table 3.5. The load associated with the erosion of native mercury-containing soils (47.8%) and the runoff of atmospherically-deposited mercury from local and global sources (47.7%) represent the two largest mercury inputs to the mainstem Willamette River system. These two source categories include a component attributable to stormwater discharges from urbanized areas from both Municipal Separate Storm Sewer System (MS4) communities and non-MS4 communities. The runoff of atmospherically-deposited mercury from urban environments was estimated at 5% of the total load. It was not possible at this time to further quantify the load of mercury attributable to stormwater discharges from urbanized environments due to a lack of site-specific data and information from the scientific literature. The stormwater inputs, however, are fully accounted for in the estimates of the loads associated with air deposition from local and global sources and native soil erosion.

The estimated average input from the municipal point sources is, at 2.7%, a relatively small contribution to the total input. Similarly, the estimated contribution from the Industrial (Pulp and Paper) Sector is 1.5 kg/yr or the equivalent of 1.2% of the total load.

The annual mean estimates presented in Table 3.5 and Figures 3.3 and 3.4 obscure the significant seasonal fluctuations in both the magnitude and source of mercury inputs. For example, seasonal variation in precipitation and snow melt can affect: flow rate, which determines whether sediment is re-suspended or deposited; wet deposition, which affects air inputs to land; and surface runoff and erosion, which together affect outputs from land to water. The estimated relative source contributions during winter (high flow) events are presented in Figure 3.5. The estimated load associated with sediment resuspension increases significantly during these periods of high winter flows.

Annual mean estimates of the relative source load contributions for the Cottage Grove and Dorena watersheds are presented in Figures 3.6 and 3.7, respectively. Whereas legacy mining represents a significant source of mercury in the Cottage Grove watershed, it does not appear to be a major source of mercury in the Dorena system. (It should be noted that whereas mercury was mined commercially in the Cottage Grove watershed, there are no known mercury mines in the Dorena system.) The analysis for the Dorena watershed was limited by a paucity of monitoring data (when compared to the Cottage Grove analysis) and less information on flow. It is possible that future analysis will demonstrate more of a legacy mining component in this particular watershed due to the historical use of mercury in gold amalgamation in the Bohemia Mining District.

The legacy mine contributions are considered as nonpoint source inputs in this TMDL analysis for the following reasons.

- Elemental mercury was used throughout the Bohemia mining district to amalgamate gold. The mercury contamination resulting from these past practices is diffuse in nature with the potential for trace levels of mercury to be found in river sediments throughout the Bohemia region, particularly along Brice Creek, the primary watershed within the Bohemia mining district. Hygelund et al. (2001) report that river sediment samples from many locations along Brice Creek contain mercury at concentrations in the range of 0.1 – 1.4 parts per million.
- Studies suggest that there may be diffuse mercury contamination at the abandoned Black Butte Mine due in part to the volatilization and subsequent deposition of mercury around the furnace areas where mercury-containing rock was cooked and crushed (Curtis, 2004). Surface soil samples taken from around the site contain mercury at elevated concentrations with concentrations highest in areas around historic furnace locations.
- There does not appear to be significant acid mine drainage or adit discharges of mercury at the Black Butte abandoned mine site (ODEQ, 2004).
- ODEQ is relying on state and federal environmental cleanup laws as the lead authority for the investigation and remediation of the Black Butte abandoned mine site.

ODEQ is not able at this time to further distinguish the contribution of mercury from individual sources within the legacy mining areas in the Coast Fork Willamette watershed due to a lack of data. ODEQ recently received an award consisting of USEPA contractor assistance worth an estimated $60K for the next phase of the Black Butte cleanup. The sampling and analysis work planned at Black Butte will help characterize the nature and extent of contamination in the on-site tailings and mine workings in the immediate vicinity of the furnaces. ODEQ is also beginning to work with USEPA's Site Assessment Program on an initial assessment of the Row River watershed, above Dorena Reservoir. This study will help estimate the extent to which historic mine sites located in the Bohemia mining district may be contributing to elevated levels of mercury in the Willamette basin. As these efforts proceed and as our understanding of sources of mercury within these legacy mining areas evolve, every effort will be made to consider the substantive requirements of the Clean Water Act, as deemed appropriate.

An attempt was made in this preliminary phase of the mercury TMDL to differentiate between non-anthropogenic (natural, background) and anthropogenic sources of mercury, to the extent possible. Each of the categories considered in the mercury source characterization analysis may include mercury originating from natural sources although the precise quantification of this background component can be constrained by a paucity of literature values and site-specific information from the Willamette Basin. Mercury loading attributable to the erosion of native soils from agricultural and forested land is, for example, based entirely on the concentration of mercury naturally present in native soils. Erosion of native soil from undisturbed areas (attributed to natural sedimentation or the sloughing of stream banks) was not quantified as available data suggest it represents only a small percentage of total native soil erosion in the Basin (NRCS 1998, 2000). Monitoring data and published studies from the area around the abandoned mercury mine above Cottage Grove reservoir clearly indicate that soil mercury concentrations significantly exceed mercury concentrations in native soil (Morgans 2003, Park and Curtis, 1997). So, although a small percentage of the total load of mercury from this area may be due to naturally occurring mercury, it is clear that legacy mining activities at this site have resulted in diffuse mercury contamination over and above this natural background component. In terms of atmospheric deposition, an attempt was made to differentiate between contributions from local (largely anthropogenic point, area, and mobile) sources within the Basin and those from global sources (a mix of natural and anthropogenic mercury emissions) from beyond the Basin. The present analysis does not account for the volatilization (or recycling) of the mercury present in native soil or that which is deposited from the atmosphere. The current estimates of mercury loading from industrial and municipal point sources do not take into consideration the presence of naturally occurring mercury in the intake water of these point sources. Knowledge of these concentrations would help greatly in refining current estimates of mercury loads associated with domestic and industrial effluents. The work planned for the next phase of this mercury TMDL will enable a more precise accounting of natural background and the loads associated with each of the source categories considered in this analysis.

Figure 3.3 **Relative Load Contributions for the Mainstem Willamette River System by Source Category (Total Load = 128.5 kg/yr).**

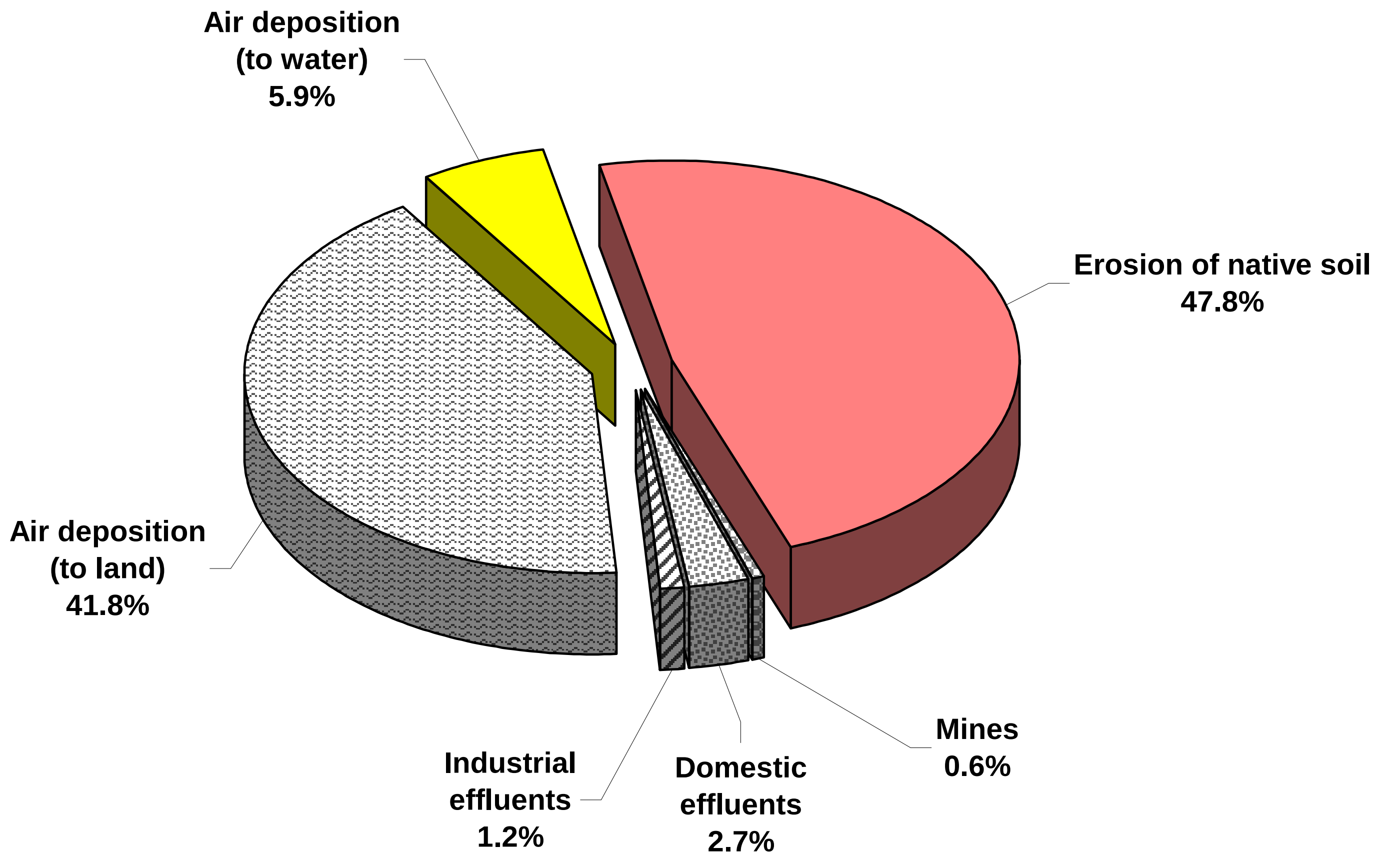


Figure 3.4 **Relative Load Contributions for the Mainstem Willamette River System by Land Use Category (Total Load = 128.5 kg/yr).**

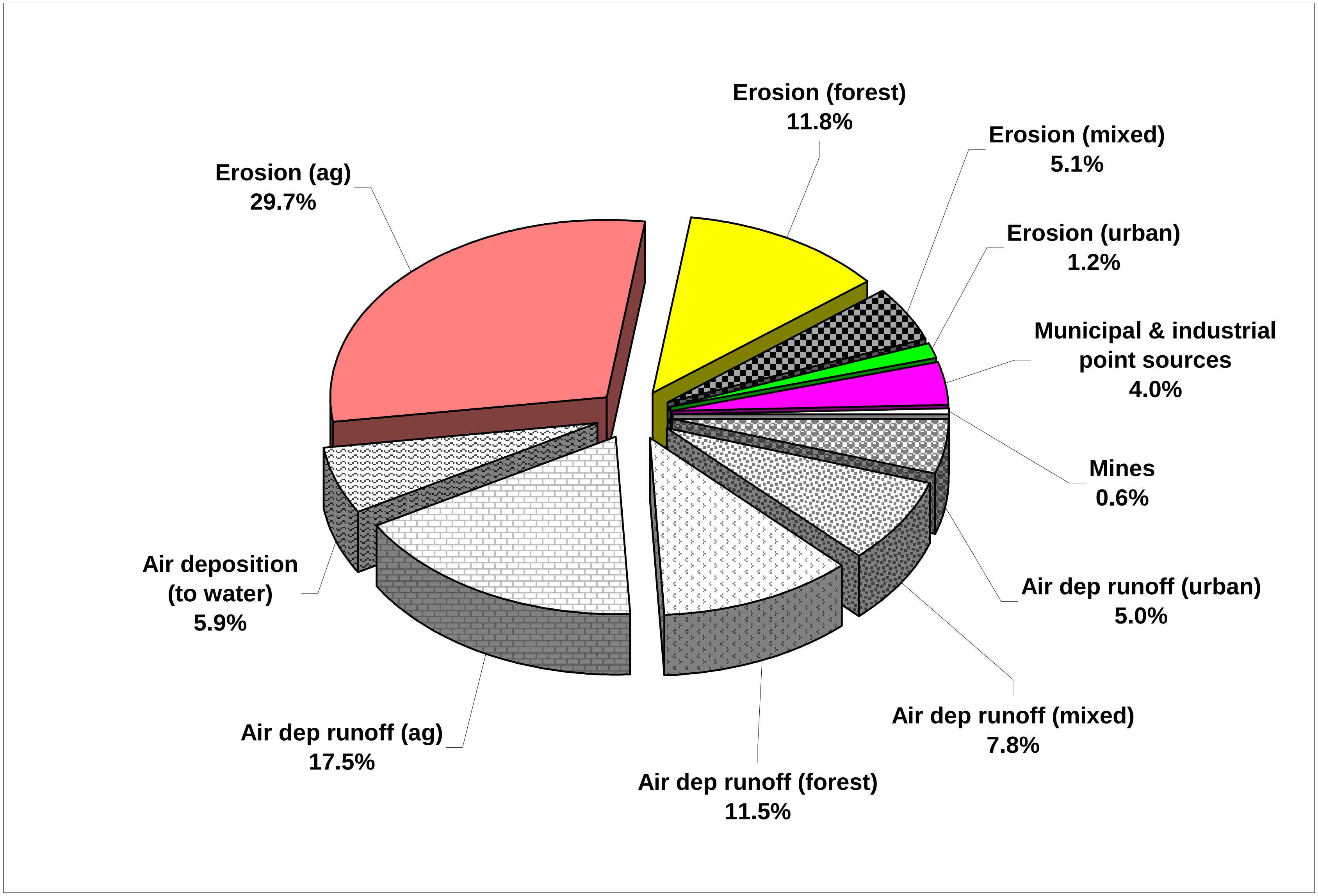


Figure 3.5 **Relative Source Load Contributions for the Mainstem Willamette River System (Winter High Flow Estimate; Total Load = 416.6 kg/yr)**

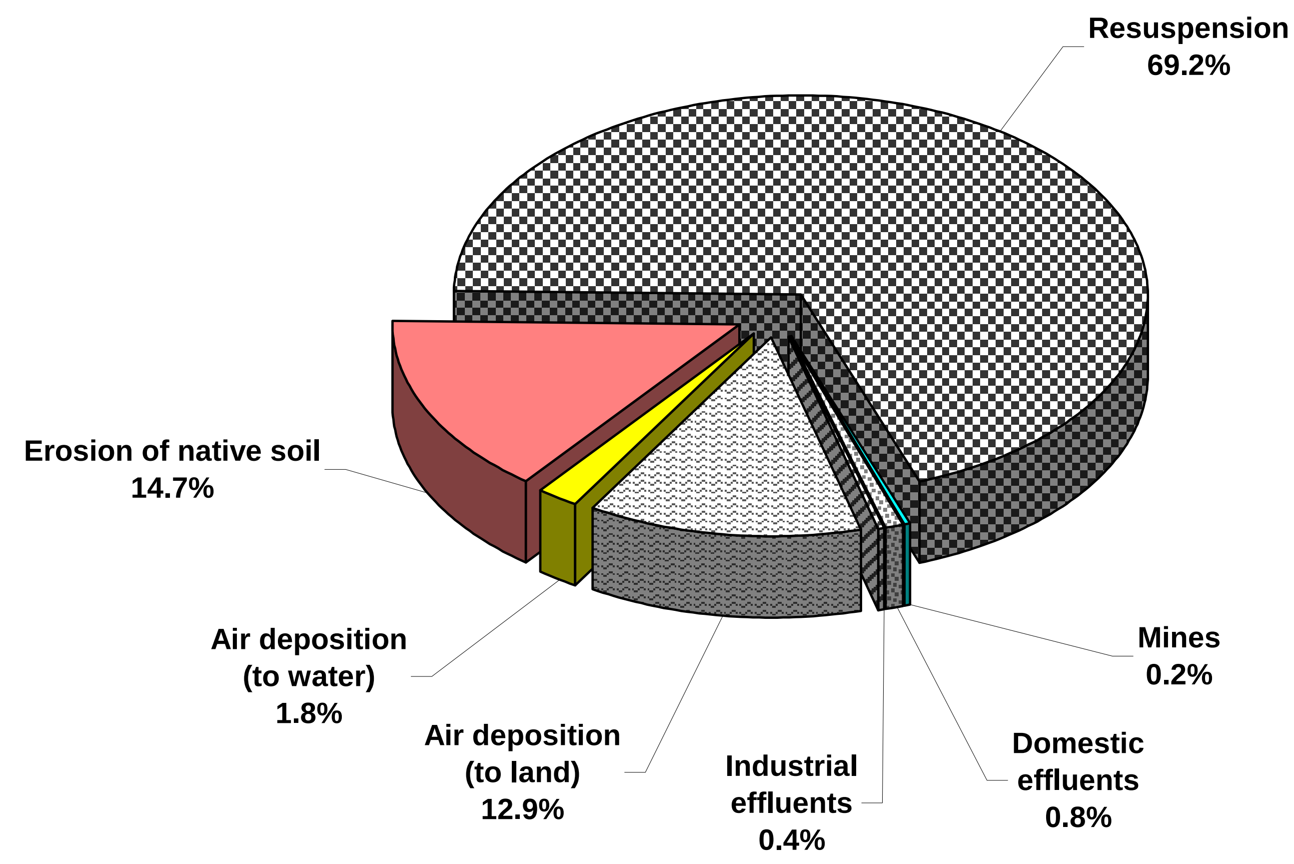


Figure 3.6 **Relative Source Load Contributions for the Cottage Grove Watershed (Total Load = 3.13 kg/yr)**

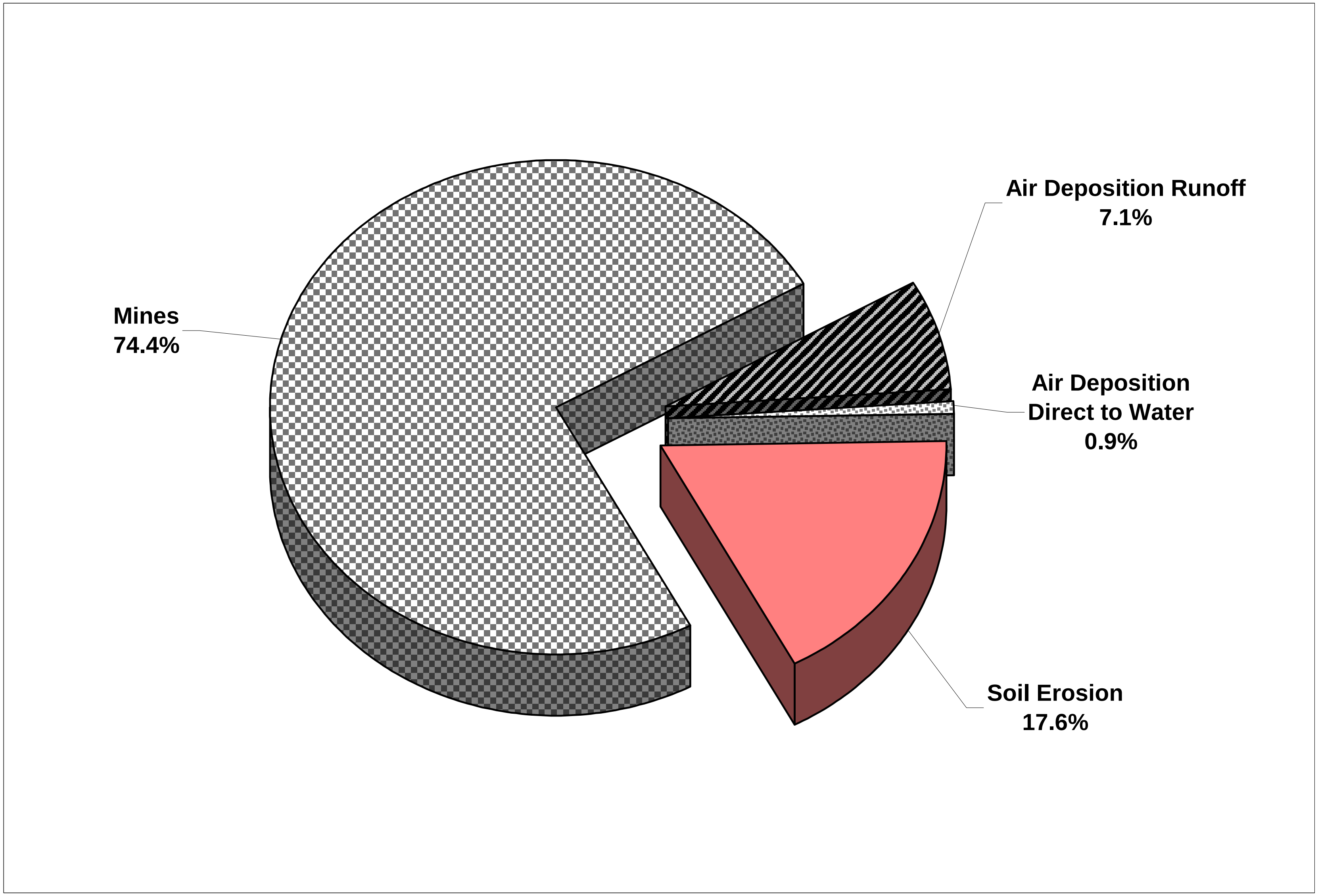
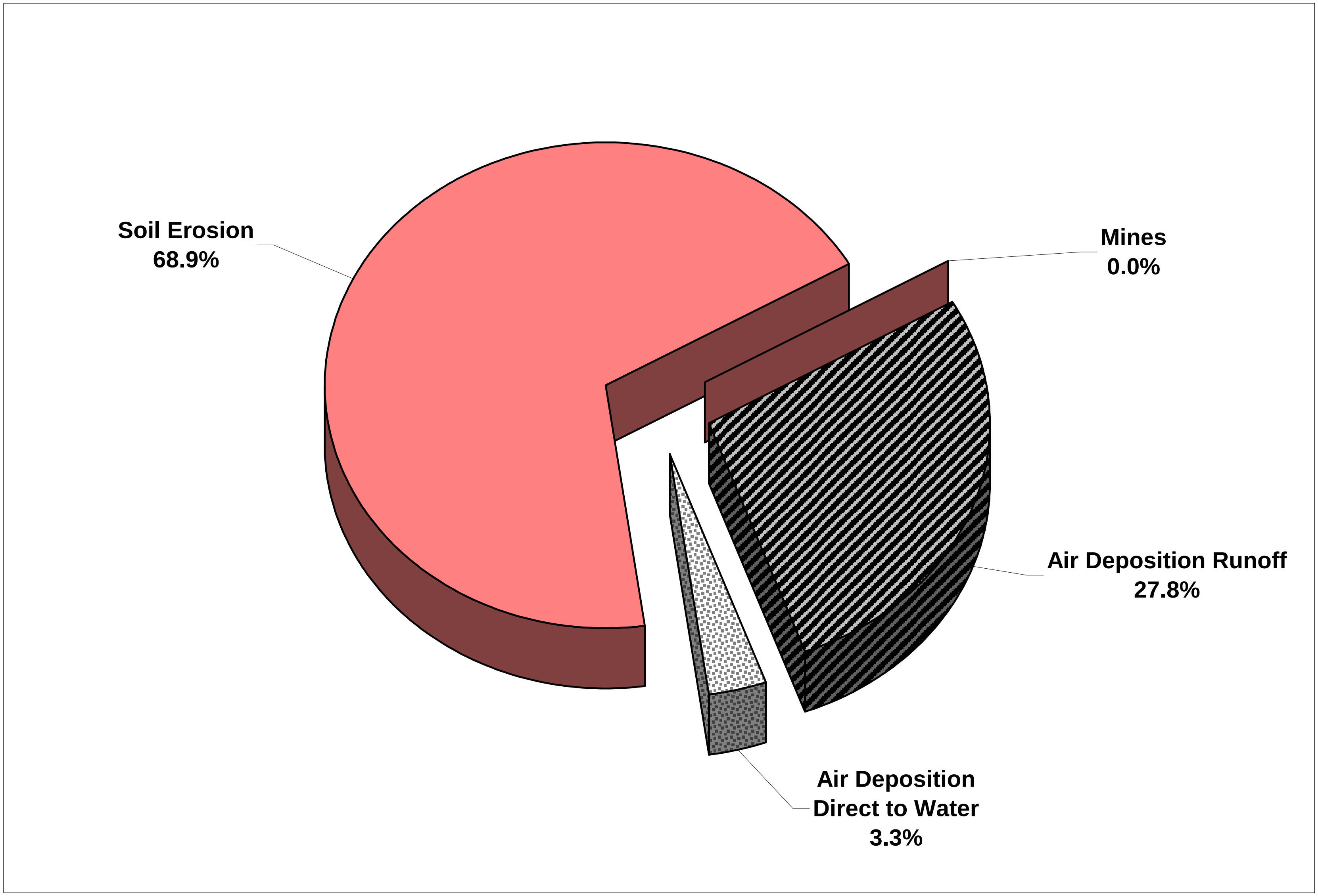


Figure 3.7 **Relative Source Load Contributions for the Dorena Watershed (Total Load = 2.08 kg/yr)**



Seasonal Variation and Critical Condition

As noted above, the annual averages in the mercury mass loading obscure the considerable variation in mass loads that are driven primarily by seasonal changes in flow rates. Because mercury binds to particles, there is a positive relationship (R^2 = 0.56) between total suspended solids (TSS) and total (unfiltered) mercury concentrations (Figure 3.8), with only a moderate (R^2 = 0.45) relationship for dissolved mercury concentrations. In the wet season, increases in soil erosion due to storm events and resuspension of bed sediment (by the higher shear velocities associated with higher flow rates) combine to produce higher TSS levels. Because mercury is both contained in, and bound to, soil and sediment particles, higher total mercury loads are evident during the wet season (Figure 3.9).

The bioaccumulation of mercury in fish is a long-term chronic effect and it would most likely take several seasons for a fish to accumulate enough methyl mercury to attain or exceed the threshold level for the issuance of fish consumption advisories. Summer conditions, however, may provide favorable conditions for the conversion of inorganic forms of mercury to methyl mercury by bacteria, a process known to be temperature-dependent (Ullrich *et al*., 2001). A more elaborate mercury mass balance analysis will need to be developed to more fully account for the seasonal variation affecting mercury loading and methyl mercury bioaccumulation and to determine how best to incorporate seasonal variation into the mercury TMDL. This analysis is being proposed for the second phase of this TMDL scheduled for completion in 2011.

Figure 3.8 **Relationship Between Total and Dissolved Mercury and Total Suspended Solids in the Mainstem Willamette River.**

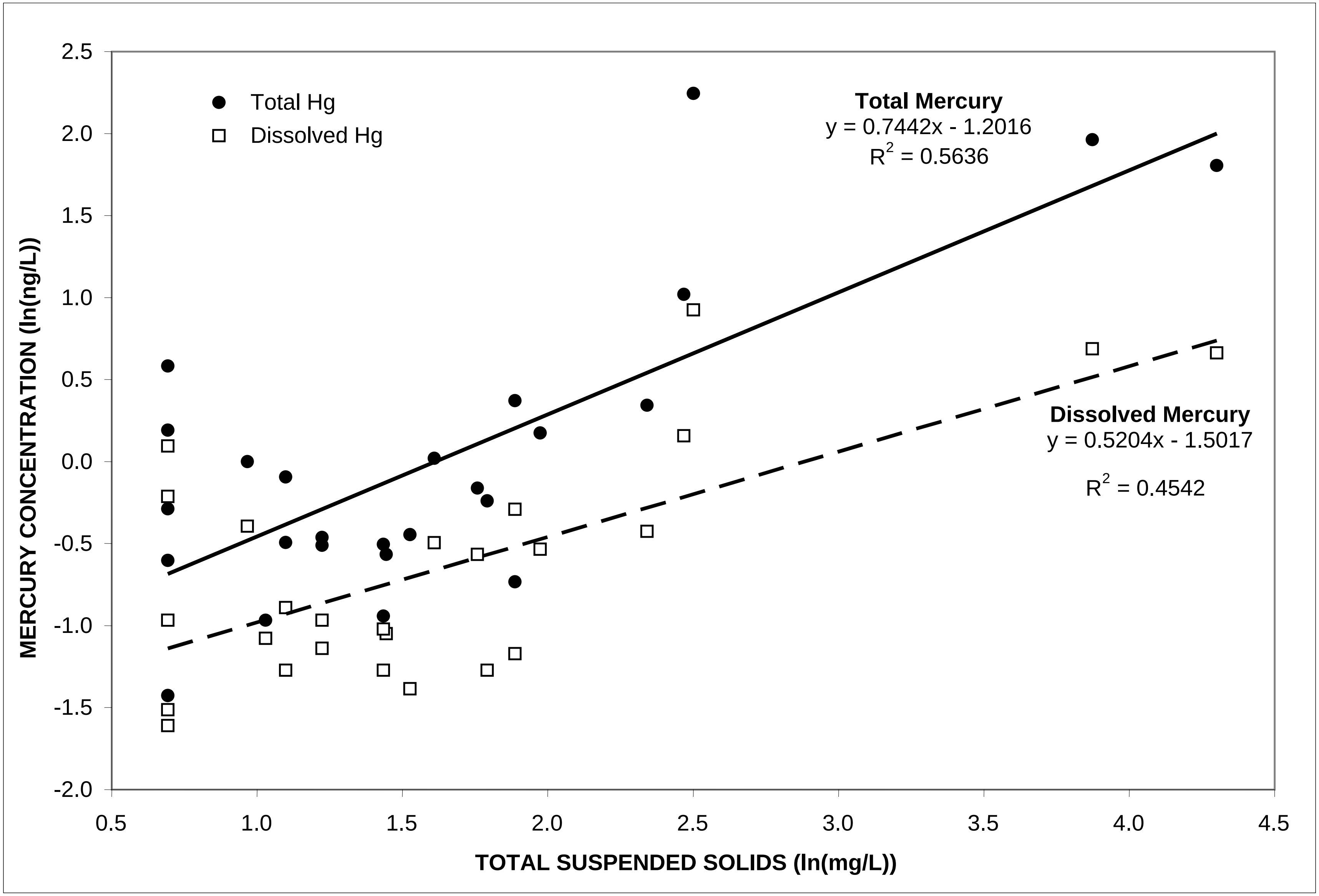
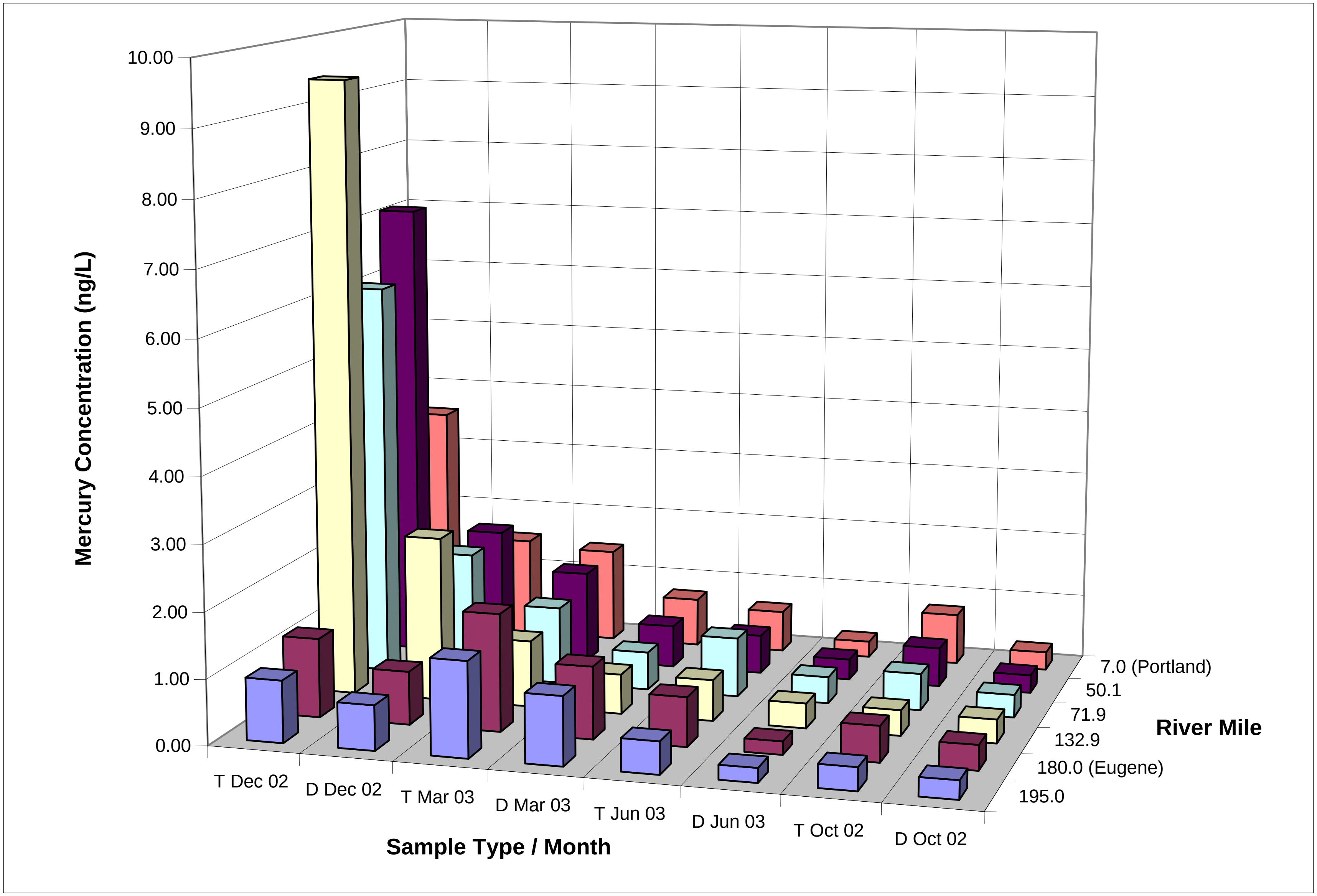


Figure 3.9 **Seasonal and Spatial Trends in Total (T) and Dissolved (D) Mercury Concentrations in the Mainstem Willamette River.**



Loading Capacity

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to restore the beneficial use of fish consumption in the Willamette Basin. The loading capacity, presented here in units of total mercury, represents the load of total mercury (in kg/yr) associated with the interim water column guidance value concentration deemed to be protective of the beneficial use of fish consumption. The derivation of this loading capacity relies on both the Basin-Specific Aquatic Food Web Biomagnification Model for Estimation of Mercury Target Levels and the estimate of mercury mass loads discussed above and presented in Appendix B.

The interim water column guidance value for total mercury (generated by the FWM) has been used to establish the estimated percent reduction needed in the load of total mercury to waters of the Willamette. For the purpose of this preliminary analysis, it is assumed that a given percent reduction in mercury mass loading will result in a linear percent reduction in water column concentrations. The various processes governing mercury speciation and transformation in the Willamette River system are complex rate-dependent processes that are poorly understood and it is difficult to predict with complete certainty how the concentrations of the various species of mercury will change with decreases in total mercury loading. The basic assumption utilized in this mass balance approach, however, is that water column concentrations will decline as source contributions decrease. The validity of this assumption will be addressed in future studies as a component of the adaptive management process (see below).

Water Column Guidance Value

The FWM was employed to establish a range of interim guidance values for total mercury and methyl mercury in surface water as described above and in Appendix B. These interim water column guidance values are linked to the restoration of the beneficial use of fish consumption. Several mercury guidance values for the Willamette Basin were generated varying in their probability of affording human health protection relative to the established fish tissue criterion. These interim guidance values are presented in Table 3.3 (for total mercury) and Table 3.4 (for methyl mercury) in the *Pollutant and Target Identification* section of this document. It should be noted that the FWM based its analysis on an acceptable fish tissue concentration of 0.3 mg/kg, as opposed to the 0.35 mg/kg utilized by the DHS in issuing their fish consumption advisory. The 0.3 mg/kg value was based on recent USEPA guidance establishing 0.3 mg/kg as the appropriate fish tissue criterion for methyl mercury (USEPA, 2001a). The use of 0.3 in our analysis, as opposed to 0.35, can be considered an explicit (15%) margin of safety (MOS).

Different fish species will bioaccumulate mercury to varying degrees based primarily on differences in their dietary patterns. The upper trophic level (piscivorous) predators like the bass and the northern pikeminnow are known to exhibit higher degrees of mercury bioaccumulation. This TMDL establishes an interim water column guidance value for mercury based on the biomagnification associated with an upper level predator namely, the northern pikeminnow (also known as squawfish). Whereas some may consider this to be an overly conservative decision, the guidance values presented in this TMDL need to address the specific species listed in the original DHS fish consumption advisory for the Willamette River, namely bass and the northern pikeminnow. Based on the results of the FWM, if the water column guidance value associated with the northern pikeminnow is attained, consumers of other fish species (including the largemouth and smallmouth bass) will also be protected. The choice of the northern pikeminnow as the basis of the water column guidance value is further validated by recent studies suggesting that northern pikeminnow are indeed consumed, although not specifically targeted by recreational or subsistence fishermen (Adolfson, 1996; EVS, 1999; DHS 2003). The pikeminnow itself is abundant throughout the mainstem Willamette system, easy to catch (as opposed to bass) and grows to be quite large. As a result of these factors, northern pikeminnow caught from the Willamette River system are known to be consumed on an occasional basis.

The FWM calculates a range of water column guidance values for each fish species considered varying in their degree of protectiveness for human consumers. If a water column guidance value associated with the fifth percentile were to be selected, there would be a five percent chance that a fish from that particular fish species would have a tissue concentration of mercury at or below the 0.3 mg/kg threshold. At guidance values corresponding to the ninety fifth percentile, there would be a ninety five percent probability that the fish would have a concentration at or below the 0.3 mg/kg threshold. ODEQ proposes to use the median value for the northern pikeminnow as the basis for the interim water column guidance value. The utilization of the median value is consistent with the various fish consumption advisories issued by the DHS which are based on average levels of mercury in fish. The median value for the northern pikeminnow corresponds to a greater degree of protectiveness for consumers of bass and other fish caught from the Willamette. The median value for the northern pikeminnow is basically equivalent to the 57th and 73rd percentile values for the largemouth and smallmouth bass, respectively.

The water column guidance value for total mercury (associated with the median value for the northern pikeminnow) is 0.92 ng/l (Table 3.3). If this guidance value were reached fifty percent of the time in the Willamette mainstem system, then our analysis predicts that average fish tissue concentrations of mercury in the northern pikeminnow will eventually fall below the threshold of 0.3 mg/kg thereby eliminating the need for fish consumption advisories pertaining to mercury.

Preliminary Estimate of the Necessary Percent Reduction

ODEQ's ambient monitoring data were used to estimate the mean annual concentration of total mercury in the mainstem Willamette River. Five sites in the mainstem Willamette River were sampled on a quarterly basis to obtain an average annual mercury concentration (total, unfiltered) of 1.25 ng/l (Appendix B). For the purpose of this analysis, the geometric mean was used as the most appropriate statistical measure of average ambient conditions. (The geometric mean more closely approximates the median of log-normally distributed data and is less sensitive to the extreme values recorded during high flow events.) This average annual mercury concentration (1.25 ng/l) was then compared to the interim water column guidance value (0.92 ng/l; the number associated with the median value for the northern pikeminnow) to obtain an estimate of the percent reduction in water column concentrations in the Willamette needed to attain the interim water column guidance value. If we were to attain a 26.4 % reduction in ambient total mercury concentrations in the Willamette River, then based on our modeling and the assumptions inherent in this approach, there would be a 50 % likelihood that a northern pikeminnow taken from the Willamette would have a fish tissue concentration less than 0.3 mg/kg. As mentioned before, if the water column guidance value associated with the northern pikeminnow were attained, consumers of largemouth and smallmouth bass would also be protected.

The estimated annual mean rate of mercury inputs in the mainstem Willamette River System is approximately 128.5 kg/yr (as presented in Table 3.5 in the *Mercury Mass Loads* section of this document). According to the hypotheses outlined above, it is assumed that a given percent reduction in the mercury mass load will result in a linear percent reduction in water column concentrations. In other words, a 26.4% reduction in the loading of total mercury would eventually lead to a corresponding reduction in water column concentrations. A 26.4% reduction in the average annual load of mercury corresponds to a 33.9 kg/yr reduction in total mercury loading to the Willamette system and a loading capacity of 94.6 kg/yr. This loading capacity represents the maximum amount of total mercury that the Willamette River can absorb on an average annual basis and still meet the beneficial use of fish consumption. If additional information suggests that any of the assumptions outlined above are not valid, then the loading capacity and the necessary percent reduction presented in this section would be modified as part of the iterative adaptive management process.

An analogous process was used to calculate the loading capacity and the required percent reduction for the watersheds above the Dorena and Cottage Grove Reservoirs. For the Dorena watershed, the estimated total mercury mass load is 2.08 kg/yr. The average annual water column concentration in Dorena Reservoir is 1.31 ng/l necessitating a 29.8% reduction to attain the water column guidance value of 0.92 ng/l. A 29.8% reduction in loading for this system corresponds to a loading capacity of 1.46 kg/yr and a required load reduction of 0.62 kg/yr.

For the Cottage Grove Watershed, the estimated total mercury mass load is 3.13 kg/yr. The average annual water column concentration in Cottage Grove reservoir is 2.86 ng/l necessitating a 67.8% reduction to attain the water column guidance value of 0.92 ng/l. A 67.8% reduction in loading for this system corresponds to a loading capacity of 1.01 kg/yr and a required load reduction of 2.12 kg/yr. As illustrated in Figures 3.6 and 3.7 of this document, legacy mines do not appear to represent a major continuing source of mercury for the Dorena Watershed but they do represent a significant source of mercury for the Cottage Grove system. Table 3.6 presents a summary of current loads, loading capacities, and necessary percent reductions for the mainstem Willamette River, Cottage Grove and Dorena systems.

It should be noted that the current estimates of the annual ambient concentration of total mercury in the mainstem Willamette and the Dorena and Cottage Grove Reservoirs are based on quarterly data from a single monitoring year. Continued ambient monitoring will help refine the estimates of annual average mercury concentrations and the percent reductions necessary to attain the water column guidance values.

Table 3. 6 Loads, loading capacities and percent reductions for waterbodies considered in this analysis.

Waterbody	Estimate of current average annual load (kg/yr)	Loading capacity (kg/yr)	Required percent reduction in total load to attain the loading capacity
Mainstem Willamette	128.5	94.6	26.4
Dorena Watershed	2.08	1.46	29.8
Cottage Grove Watershed	3.13	1.01	67.8

Interim Wasteload and Load Allocations

The source characterization presented in Appendix B presents an estimate of the average annual loading of mercury from various source categories including atmospheric deposition, soil erosion, abandoned mines, and municipal and industrial discharges. As mentioned previously, the urban stormwater component is contained within the estimates of runoff from atmospherically deposited mercury and the erosion of native mercury containing soils.

Interim wasteload allocations are assigned to source sector categories as opposed to individual point sources within a sector. This policy decision is based on the significant uncertainty that exists concerning mercury's behavior in the environment, the precise contribution from individual point sources (adding or contributing to the standards violation), and the effectiveness of potential implementation activities. Given these factors, ODEQ sees no benefit in developing wasteload allocations at a level of detail finer than the sector-wide allocations presented in this TMDL or to develop individual numeric NPDES permit limits, at this point in time. Point sources within a sector will be required to develop mercury minimization plans and to monitor their effluent to better characterize their contribution of mercury and the effectiveness of management measures. The implementation of best management practices (BMPs) should allow point sources to meet the overall allocation for the specific sector. Nonpoint source sectors will be expected to implement mercury reduction activities via the established programs presented in the Water Quality Management Plan (see Chapter 14). The effectiveness of these BMPs in attaining sector-wide allocations will be evaluated over time as part of the adaptive management framework.

The summary balance of mercury inputs are presented in Table 3.5 and the relative source load contributions for the mainstem are presented in Figures 3.3 and 3.4. Each of the categories considered in the source characterization analysis has been given an interim allocation consistent with the need to reduce total mercury loading by 26.4% (see above). The addition of a small reserve capacity of 0.6% to account for growth and/or new sources (see below) brings the required percent reduction for the mainstem Willamette sources to 27%. ODEQ is proposing an ‘across the board’ reduction of 27% for *each* of the source categories considered in the analysis. A prorated or proportional allocation framework was at one time being considered for this TMDL but a number of members of the Willamette Basin TMDLs Council felt that an across the board reduction framework was more equitable and justifiable given the limited information available. The sum of the wasteload allocations (for point sources), the load allocations (for nonpoint sources), and the reserve capacity is equal to the loading capacity for the system. In order to achieve the guidance value for mercury in the mainstem Willamette system, the sum of all loads from the various source categories would need to be equal to or less than the loading capacity of 94.6 kg/yr.

The estimated current loads and interim allocations for each of the source sector categories considered in the Source Characterization analysis are presented in Table 3.7. The sum of the current loads is 128.5 kg/yr and the sum of the allocated loads is 93.8 kg/yr, representing a 27% reduction from current levels. The total current loads into the Dorena and Cottage Grove Reservoirs are 2.08 and 3.13 kg/yr, respectively. Allocations for the Dorena and Coast Fork watersheds are presented in Table 3.8. Interim load allocations for the Dorena and Cottage Grove watersheds are 1.46 and 1.01 kg/yr, respectively.

The estimated load of total mercury from all known and currently quantified point sources (5 kg/yr) represents approximately 4% of the total load of mercury in the mainstem Willamette River system. Due to the fact that the impairment of the Willamette River is due primarily to nonpoint sources associated with either atmospheric deposition or the erosion of mercury containing soils, the complete elimination or significant reduction of mercury from water point source discharges would not be enough to attain the interim water column target. In other words, even if this TMDL were to allocate none of the calculated allowable load to NPDES point sources (i.e. a wasteload allocation of zero), the applicable water column targets for mercury would not be attained because of the very high mercury loadings from nonpoint sources. At the same time, however, ODEQ recognizes that mercury is an environmentally persistent bioaccumulative toxic substance that should be eliminated from discharges to the extent practicable. In this initial phase of the TMDL, ODEQ expects that point source loadings of mercury would be reduced primarily through mercury minimization programs developed and implemented by industrial and municipal point sources. Eliminating the point source discharges of mercury (through a wasteload allocation of zero) would have little overall effect on water quality and would cause much economic hardship. Furthermore, reducing point source loadings beyond the levels contemplated by the cumulative wasteload allocation would not be necessary to achieve the interim water column targets.

The analysis presented in this document suggests that no one source category is entirely responsible for the mercury contamination in the Willamette Basin. Collaborative efforts extending across all source categories (both point and nonpoint) will be necessary to achieve reductions in mercury loading and, ultimately, the restoration of the beneficial use of fish consumption. A description of the various implementation activities designed to achieve cross-sector reductions in the load of total mercury are presented in detail in the Water Quality Management Plan (see Chapter 14).

Table 3. 7 Estimated Current Loads and Interim Mercury Allocations for the mainstem Willamette River System.

Source Sector Category	Estimated Load of Total Hg (kg/yr)	Interim Allocation Load or Wasteload (kg/yr)
Nonpoint Sources (assigned interim load allocations)		
Runoff of atmospherically deposited mercury	53.7[(a)]	39.2
Direct deposition to open water	7.6	5.5
Erosion of mercury containing soils	61.4[(a)]	44.8
Legacy mine discharges	0.8[(b)]	0.6
Sediment re-suspension (input to water column)	0.0 [(c)]	0.0 [(c)]
Point Sources (assigned interim wasteload allocations by sector)		
POTW Discharges	3.5	2.6
Industrial Discharges	1.5	1.1
Sum of Current or Allocated Loads	**128.5**	**93.8**
Reserve Capacity	NA	0.8[(d)]

(a) The estimate of the total mercury load for this source category includes a component attributable to stormwater discharges from urbanized areas. These stormwater inputs may originate in either MS4 communities or non-MS4 communities and includes the overland flow of mercury directly into impacted waterbodies. In certain situations these loadings may be considered to be point sources, as in the case of MS4 discharges, but for the purpose of this analysis, the stormwater component is contained within the 'runoff of atmospherically deposited mercury' and 'erosion of mercury containing soils' categories and is accounted for here as a nonpoint source category.

(b) The contribution from legacy mines is considered to be a nonpoint source input due to the reasons outlined in the text of this document.

(c) Seasonal average value, expected to be significantly higher during the wet (high flow) season.

(d) The sum of the allocated loads and the reserve capacity is equal to the loading capacity of the system (94.6 kg/yr).

Table 3. 8 Estimated Current Loads and Interim Mercury Allocations for the Cottage Grove and Dorena Watersheds.

Source Sector Category	Estimated Load of Total Hg (kg/yr)	Interim Allocation Load or Wasteload (kg/yr)
Cottage Grove Watershed		
Runoff of atmospherically deposited mercury	0.22	0.07
Direct atmospheric deposition to water	0.03	0.01
Erosion of mercury containing soils	0.55	0.18
Legacy mine discharges	2.33	0.75
Sum of Current or Allocated Loads for CG Reservoir	**3.13**	**1.01**[b,c]
Dorena Watershed		
Runoff of atmospherically deposited mercury	0.58	0.41
Direct atmospheric deposition to water	0.07	0.05
Erosion of mercury containing soils	1.43	1.00
Legacy mine discharges	ND[a]	ND[a]
Sum of Current or Allocated Loads for Dorena Res.	**2.08**	**1.46**[b,d]

(a) ND = Not Determined; no data currently available with which to estimate an actual value or to assign an interim load allocation. In the event new information allows us to quantify a load attributable to legacy mining discharges, the estimated rates for the runoff of atmospherically deposited mercury and the erosion of mercury containing soils will be adjusted accordingly. The sum of the current loads would not change.
(b) The sum of the allocated loads is equal to the loading capacity of the system.
(c) For the Cottage Grove Watershed, a total reduction of 67.8% is needed to attain the interim water quality guidance value.
(d) For the Dorena Watershed, a total reduction of 29.8% is needed to attain the interim water quality guidance value.

Margin of Safety

The FWM employed in this TMDL utilizes a fish tissue criterion of 0.3 mg/kg in establishing water column targets consistent with current USEPA recommendations. The DHS, on the other hand, employed a threshold of 0.35 mg/kg in edible fish tissue in issuing their fish consumption advisories (DHS, 1993, 1997a, 1997b, 2004a, 2004b). The use of the lower more conservative 0.3 mg/kg represents a conservative margin of safety on the order of 15%. The selection of the interim water column guidance value was also conservative by nature as we have utilized the northern pikeminnow, the most efficient bioaccumulator considered in our model. In selecting a guidance value based on the northern pikeminnow, we have chosen one that is also protective of consumers of other fish species that are more readily consumed by anglers. For example, the median guidance value associated with the northern pikeminnow would correspond to the 57th percentile value for the largemouth bass. In other words, at the guidance value utilized in this analysis (0.92 ng/l), 57% of the largemouth bass would be expected to exhibit fish tissue concentrations at or below 0.3 mg/kg.

Reserve Capacity

The reserve capacity is an allocation set aside for increases in pollutant loads from future growth and/or new or expanded sources. ODEQ has the discretion of issuing (or choosing not to issue) a reserve capacity. ODEQ has incorporated a small reserve capacity of 0.8 kg/yr (0.6% of the total estimated load) in this TMDL analysis for mercury. This small reserve capacity would allow a growing municipality or a new source to discharge effluent containing low levels of mercury. ODEQ, however, does not anticipate major increases in mercury loading in the near future. Mercury has been identified as a persistent bioaccumulative chemical of concern and many actions are currently occurring throughout the region to minimize the use of mercury in products and to remediate sites contaminated with mercury. These cross programmatic actions to reduce mercury discharges are outlined in ODEQ's Mercury Reduction Strategy (ODEQ, 2003a). Measures to minimize soil erosion from agricultural areas, forested environments, and construction sites are currently being implemented throughout the basin. In addition, there are no longer active mercury mines in the Willamette Basin and the use of mercury in gold and silver mining has been curtailed. The incorporation of this small reserve capacity in this TMDL analysis changes the total required percent reduction from the various sectors from 26.4% to 27%.

Adaptive Management

ODEQ recognizes that a number of assumptions were made as part of this TMDL process and that gaps in our understanding of mercury's sources and fate and transport still exist. For example, little is known regarding the precise rates and locations of mercury methylation in the Willamette Basin. A more detailed mass balance analysis is needed to better understand how mercury cycles within the Willamette Basin. A mass balance analysis for mercury, considering both anthropogenic and natural inputs as well as the partitioning of mercury into discreet environmental media, will permit a more complete and representative accounting of the relative contributions of total and methyl mercury to the Willamette River system. Without a comprehensive numeric model such as this, it is difficult to assess the relative percentages of total and methyl mercury mass loads from natural and anthropogenic sources. A calibrated model would also allow us to predict the effectiveness of remediation efforts or sector-specific source category reductions in terms of ultimately achieving reduced environmental/fish tissue concentrations. Additional information is also needed to better understand the significant seasonal variations known to affect mercury loading and methylation in the Willamette River system.

ODEQ expects to work with its stakeholders over time to help fill any remaining data gaps and to refine the interim targets and policy recommendations presented in this document. Potential projects include: refining our estimate of sediment resuspension; quantifying tributary inputs; identifying sinks and sources of mercury; determining the systems responsiveness to decreases in mercury loading; and clarifying how much of the mercury associated with each source category is actually bioavailable for uptake into aquatic organisms. It will also be essential to incorporate additional ambient data and more extensive source data (on total mercury and dissolved methyl mercury concentrations and discharge rates) from key major industrial, municipal and stormwater source categories. The lack of adequate information on mercury source contributions from the various source categories mentioned above is a significant limitation of this TMDL.

The WQMP associated with this TMDL (see Chapter 14) provides a well-defined framework for gathering additional information related to mercury and conducting additional analyses with the ultimate goal of releasing *revised* guidance values and allocations by the end of 2011. The activities presented in the WQMP will help address some of the remaining unknowns and reduce some of the inherent uncertainties. ODEQ also commits to further evaluation of the methodological and modeling tools employed in this study. In the event new information suggests improved alternative methods for establishing guidance values and/or load allocations, this information will be incorporated into the 2011 revisions as part of the adaptive management framework.

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UNITED STATES DISTRICT COURT

DISTRICT OF OREGON

PORTLAND DIVISION

NORTHWEST ENVIRONMENTAL ADVOCATES, an Oregon nonprofit corporation,

Plaintiff,

v.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY and **GINA McCARTHY**, in her official capacity as Administrator of the United States Environmental Protection Agency,

Defendants.

Case No. 3:15-cv-01151

COMPLAINT
Administrative Procedure Act
(5 U.S.C. § 702)

INTRODUCTION

1. Plaintiff Northwest Environmental Advocates ("NWEA") brings this action pursuant to the judicial review provisions of the Administrative Procedure Act, 5 U.S.C. § 702 *et seq*., challenging the United States Environmental Protection Agency's ("EPA") and the EPA Administrator's approval of Idaho's water quality criteria for arsenic, established by that State and submitted for EPA review under section 303 of the Clean Water Act ("CWA"), 33 U.S.C. § 1313.

2. Arsenic is a highly toxic pollutant that can harm people at low concentrations. Studies have shown that exposure to or consumption of arsenic, in its inorganic form, can impair or damage almost every human function, including the nervous, cardiovascular, renal, and respiratory systems, and arsenic is a known human carcinogen, causing lung, urinary bladder, skin, and possibly liver, kidney, and prostate cancers. Arsenic is found throughout the surface and ground waters of the State of Idaho, often as a result of human land-disturbing activities such as metallic mining and ore processing, and people are exposed to this arsenic through the consumption of water and fish.

3. The CWA requires states to adopt, and EPA to review and approve or disapprove, water quality standards that, *inter alia*, "protect the public health and welfare [and] enhance the quality of water" in each state. 33 U.S.C. § 1313(c)(2)(A). EPA regulations explicitly require states to follow EPA guidance or "[o]ther *scientifically defensible* methods" when adopting numeric water quality criteria.[1] 40 C.F.R. § 131.11(b) (emphasis added). These directives

[1] Water quality "criteria" are but one part of water quality "standards" under the CWA; criteria are defined by EPA as "elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use." 40 C.F.R. § 131.3; *see also Nw. Envtl. Advocates v. U.S. E.P.A.*, 855 F. Supp. 2d 1199, 1208-09 (D. Or. 2012). While the CWA requires EPA approval of state water

notwithstanding, in 2010 EPA impermissibly approved Idaho's adoption of numeric water quality criteria for arsenic that were developed under a wholly separate regulatory regime—the federal Safe Drinking Water Act ("SDWA")—without considering the relevant factors under the CWA, without employing a "scientifically defensible" methodology, and without determining whether Idaho's new arsenic criteria would actually protect human health, a designated use.

4. Moreover, EPA's approval contradicts its own established policy against allowing states to use SDWA standards when they establish human health criteria pursuant to the CWA. EPA has long recognized that standards developed for SDWA purposes do not account for fish consumption or other pathways of human exposure, and take economic and other factors into account that are not permissible when setting water quality standards under the CWA. *See, e.g.*, Memorandum from Martha G. Prothro, Director, EPA Office of Water Regulations and Standards, to Water Management Division Directors, EPA Regions I-IX (Nov. 3, 1999); 65 Fed. Reg. 66,444, 66,451 (Nov. 3, 2000).

5. Notably, EPA's national recommended water quality criteria for arsenic for the protection of human health are 0.14 µg/L (for consumption of fish only) and 0.018 µg/L (for consumption of both fish and water). However, Idaho adopted, and EPA approved, arsenic human health criteria of 10 µg/L (for both consumption of fish only and for consumption of both fish and water)—a level several orders of magnitude greater than EPA's recommended criteria, but equal to the arsenic Maximum Contaminant Level ("MCL") established by EPA under the SDWA.

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quality standards in their entirety, including but not limited to numeric and narrative criteria, in this action NWEA challenges only EPA's approval of Idaho's numeric human health criteria for arsenic.

6. Because Idaho's human health criteria for arsenic fail to satisfy the relevant statutory and regulatory requirements under the CWA, EPA's approval of those criteria was arbitrary, capricious, an abuse of discretion, and otherwise contrary to law within the meaning of the Administrative Procedure Act ("APA"), 5 U.S.C. § 706(2)(A).

7. EPA's arbitrary and capricious action has harmed and continues to harm NWEA's interest, and the interests of its members, in having clean and unpolluted waters in Idaho that are fit for human use, including fish consumption, and as habitat for aquatic and aquatic-dependent species. NWEA seeks declaratory, injunctive, and other appropriate relief on its own behalf and on behalf of these members.

JURISDICTION AND VENUE

8. The Court has subject matter jurisdiction pursuant to the APA, 5 U.S.C. §§ 701–704, and the federal question statute, 28 U.S.C. § 1331.

9. Venue in this district and division is proper pursuant to 28 U.S.C. § 1391(e)(1)(C) and Local Rule 3-2 because no real property is involved in this action and plaintiff NWEA resides in this district and division.

10. The relief requested herein is authorized by the APA, 5 U.S.C. § 706(2); the Equal Access to Justice Act, 28 U.S.C. § 2412; and 28 U.S.C. §§ 2201-02.

PARTIES

11. Plaintiff NORTHWEST ENVIRONMENTAL ADVOCATES is a regional non-profit environmental organization incorporated under the laws of Oregon, with its principal place of business in Portland, Oregon, located within Multnomah County. NWEA's mission is to work through advocacy and education to protect and restore water and air quality, wetlands, and wildlife habitat in the Northwest.

12. Defendant UNITED STATES ENVIRONMENTAL PROTECTION AGENCY is an agency of the United States Government charged with oversight responsibility under the CWA. EPA's oversight role includes supervision of state efforts to establish and implement water quality standards, and a duty to review and either approve or disapprove such state-promulgated standards.

13. Defendant GINA MCCARTHY is the Administrator of the EPA, and in that official capacity is required to take certain actions to oversee and implement the CWA, including the review and approval or disapproval of state-submitted water quality standards as well as the promulgation of replacement standards where necessary. 33 U.S.C. § 1313(c).

LEGAL BACKGROUND

14. In 1972, Congress adopted amendments to the Clean Water Act in an effort "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a). To that end, the CWA requires states to develop water quality standards that establish and protect the desired conditions of each waterway within the state's regulatory jurisdiction. 33 U.S.C. § 1313(a). Water quality standards must be sufficient to "protect the public health or welfare, enhance the quality of water, and serve the purposes of" the CWA. 33 U.S.C. § 1313(c)(2)(A).

15. Water quality standards establish the water quality goals for a waterbody. 40 C.F.R. § 131.2. Water quality standards are implemented, in part, through the issuance of permits to "point sources" of water pollution under the National Pollutant Discharge Elimination System ("NPDES"). 33 U.S.C. § 1342. Without such an NPDES permit, any discharge of any pollutant from a point source to waters of the United States is unlawful. 33 U.S.C. §§ 1311(a), 1342(a)(1). All NPDES permits are required to include, among other provisions, effluent limitations or other

conditions that are "necessary to meet water quality standards." 33 U.S.C. §§ 1311(b)(1)(C), 1342.

16. Water quality standards must include three elements: (1) one or more designated uses of a waterway; (2) numeric and narrative criteria specifying the water quality conditions, such as maximum amounts of toxic pollutants, maximum temperature levels, and the like that are necessary to protect the designated uses; and (3) an antidegradation policy that protects existing uses and ensures and that high quality waters will be maintained. 33 U.S.C. §§ 1313(c)(2), 1313(d)(4)(B); 40 C.F.R. Part 131, Subpart B. For waters with multiple use designations, the criteria must support the most sensitive use. 40 C.F.R. § 131.11(a)(1).

17. States are required to adopt water quality criteria that protect the designated uses of a water body. 33 U.S.C. § 1313(c). Water quality criteria "must be based on sound scientific rationale and must contain sufficient parameters or constituents to protect the designated use." 40 C.F.R. § 131.11(a)(1).

18. To guide the states, EPA publishes national recommended water quality criteria "accurately reflecting the latest scientific knowledge" on health effects, biological effects, and pollutant characteristics. 33 U.S.C. § 1314(a). States may base their new or revised water quality criteria on this EPA guidance, or they may use other "scientifically defensible methods" of establishing their criteria. 40 C.F.R. § 131.11(b).

19. EPA's current national recommended human health criteria for arsenic developed under 33 U.S.C. § 1314(a) are 0.018 μg/L for the consumption of water + organisms, and 0.14 μg/L for the consumption of organisms only. *See* EPA, National Recommended Water Quality Criteria, *at* http://water.epa.gov/scitech/swguidance/ standards/criteria/current/index.cfm. EPA notes that these criteria, published in 1992, are currently being reassessed. *Id*. at footnote M.

For example, the National Academy of Sciences has advised that "[c]onsideration should also be given to the growing evidence from human and animal studies that suggests that early-life exposure to arsenic may increase the risk of adverse health effects and the risk of impaired development in infancy and childhood and later in life." National Academy of Sciences, Critical Aspects of EPA's IRIS Assessment of Inorganic Arsenic: Interim Report (2013), at 6, *available at* http://www.nap.edu/catalog/18594/critical-aspects-of-epas-iris-assessment-of-inorganic-arsenic-interim (accessed June 15, 2015).

20. The CWA requires States to review and, where necessary, revise their water quality standards, including numeric and narrative criteria, at least every three years. 33 U.S.C. § 1313(c)(1). Revised standards must be submitted to EPA for review, and only become effective for CWA purposes if and when EPA approves them. *Id*. § 1313(c)(1), (3); 40 C.F.R. § 131.5.

21. EPA must review the submitted standards to determine whether the criteria meet the requirements of the CWA. 33 U.S.C. § 1313(c)(3); 40 C.F.R. § 131.5. Among other requirements, prior to approving a state water quality standard EPA must determine that the State has provided "[m]ethods used and analyses conducted to support [the] water quality standards revisions" and that the State's criteria are "based on sound scientific rationale[.]" 40 C.F.R. §§ 131.6(b), 131.5(a)(5).

22. Congress enacted the SDWA to ensure that public water supply systems meet minimum national standards for the protection of public health. 42 U.S.C. § 300f *et seq*.

23. The SDWA requires EPA to promulgate a national primary drinking water regulation, including a maximum contaminant level ("MCL") and maximum contaminant level goal ("MCLG"), for those contaminants that may have an adverse effect on the health of consumers. 42 U.S.C. § 300g-1.

24. An MCL is "the maximum permissible level of a contaminant in water which is delivered to any user of a public water system." 42 U.S.C. § 300f(3). An MCLG, by contrast, is a non-enforceable health-based goal, representing contaminant levels in drinking water below which there are no known or expected risks to health. 42 U.S.C. § 300g-1(b)(4). MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking treatment costs into consideration. 42 U.S.C. § 300g-1(b)(3)(C).

25. Arsenic is a regulated contaminant under the SDWA. EPA has promulgated an MCL of 10 µg/L, and a MCLG of zero (0 µg/L), for arsenic. 40 C.F.R. §§ 141.51(b), 141.62(b)(16).

26. EPA has a longstanding policy of discouraging states from blindly adopting SDWA MCLs as their human health water quality criteria for CWA purposes, especially where routes of human exposure other than drinking water—for example, consumption of fish—must be considered. *See, e.g.*, EPA, Notice of Availability of Water Quality Criteria Documents, 45 Fed. Reg. 79,318, 79,320 (Nov. 28, 1980) (explaining the important differences between MCLs developed under the SDWA and national recommended water quality criteria developed under section 304(a) of the CWA, 33 U.S.C. § 1314(a)).

27. In a February 28, 1985 guidance memorandum, EPA emphasized that states' deviations from EPA's national recommended water quality criteria were acceptable in appropriate circumstances, "but such deviations <u>must</u> have justifications which are scientifically defensible and adequately documented" and should "reflect the nature of the pollutant[.]" EPA Memorandum from Edwin L. Johnson to Water Division Directors (Feb. 28, 1985), at 1 (emphasis in original), *available at* http://water.epa.gov/ scitech/swguidance/standards/upload/1999_11_03_standards_criteriaselection.pdf.

28. In a November 3, 1999 guidance memorandum, EPA noted that certain states "have adopted inappropriate human health criteria (e.g., a maximum concentration limit (MCL) when fish ingestion is an important activity)" and that "[f]or the protection of public water supplies, EPA encourages the use of MCLs . . . [but when] fish ingestion is important, then the water quality criteria value developed under Section 304(a) of the Clean Water Act based on fish consumption should be used." EPA Memorandum from Martha G. Prothro to Water Management Division Administrators (Nov. 3, 1999), at 1, *available at* http://water.epa.gov/scitech/swguidance/standards/ upload/1999_11_03_criteria_compliance.pdf.

29. On November 3, 2000, EPA issued guidance on Revisions to the Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. 65 Fed. Reg. 66,444 (Nov. 3, 2000). This Methodology provides that where EPA has published a recommended CWA § 304(a) criterion based on its 1980 methodology and "for which EPA has more recently promulgated an MCLG, EPA generally recommends . . . a criterion derived by recalculating the MCLG at an acceptable cancer risk level[.]" *Id*. at 66,450. It further provides that "EPA no longer recommends that an MCL be used where consideration of available treatment technology, costs, or availability of analytical methodologies has resulted in an MCL that is less protective than an MCLG." *Id*. at 66,450–51.

FACTUAL BACKGROUND

Arsenic and its Effects on Human Health

30. Arsenic is a semi-metal element found in both organic and inorganic compounds. Arsenic occurs naturally in soil and in many kinds of rock, especially in minerals or ores that contain copper or lead. Arsenic is commonly released into the environment, including surface

waters and groundwater, through land-disturbing activities such as mining, ore crushing, waste rock storage and disposal, smelting, and burning coal.

31. EPA has designated arsenic and its compounds as "toxic pollutants" pursuant to CWA § 307(a)(1). 40 C.F.R. § 401.15.

32. In Idaho, releases of arsenic into the environment are often associated with past or present hard rock mining activities. Several former mines in Idaho are now listed or proposed for listing on EPA's National Priorities List pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA")[2] or are being actively investigated and remediated by the EPA, in part because of their historic arsenic pollution of surface and groundwater or the ongoing threat of arsenic discharges to surface and groundwater. Examples include the Blackbird Mine in Lemhi County; the Eastern Michaud Flats Contamination Superfund Site near Pocatello, Idaho; the Conjecture Mine in Bonner County, Idaho; the Lakeview Mine in Bonner County; the Stibnite/Yellow Pine Mining Area in Valley County, Idaho; and the Talache Tailings Mine Site near Atlanta, Idaho. Additionally, the Atlanta Gold Mine, which is located near Montezuma Creek in the Boise River watershed, was recently held liable for violations of the Clean Water Act and ordered to pay a large civil penalty after it repeatedly violated its NPDES permit limits for arsenic, among other pollutants.

33. Exposure to arsenic can cause significant adverse effects to human health. *See generally* U.S. Dept. of Health & Human Services, Toxicological Profile for Arsenic (2007) ("Toxicological Profile"), *available at* http://www.atsdr.cdc.gov/toxprofiles/ tp2.pdf. Scientific studies have identified its adverse effects on virtually every human organ evaluated; for example,

[2] The National Priorities List is EPA's list of the most contaminated sites that warrant priority cleanup under CERCLA. *See generally* EPA, National Priorities List: Basic Information, *at* http://www.epa.gov/superfund/sites/npl/npl_hrs.htm.

oral exposure in humans can lead to peripheral vascular effects, including gangrene, and can result in increased incidence of high blood pressure, cardiovascular disease, and circulatory problems. Individuals exposed to arsenic in drinking water may also exhibit skin lesions and decreased lung function. Nausea, vomiting, and diarrhea are common symptoms in humans, resulting from irritation of the gastrointestinal tract following repeated oral exposure to low doses. Long-term, low-dose exposure can also lead to peripheral nerve damage, and studies have reported neurobehavioral alterations in children exposed to arsenic. A person's risk for experiencing health effects from arsenic increases the longer that person is exposed.

34. Arsenic is a known human carcinogen. Skin tumors are the most common type of cancer resulting from oral exposure, but epidemiological studies also indicate increased risk of internal tumors of the bladder, lung, liver, kidney, and prostate. Toxicological Profile at 6; *see also* EPA, "National Primary Drinking Water Regulations; Arsenic and Clarifications to Compliance and New Source Contaminants Monitoring," 66 Fed. Reg. 6,976, 7,001–7,003(Jan. 22, 2001).

35. People are exposed to arsenic by eating or drinking food or water containing arsenic, inhaling arsenic dust, or direct contact with arsenic. The likely primary route of human exposure to arsenic is through drinking water and consuming food, including fish.

36. The concentration of arsenic in fish tissue is an important driver of the risks associated with consuming toxic chemicals, including arsenic, present in Idaho's waters. Aquatic organisms bioaccumulate arsenic—meaning the substance builds up and increases concentration in their bodies over time—when they are exposed to arsenic through the water or through their diet.

37. Fish consumption is a use, for CWA purposes, throughout Idaho's surface waters.

To protect that use, Idaho has adopted numeric water quality criteria for the consumption of "water and organisms" and "organisms only" for a wide range of toxic pollutants, including arsenic, that are applicable to nearly every surface water in the State. *See* Idaho Admin. Code § 58.01.02.210.01(a)-(c) and Tables. In fact, Idaho's use of an inadequate fish consumption level in revising its human health criteria for 88 toxic pollutants was the basis for EPA's disapproval of those criteria in May 2012. Arsenic was not included in this disapproval, however, because Idaho's arsenic criteria are not based on human fish consumption.

The Interests of NWEA's Members

38. NWEA has members who reside near, visit, use and enjoy rivers, streams, and other surface waters, including wetlands, throughout the State of Idaho, including the Boise River, Salmon River, Snake River, and their many tributaries. These NWEA members regularly use and enjoy these waters and adjacent lands and have definite future plans to continue to use and enjoy these waters for recreational, subsistence, scientific, aesthetic, spiritual, commercial, conservation, educational, or other purposes. NWEA's members derive benefits from their use and enjoyment of Idaho's waters and the fish and aquatic-dependent wildlife that rely upon Idaho's waters.

39. EPA's approval of Idaho's water quality standard for arsenic harms NWEA and its members because the criteria in that standard are not sufficiently protective of human health, and in particular do not account for potential exposure to arsenic via fish consumption. Some of NWEA's members enjoy fishing in rivers and streams in Idaho that contain elevated concentrations of arsenic or are at risk of degradation from arsenic pollution, especially from mining activities. These members are reasonably concerned about their exposure to arsenic via consumption of fish; in fact, some of NWEA's members have stopped or reduced eating the fish

they catch in some of Idaho's waters because of their concern over potential exposure to elevated levels of arsenic.

40. EPA's approval of Idaho's water quality standard for arsenic is likely to result in the discharge of arsenic from NPDES-permitted facilities in concentrations greater than what would otherwise be allowed had EPA *disapproved* the Idaho arsenic standard and required the State to develop human health criteria consistent with EPA's far more stringent national recommended human health criteria. These increased concentrations of arsenic in Idaho's waters will further injure NWEA's members by further exposing them to, or increasing the risk of their exposure to, arsenic through fish consumption, among other routes of exposure.

41. As a result of EPA's arbitrary and capricious approval of Idaho's arsenic water quality standard for the protection of human health, less protective standards are in use in Idaho than would otherwise be applicable, which adversely affects human health and aquatic and aquatic-dependent species. NWEA's members would derive more benefit and enjoyment from their use of Idaho's waters, including through fish consumption, and adjacent lands if they knew that Idaho's arsenic standard was fully protective of human health, fish, and wildlife.

42. NWEA and its members have a specific interest in the full and proper implementation of the CWA, which was designed to protect our nation's waters and the designated uses that depend upon the quality of those waters. EPA's approval of Idaho's water quality standard for arsenic harms NWEA and its members' interests by decreasing the CWA's protections for water bodies and the people who use them.

43. The above-described interests of NWEA and its members have been, are being, and, unless the relief requested herein is granted, will continue to be adversely affected by EPA's approval of Idaho's arsenic standard. The relief requested in this complaint will ensure that the

arsenic water quality criteria used and implemented in Idaho are scientifically defensible and sufficiently protective of human health.

Idaho's Water Quality Standard for Arsenic

44. On December 22, 1992, EPA promulgated the National Toxics Rule ("NTR"), which established numeric toxic criteria for Idaho. 33 U.S.C. § 1313(c)(2)(B); 40 C.F.R. § 131.36(b)(1). The NTR arsenic criteria for the protection of human health are 0.14 µg/L for consumption of fish only and 0.018 µg/L for consumption of both fish and water. The NTR criteria are identical to EPA's current CWA section 304(a) recommended criteria for arsenic, published in 1992, which are based on a one in a million risk of cancer and a fish consumption rate of 6.5 grams/day.

45. On August 24, 1994, Idaho adopted its own water quality standards by incorporating the NTR into Idaho's rules by reference. On June 25, 1996, EPA approved Idaho's standards for toxics and subsequently withdrew Idaho from the NTR, effective November 10, 1997. 62 Fed. Reg. 52,926 (Oct. 9, 1997).

46. Idaho subsequently weakened its CWA arsenic human health criteria by raising them more than a hundredfold to 50 µg/L, which was at the time the arsenic MCL for drinking water under the SDWA. On April 23, 1999, Idaho submitted its revised arsenic criteria to EPA for approval; EPA never acted on that submission, which under EPA regulations applicable at the time made it effective for CWA purposes. *See* 40 C.F.R. § 131.21(c)(1) (1999); 65 Fed. Reg. 24,641, 24,642 (April 27, 2000).

47. On January 22, 2001, EPA finalized a rule that lowered the arsenic MCL from 50 µg/L to 10 µg/L under the SDWA.

48. In 2010, Idaho again revised its CWA arsenic human health criteria by adopting EPA's 10 µg/L MCL under the SDWA as the criteria for both consumption of water and fish and consumption of fish only. Idaho Admin. Code § 58.01.02.210(b). Idaho submitted its revised arsenic criteria to EPA for approval on June 21, 2010.

49. Idaho's 2010 revision to its arsenic human health criteria was not the result of a meaningful and CWA-compliant scientific process, but rather was a negotiated outcome to resolve pending litigation. As Idaho explained at the time:

> EPA's current recommended Clean Water Act 304(a) arsenic criteria for the protection of human health from exposure to arsenic due to drinking water and/or eating fish from surface water are much lower than the arsenic MCL of 10 µg/L. Nonetheless, EPA has approved the use of 10 µg/L as CWA criteria in many states around the country . . . It was agreed that if Idaho adopted and EPA approved an arsenic human health criterion of 10 ug/L for surface waters in Idaho . . . then [the plaintiff] would settle its complaint.

Idaho Department of Environmental Quality Memorandum, Justification: Idaho Rulemaking Docket 58-0102-0801, Arsenic Human Health Criteria & Low Limit on Hardness Used in Cadmium Aquatic Life Criteria Calculation (June 21, 2010), at 1.

50. By letter dated July 7, 2010, EPA formally approved Idaho's June 21, 2010 revisions to its arsenic human health criteria pursuant to EPA's authorities and obligations under 33 U.S.C. § 1313(c)(2) and 40 C.F.R. § 131.5.

CLAIM FOR RELIEF

51. Plaintiff hereby realleges and incorporates by reference all of the preceding paragraphs.

52. The CWA requires that water quality criteria be set at a level necessary to protect the designated uses of a waterbody and to enhance water quality. 33 U.S.C. § 1313(c)(2), (d)(4)(B); 40 C.F.R. Part 131, Subpart B.

53. EPA regulations state that water quality criteria "must be based on sound scientific rationale and must contain sufficient parameters or constituents to protect the designated use," and must also be set at the level necessary to protect the most sensitive use. 40 C.F.R. § 131.11(a)(1).

54. Before EPA may approve a state-promulgated water quality standard, it must determine that the state has provided "[m]ethods used and analyses conducted to support [the] water quality standards revisions" and that the state's criteria are "based on sound scientific rationale[.]" 40 C.F.R. §§ 131.6(b), 131.5(a)(5).

55. The APA provides those who are "adversely affected or aggrieved" by an agency action a right to judicial review of that action. 5 U.S.C. § 702 *et seq*.

56. EPA's July 7, 2010 approval of Idaho's revised human health water quality criteria for arsenic is a final agency action for which there is no other adequate remedy in a court, and is therefore subject to judicial review under the APA, 5 U.S.C. § 704.

57. The APA provides that an agency's action shall be held unlawful and set aside by a reviewing court if the agency's findings are "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." 5 U.S.C. § 706(2)(A).

58. EPA's July 7, 2010 approval of Idaho's revised human health water quality criteria for arsenic was arbitrary, capricious, an abuse of discretion, and otherwise not in accordance with law within the meaning of the APA, 5 U.S.C. § 706(2)(A), for at least the following reasons:

(A) EPA's approval was contrary to the CWA and its implementing regulation at 40 C.F.R. § 131.5(a)(2) because EPA failed to determine whether—or incorrectly determined that—Idaho's revised arsenic criteria protect the designated uses of Idaho's waters;

(B) EPA's approval was contrary to the CWA and its implementing regulation at 40 C.F.R. § 131.5(a)(5) because EPA failed to determine whether—or incorrectly determined that—Idaho's revised arsenic standard contained the minimum elements required by 40 C.F.R. § 131.6;

(C) EPA's approval was contrary to the CWA and its implementing regulation at 40 C.F.R. § 131.11 because Idaho's revised arsenic criteria were neither "based on sound scientific rationale" nor based on EPA's national recommended arsenic criteria or "[o]ther scientifically defensible methods;"

(D) EPA's approval was arbitrary and capricious because it was counter to EPA's longstanding policy against using SDWA MCLs as the human health criteria where fish consumption is a use, or where the MCL is less protective than the MCLG.

REQUEST FOR RELIEF

WHEREFORE, Plaintiff NWEA respectfully requests that this Court:

1. Declare that EPA's July 7, 2010 approval of Idaho's human health criteria for arsenic was arbitrary, capricious, and contrary to law within the meaning of the APA, 5 U.S.C. § 706(2)(A);
2. Hold unlawful and set aside EPA's approval of Idaho's arsenic water quality criteria;
3. Award Plaintiff its reasonable fees, costs, expenses, and disbursements, including attorneys' fees, associated with this litigation; and
4. Grant such other and further relief as this Court deems just and proper.

DATED this 25th day of June, 2015.

Respectfully Submitted,

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EPA 910-R-02-006

COLUMBIA RIVER BASIN
FISH CONTAMINANT SURVEY
1996-1998

U.S. Environmental Protection Agency
Region 10
Seattle, Washington 98101

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ACKNOWLEDGMENTS

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LIST OF ABBREVIATIONS AND ACRONYMS

ADD	average daily dose of a specific chemical (mg/kg-day)
AFC	average fish consumption
ALM	EPA Adult Lead Model
AT	averaging time for exposure duration (days)
ATSDR	Agency for Toxic Substances and Disease Registry
AVE	average
BCF	bioconcentration factor
BEIR	Biological Effects of Ionizing Radiation
BEST	Biomonitoring of Environmental Status and Trends
BKSF	biokinetic slope factor
BW	body weight
C	chemical concentration in fish tissue
CDC	Centers for Disease Control
CF	conversion factor
CSFII	Continuing Survey of Food Intake by Individuals
CSFs	cancer slope factors
CRITFC	Columbia River Intertribal Fish Commission
DDE	1,1-dichloro-2,2-*bis*(p-chlorophenyl)ethylene
DDT	1,1,1-trichloro-2,2-*bis*(p-chlorophenyl)ethane
DDD	1,1-dichloro-2,2-*bis*(p-chlorophenyl)ethane
DDMU	1,1-*bis*(p-chlorophenyl)2 chloro-ethylene
DF	detection frequency
DMA	dimethyarsenic
EF	exposure frequency (days/year)
ED	Exposure duration (years)
ECR_{new}	Excess cancer risk for the new exposure duration
ECR_{70}	Excess cancer risk estimate for a lifetime exposure duration of 70 years
ED_{new}	Individual exposure duration in years
ED_{70}	Default lifetime exposure duration of 70 years
EPA	Environmental Protection Agency
FS	fillet with skin
FW	fillet without skin
GC/AED	Gas Chromatograph/Atomic Emission Detector
GSD	Geometric Standard Deviation
GPS	global positioning system
HEAST	Health Effects Assessment Summary Tables
HFC	high fish consumption
HI	hazard index
HQ	hazard quotient
IEUBK	EPA integrated exposure uptake biokinetic model
IR	ingestion rate
LLD	lower limit of detection
LOAEL	lowest observed adverse effect level

MAX	maximum
MDC	minimum detectable concentration
MF	modifying factor
MIN	minimum
MMA	monomethylarsenic
NA	not applicable
NAERL	National Air and Radiation Environmental Laboratory
NCEA	National Center for Environmental Assessment
NCBP	National Contaminant Biomonitoring Program
NCRP	National Council on Radiation Protection and Measurements
ND	not detected
NOAEL	no observable adverse effect level
NS	not sampled
OCDD	Octachlorodibenzo-p-dioxin
OERR	EPA Office of Emergency and Remedial Response
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PSAMP	Puget Sound Ambient Monitoring Program
RfD	reference dose
RPFs	relative potency factors
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
2,3,7,8 TCDF	2,3,7,8 tetrachlorodibenzo-*p*-furan
TEC	toxicity equivalence concentration
TEF	toxicity equivalence factor
TRW	EPA Technical Review Workgroup for Lead
UF	uncertainty factors
WB	whole body
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey

Units

ng/kg	nanograms per kilogram (ppt)
µg/dl	micrograms per deciliter
µg/kg	micrograms per kilogram (ppb)
g/day	grams per day
mg/kg	milligram per kilogram (ppm)
kg	kilogram
kg/g	kilogram per gram
Bq	one radioactive disintegration per second
mg/kg-day	milligram per kilogram-day

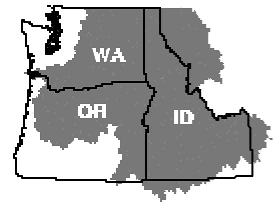
EXECUTIVE SUMMARY

Introduction

This report presents the results of an assessment of chemical pollutants in fish and the potential risks from consuming these fish. The fish were collected throughout the Columbia River Basin in Washington, Oregon, and Idaho.

After reviewing the results of the U.S. Environmental Protection Agency (USEPA. 1992a) 1989 national survey of pollutants in fish in the United States, EPA became concerned about the potential health threat to Native Americans who consume fish from the Columbia River Basin. The Columbia River Intertribal Fish Commission (CRITFC) and its member tribes (Warm Springs Tribe, Yakama Nation, Umatilla Confederated Tribes, Nez Perce Tribe) were also concerned for tribal members who consume more fish than non-Indians.

Map of Columbia River Basin



In order to evaluate the likelihood that tribal people may be exposed to high levels of contaminants in fish tissue EPA, CRITFC and its member tribes, designed a study in two phases. The first phase was a fish consumption survey which was conducted by the staff of CRITFC and its member tribes. The fish consumption survey was completed in 1994 (CRITFC 1994). The conclusions of the tribal survey were:

> "The rates of tribal members' consumption across gender, age groups, persons who live on- vs. off-reservation, fish consumers only, seasons, nursing mothers, fishers, and non-fishers range from 6 to 11 times higher than the national estimate used by USEPA."(quote from CRITFC, 1994, Page 59)

The results of the fish consumption survey accentuated the need to complete an assessment of chemicals in the fish being consumed by CRITFC's member tribes.

In 1994, EPA and CRITFC's member tribes initiated the second phase of the study which was a survey of contaminants in fish tissue in the Columbia River Basin and the subject of this report. The contaminant survey was designed by a multi-agency group including CRITFC, Washington Departments of Ecology and Health, Oregon Departments of Environmental Quality and Health, the Confederated Tribes of Warm Springs, the Yakama Nation, the Umatilla Confederated Tribes, the Nez Perce Tribe, U.S. Geological Survey, and U.S. Fish and Wildlife Service. Sample collection took place between 1996 and 1998 with the help of CRITFC's member tribes and staff of federal and state agencies. Chemical analyses were completed in 1999. The analyses were done by EPA and commercial laboratories.

While the study was initiated because of concern for Native American tribes, the results are

important to all people who consume fish from the Columbia River Basin.
This study provided EPA with information to determine:

1) if fish were contaminated with toxic chemicals,

2) the difference in chemical concentrations among fish species and study sites, and

3) the potential human health risks due to consumption of fish from the Columbia River Basin.

The results of this survey provided information on those chemicals which were most likely to be accumulated in fish tissue and therefore posed the greatest potential risks to people. These are the chemicals for which regulatory strategies need to be defined to reduce these chemicals in our environment.

This study was *not* designed to evaluate:

1) health of past or future generations of people who consume fish from the Columbia River Basin,

2) rates of disease in tribal communities,

3) specific sources of chemicals,

4) multiple exposures to chemicals from air, water, and soil,

5) food other than fish, and

6) risks for a specific tribe or individual.

It is our hope that the results of this survey will be used by CRITFC's member tribes as well as others to more completely evaluate and protect the quality of the fishery resource.

Study Design

This study was designed to estimate risks for a specific group of people (CRITFC's member tribes). Therefore, the sample location, fish species, tissue type, and chemicals were not randomly selected. Collection sites were selected because they were important to characterizing risks to CRITFC's member tribes. Chemicals were chosen because they were identified in other fish tissue surveys of the Columbia River Basin as well as being found throughout the environment.

This type of sampling is biased with unequal sample sizes and predetermined sample locations rather random. This bias is to be expected when attempting to provide information for individuals or groups based on their preferences. The results of this survey should not be extrapolated to any other fish or fish from other locations.

A total of 281 samples of fish and fish eggs were collected from the Columbia River Basin. The fish species included five anadromous species (Pacific lamprey, smelt, coho salmon, fall and spring chinook salmon, steelhead) and six resident species (largescale sucker, bridgelip sucker, mountain whitefish, rainbow trout, white sturgeon, walleye). Four types of samples were collected: whole-body with scales, fillet with skin and scales, fillet without skin (white sturgeon only), and eggs. The fillets were all with skin except for the white sturgeon. The armor-like skin of the white sturgeon is considered too tough for ingestion. All the samples were composites of individual fish, except white sturgeon. The white sturgeon were analyzed as single fish instead of composites because of their large size. The number of fish in a composite varied with species, location, and tissue type. Eleven samples of eggs were collected from steelhead and salmon. Due to availability of fish, limitation in time and funds, certain species were not sampled as frequently as others. In particular, the bridgelip sucker, coho salmon, and eulachon were collected at only one location. Pacific lamprey and walleye were collected at only two locations. The type of tissue tested (whole body, fillet, egg) varied with species and sample location.

Three replicate samples for each fish type were collected from a total of 24 study sites. These sites were located on 16 rivers and creeks, including, Hood River, Little White Salmon River, Wind River, Fifteen Mile Creek, Wenatchee River, Willamette River, Deschutes River, Umatilla River, Thomas Creek, Meacham Creek, Klickitat River, Yakima River, Snake River, Clearwater River, Looking Glass Creek, and the mainstream Columbia River. Different species were collected from each site depending upon the fishing practices of CRITFC's member tribes. Despite these many variables, general trends in the monitoring of pollutants in these various species and tissues were evident.

The fish tissues were analyzed for 132 chemicals including 26 pesticides, 18 metals, 7 PCB Aroclors, 13 dioxin-like PCBs, 7 dioxin congeners, 10 furan congeners, and 51 miscellaneous organic chemicals. Of these 132 chemicals, 92 were detected. The most frequently detected chemicals in fish tissue were 14 metals, DDT and its structural analogs (DDD, DDE), chlordane and related compounds (*cis*-chlordane, *trans*-chlordane, *cis*-nonachlor, *tran*s-nonachlor, and oxychlordane), PCBs (Aroclors[1] and dioxin-like PCBs), and chlorinated dioxin and furans.

Results

The fish tissue chemical concentrations were evaluated for each study site and for the whole basin. The results of the study showed that all species of fish had some levels of toxic chemicals in their tissues and in the eggs of chinook and coho salmon and steelhead. The fish tissue chemical concentrations were variable within fish (duplicate fillets), across tissue type (whole body and fillet), across species, and study sites. However, the chemical residues exhibited some

[1]Aroclors = commercial formulation of mixtures of PCB congeners; Aroclors 1242, 1254, and 1260 were the only aroclors detected in fish tissue in our study

trends in distribution across species and locations. The concentration of organic chemicals in the salmonids (chinook and coho salmon, rainbow and steelhead trout) and eulachon were lower than any other species. The concentrations of organic chemicals in three species (white sturgeon, mountain whitefish, largescale sucker) and Pacific lamprey were higher than any other species. The concentrations of metals were more variable, with maximum levels of occurring in different species.

Of the 132 chemicals analyzed in this study, DDE, Aroclors, zinc, and aluminum were detected in the highest concentration in most of the fish tissues sampled throughout the basin. The basin-wide average concentrations for for the organic chemicals (DDE, Aroclors, chlorinated dioxins and furans) ranged from non-detectable in the anadromous fish species to the highest levels in resident species. DDE, the most commonly found pesticide in fish tissue from our study, ranged from a basin- wide average of 11 ppb[2] in whole body eulachon to 620 ppb in whole body white sturgeon. The sum of Aroclors ranged from non-detectable in eulachon to 190 ppb in mountain whitefish fillets. sturgeon. Chlorinated dioxins and furans were found at low concentrations in fish species. The basin-wide average concentration of the sum of chlorinated dioxins and furans ranged from 0.0001 ppb in the walleye, largescale sucker, coho, and steelhead fillets, fall chinook salmon (whole body, fillet, egg) and steelhead eggs to 0.03 ppb in whole body white sturgeon.

The concentration of metals did not show a distinct difference between anadromous and resident fish species. The basin-wide average concentrations of arsenic ranged from non-detectable in rainbow trout fillet to 890 ppb in whole body eulachon. Mercury ranged from non-detectable levels in Pacific lamprey fillets and whole body eulachon to 240 ppb in largescale sucker.

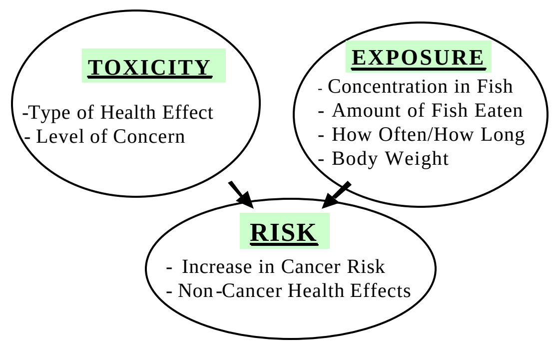
The distribution across stations was variable although fish collected from the Hanford Reach of the Columbia River and the Yakima River tended to have higher concentrations of organic chemicals than other study sites.

The chemical concentrations in fish species measured in this study were generally lower than levels reported in the literature from the early 1970's and similar to levels reported in the late 1980's to the present. The literature included studies from the Columbia River Basin as well as other water bodies in the United States.

[2]ppb = parts per billion = µg/kg

EPA uses a risk model to characterize the possible health effects associated with chemical exposure. For this model, toxicity information is combined with estimates of exposure to characterize cancer risks and non-cancer health effects. Toxicity information (*reference doses and cancer slope factors*) used in this study was obtained from USEPA databases.

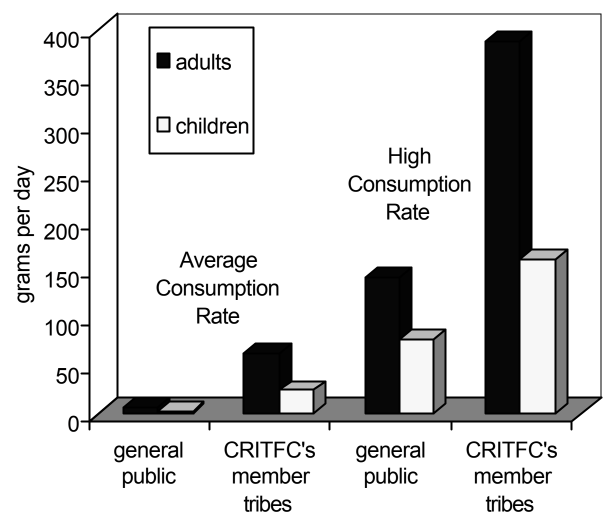
EPA's Risk Assessment Model



The EPA method to estimate exposure to chemicals in fish depends upon the chemical concentration in the fish tissue, the amount and types of fish eaten, how long and how often fish is eaten, and the body weight of the person eating the fish. For this assessment, exposures to chemicals were estimated for both adults and children of CRITFC's member tribes and the general population. In addition to estimating exposure for each site, exposures were also estimated for the basin wide average of fish tissue. In estimating these exposures, it was assumed that a person eats the same type of fish for their lifetime.

Different fish ingestion rates were used for the general public and for CRITFC's member tribes. Fish consumption rates for CRITFC's member tribes were based upon data from the CRITFC fish consumption survey (CRITFC, 1994) while those for the general public were based upon EPA analysis of national fish consumption rates (USEPA, 2000b).

Average and high (99th percentile) fish consumption rates for CRITFC's member tribes and the general public.



In conducting a risk assessment, EPA evaluates the potential for developing non-cancer health effects such as immunological, reproductive, developmental, or nervous system disorders and for increased cancer risk. Different methods are used to estimate non-cancer health effects and cancer risks.

For non-cancer health effects, EPA assumes that a threshold of exposure exists below which health effects are unlikely. To estimate non-cancer health effects, the estimated lifetime average daily dose of a chemical is compared to its *reference dose (RfD*). The reference dose represents an estimate of a daily exposure level that is likely to be without deleterious effects in a lifetime. The ratio of the exposure level in humans to the *reference dose* is called a hazard quotient. To account for the fact that fish contained multiple chemicals, the hazard quotients for the chemicals which cause similar health effects were added to calculate a single hazard index for each type of health effect. For exposures resulting in hazard indices equal to or less than one, health impacts are unlikely. Generally, the higher hazard index is above one, the greater the level of concern for health effects.

For cancer, EPA assumes that any exposure to a carcinogen may increase the probability of getting cancer. Thus, the risk from exposure to a carcinogen is estimated as the increase in the probability or chance of developing cancer over a lifetime as a result of exposure to that chemical (e.g. an increased chance of 1 in 10,000). Cancer risks, which are calculated for adults only, are estimated by multiplying the lifetime average daily intake of a chemical by its *cancer slope factor*. The estimated cancer risk from exposure to a mixture of carcinogens is estimated by adding the cancer risks for each chemical in a mixture. The cancer risk estimates which are based on EPA's methodology are considered to be upper-bound estimates of risk or the most health-protective estimate. Due to our uncertainty in understanding the biological mechanisms which cause cancer, the true risks may in fact be substantially lower than the number estimated with EPA's risk assessment model.

In interpreting cancer risks, different federal and state agencies often have different levels of concern for cancer risks based upon their laws and regulations. EPA has not defined a level of concern for cancer. However, regulatory actions are often taken when the probability of risk of cancer is within the range of 1 in 1,000,000 to 1 in 10,000. Risk managers make their decisions regarding which level within this range is a concern depending on the circumstances of the particular exposure(s). A level of concern for cancer risk has not been defined for this risk assessment.

Using EPA's risk assessment models, hazard indices and cancer risks were estimated for people who consume resident and anadromous fish from the whole Columbia River Basin and from each study site in the basin. For adults, hazard indices and cancer risks were lowest for the general public at the average ingestion rate and highest for CRITFC's member tribes at the high ingestion rate. For adults in the general public with an average fish ingestion rate of about a meal[3] per month (7.5 g/day), hazard indices were less than 1 and cancer risks were less than 1 in 10,000, except for a few of the more highly contaminated samples of mountain whitefish and white sturgeon. For adults in CRITFC's member tribes, at the highest fish ingestion rate at about 48 meals[1] per month (389 g/day), hazard indices were greater than 1 for several species at some sites. Hazard indices (less than or equal to 8 at most sites) and cancer risks (7 in 10,000 to 2 in 1,000) were lowest for salmon, steelhead, eulachon and rainbow trout and highest (hazard indices greater than 100 and cancer risks up to 2 in 100 at some sites) for mountain whitefish and white sturgeon.

[3]Meal = eight ounces of fish

For the general public, the hazard indices for children at the average fish ingestion rate were less for adults (0.9) at the average ingestion rate; the hazard indices for children at the high ingestion rate were 1.3 times greater than those for adults at the high ingestion rate. For CRITFC's member tribes, the hazard indices for children at the average and high ingestion rates were 1.9 times greater than those for adults in CRITFC's member tribes at the average and high ingestion rates, respectively.

For both resident and anadromous species, the major contributors to the hazard indices were PCBs (Aroclors) and mercury. DDT and its structural analogs were also important contributors for some resident species. The chemicals and or chemical classes that contributed the most to cancer risk for most of the resident fish were PCBs (Aroclors and dioxin-like PCBs), chlorinated dioxins and furans, and a limited number of pesticides. For most of the anadromous fish, the chemicals that contributed the most to cancer risk were PCBs (Aroclors and dioxin-like PCBs), chlorinated dioxins and furans, and arsenic.

In estimating hazard indices and cancer risks for people who eat a certain fish species, it is assumed that they eat only that type of fish for their lifetime. However, many people eat a variety of fish over a lifetime. Hazard indices and cancer risks were also estimated using a hypothetical multiple species diet. This hypothetical multiple species diet was based upon information from the CRITFC fish consumption study (CRITFC, 1994). The hazard indices and cancer risks for the multiple species diet were lower than those for most contaminated species of fish and greater than those for some of the least contaminated species. The risks for eating one type of fish may be an over or underestimate of the risks for consumers of a multiple-species diet depending upon the types of fish and concentration of chemicals in the fish which make up the diet.

The risk assessment model for assessing exposure to lead is different from other chemicals. Lead risk is based on a bio-kinetic model which includes all routes of exposure (ingestion of food, soil, water, and inhalation of dust). Based on EPA's risk assessment model, the lead concentrations in Columbia River Basin fish tissues were estimated to be unlikely to cause a human blood lead level greater than 10 µg/dl. The blood lead level of 10 µg/dl is the national level of concern for young children and fetuses (CDC, 1991).

In addition to the survey of the basin for the 131 chemicals, a special study of radionuclides was completed for a limited number of samples. White sturgeon were collected from the Hanford Reach of the Columbia River, artificial ponds on the Hanford Reservation, and from the upper Snake River and analyzed for radionuclides. The levels of radionculides in fish tissue from Hanford Reach of the Columbia River and the ponds on the Hanford Reservation were similar to levels in fish from the Snake River. Cancer risks were estimated for consumption of fish which were contaminated with radionuclides. These risks estimates were not combined with the potential risks from other chemicals at these study sites. The potential cancer risks from consuming fish collected from Hanford Reach and the artificial ponds on the Hanford Reservation were similar to cancer risks in fish collected from the upper Snake River.

Conclusions

The concentration of toxic chemicals found in fish from the Columbia River Basin may be a risk to the health of people who eat them depending on:

1) the toxicity of the chemicals,

2) the concentration in the fish,

3) the species and tissue type of the fish, and

3) how much and how often fish is consumed

The chemicals which contribute the most to the hazard indices and cancer risks are the persistent bioaccumulative chemicals (PCBs, DDE, chlorinated dioxins and furans) as well as some naturally occurring chemicals (arsenic, mercury). Some pollutants persist in the food chain largely due to past practices in the United States and global dispersion from outside North America. Although some of these chemicals are no longer allowed to be used in the United States, a survey of the literature indicates that these chemical residues continue to accumulate in a variety of foods including fish. Human activities can alter the distribution of the naturally occurring metals (e.g. mining, fuel combustion) and thus increase the likelihood of exposure to toxic levels of these chemicals through inhalation or ingestion of food and water.

Many of the chemical residues in fish identified in this study are not unlike levels found in fish from other studies in comparable aquatic environments in North America. The concern raised in the Columbia River Basin also gives rise to a much broader issue for water bodies throughout the United States. The results of this study, therefore, have implications not only for tribal members but also the general public.

While contaminants remain in fish, it is useful for people to consider ways to still derive beneficial effects of eating fish, while

Recommendations for eating fish
EPA recommends that people follow the general advice provided by the health departments for preparing and cooking fish;

***Remove fat and skin before cooking**

***While cooking, allow fat and oil to drain**

These preparation and cooking methods should help to reduce exposures to PCBs, DDTs, dioxins, and furans, and other organics which accumulate in the fatty tissues of fish.

Note: It is also important to consider the health benefits of eating fish. While fish accumulate chemicals from the environment they are also an excellent source of protein that is low in saturated fats, rich in vitamin D and omega-3 fatty acids, as well as other nutrients.

at the same time reducing exposure to these chemicals. Fish are a good source of protein, low in saturated fats, and contain oils which may prevent coronary heart disease. Risks can be reduced by decreasing the amount of fish consumed, by preparing and cooking fish to reduce contaminant levels, or by selecting fish species which tend to have lower concentrations of contaminants.

The results of this study confirm the need for regulatory agencies to continue to pursue rigorous controls on environmental pollutants and to continue to significantly reduce those pollutants which have been dispersed into our ecosystems. Reducing dietary exposure through cooking or by eating a variety of fish will not eliminate these chemicals from the environment. Elimination of many of the man-made chemicals from the environment will take decades to centuries. Regulatory limits for new waste streams and clean up of existing sources of chemical wastes can help to reduce exposure. The exposure to naturally occurring chemicals can be reduced through better management of our natural resources.

There are many uncertainties in this risk assessment which could result in alternate estimates of risk. These uncertainties include our limited knowledge of the mechanisms which cause disease, the variability of contaminants in fish and fish ingestion rates, and the effects of food preparation. The uncertainties in our estimates may increase or decrease the risk estimates reported in this study.

1.0 Introduction

1.1 Report Organization

This report presents the results of an assessment of chemicals in fish and the risk estimates from consuming these fish based on data analysis and conclusions reached by EPA. It is organized into five volumes.

The study results are presented in 10 sections in Volume 1. Sections 1 and 2 describe the study background, methods, and the chemical concentrations in fish tissues. Sections 3,4, and 5 describe risk assessment methods. The risk characterization is presented in Section 6 for all chemicals except lead and radionuclides. Lead and radionuclide risk characterizations are presented in sections 7, and 8, respectively. The fish tissue residues from this study are compared to other fish contaminant studies as well as other food types in Section 9. Uncertainties in this study are presented in Section 10. The discussion of uncertainty includes all aspects of the risk assessment as well as the sections on fish tissue concentrations (Section 2) and the comparisons with other studies (Section 9). The uncertainty section contains additional calculations to show how the characterization of cancer risk and non-cancer hazards would change if different values had been used to estimate exposure or to characterize toxicity. Finally, conclusions for this study are discussed in Section 11.

Volume 2 provides all the chemical data from the results of the study, as well as sex, length and weight of the fish, and other descriptive data on fish collection. Volume 3 is the Field Operations Manager sampler's notebook(s) which provides a record for the collection of samples. Volume 4 is the Quality Assurance Report which includes a review of the field activities, sample preparation, laboratory measurements, quality assurance procedures, system audits, corrective actions, and the data quality assessment. The appendices to this volume contain all the project data including information about the field sampling locations. Volume 5 is the Quality Assurance Project Plan which was prepared in 1996. The Quality Assurance Project Plan contains the documentation for the study design, objectives, methods, and quality control procedures.

1.2 Study Background

After reviewing the results of the EPA 1989 national survey of pollutants in fish (USEPA, 1992a), EPA became concerned about the potential health threat to Native Americans who consume large amounts of fish from the Columbia River Basin. The cause for concern for native peoples in the Columbia River Basin was also raised by the Columbia River Intertribal Fish Commission (CRITFC) and its member tribes[4].

In order to evaluate the likelihood that tribal people may be exposed to high levels of

[4]All references to "tribes" in this report are only applicable to CRITFC's member tribes: Confederated Tribes of Warm Springs, Yakama Nation, Umatilla Confederated Tribes, Nez Perce Tribe. They are collectively referred to as CRITFC's member tribes.

contaminants in fish tissue EPA, CRITFC and its member tribes designed a study in two phases. The first phase of this study was a fish consumption survey which was completed in 1994 by CRITFC (CRITFC, 1994). The results of this survey documented the importance of fish in the diet and culture of CRITFC's member tribes. The types and amounts of fish that were eaten by the four CRITFC's member tribes were identified. The primary fish that were consumed by CRITFC's member tribes were salmon and trout. The survey also demonstrated that the average daily fish consumption for adults (63.2 g/day) of CRITFC's member tribes was much higher than the national average for adults (6.5 g/day)[5]. This survey accentuated the need to complete a survey of contaminants in fish tissue to provide information on the quality of the fish being consumed by CRITFC's member tribes.

The plans for the fish contaminant survey began with the formation of a multi-agency task force with representatives from EPA, CRITFC, the Yakama Nation, the Umatilla Confederated Tribes, the Nez Perce Tribe, the Warm Springs Tribe, the Washington Departments of Ecology and of Health, the Oregon Departments of Environmental Quality and Health, the US Geological Survey (USGS), and the US Fish and Wildlife Service. A Memorandum of Agreement signed by EPA and CRITFC in 1996 established the basis for the continued interaction of the EPA staff and tribal members to complete the contaminant survey. With the help of members of CRITFC's member tribes as well as state and federal fish hatchery personnel, sample collection took place between 1996 and 1998. Chemical analyses were completed in 1999. The analyses were done by EPA and commercial laboratories.

This study was designed to estimate risks for a specific group of people (CRITFC's member tribes). The CRITFC fish consumption survey combined information from all the member tribes into a single distribution, therefore, the risk estimates in this study do not represent the risks of any specific tribe.

The types of fish, tissue types, and sampling locations were selected by the CRITFC's member tribes. Fish collection locations were selected because they were important to characterizing risks to CRITFC's member tribes. Chemicals were chosen because they were identified in other fish tissue surveys of the Columbia River Basin as well as being common contaminants found in the environment.

This type of sampling is biased with unequal sample sizes and predetermined sample locations rather random. This bias is to be expected when attempting to provide information for individuals or groups based on their preferences. The results of this survey should not be extrapolated to any other fish or fish from other locations.

The exposure assumptions used to estimate risk for CRITFC's member tribes were also predetermined from CRITFC fish consumption survey (CRITFC, 1994). While the study was designed to assess fish which were known to be important to CRITFC's member tribes, it was

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[5]The average fish ingestion used by the EPA in risk assessments for the general public was changed from 6.5 g/day to 7.5 g/day in 2000 (USEPA 2000a)

assumed that other people would be concerned about the contaminant levels in fish from the Columbia River Basin. This decision to estimate risks for the general public was determined after the chemical analyses were completed. Thus, the consumption patterns used this assessment for the general public were not specific to people who eat fish from the Columbia River Basin. However, the risk estimates provide a point of departure for discussions of levels of contamination in the fish from this river basin.

The objectives of this study of chemical residues in the fish from the Columbia River Basin were to determine:

1) if fish were contaminated with toxic chemicals,

2) the difference in chemical concentrations among fish species and study sites, and

3) the potential human health risk due to consumption of fish from the Columbia River Basin.

This contaminant survey also provided information on those chemicals which were most likely to be accumulated in fish tissue and therefore pose the greatest risks to people.

1.3 Study Area

The Columbia River Basin dominates more than a dozen ecological regions as it flows 1,950 km from its source, Columbia Lake, located near the crest of the Rocky Mountains in British Columbia, to the Pacific Ocean. The Columbia River drains an area of about 670,800 km^2 of which about fifteen percent is in Canada. Eleven major tributaries enter the river: Cowlitz, Lewis, Willamette, Deschutes, Snake, Yakima, Spokane, Pend Oreille, Wenatchee, Okanagan, and Kootenay Rivers (Lang and Carriker, 1999). The study was confined to the Columbia Basin below Grand Coulee to the north, the Clearwater River to the east, just below Bonneville Dam to the west and the Willamette River to the south(Figure 1-1).

1.4 Sampling Locations

One hundred and two fishing locations were identified by the Yakama, Nez Perce, Umatilla, and Warm Springs tribal biologists. Due to resource constraints, all of these sampling locations could not be sampled. The study design (Volume 5) presents in detail the process that was used to reduce the number of sampling locations. Initially fishing locations that represented greater than 40% of each CRITFC's member tribes' fishing use for resident and anadromous fish species were identified. The number of fishing locations was further reduced by selecting sampling locations at the base of a watershed to represent the entire watershed (98, 30,101, 96) and limiting the number of sampling locations on the mainstream Columbia River to each of the dam reaches (6, 7,8,9,14). Additional sampling locations (48,49) were added because they were near local pollution sources. Sample location 49 on the Yakima River was also important for rainbow trout spawning (personal communication CRITFC's member tribes). Other sampling locations (3, 21,21b, 62,63) were selected because of the concern for a particular fish species.

The final sampling locations were located on 16 rivers and creeks and the mainstream Columbia (Figure 1-1, Table 1-1). The actual *sampling locations* were variable within a study reach because of the sampling techniques and/or mobility of fish species. To simplify the data analysis, similar *sampling locations* within a study reach were combined to yield one *study site.* The river miles for *sampling locations* are presented in Table 1-1. The latitude and longitude for each *sampling location* is presented in Volume II, Appendix A-2.

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Table 1-1. Description, study site, sampling location, and river mile for Columbia River Basin fish sampling 1996-1998. Some of the *sampling locations* (S. Location) are combined into a single site for this study (SS = *study site*). Fish species are also listed. RM = river mile

Waterbody	SS	S. Location	RM	Fish Species
Columbia River below Bonneville Dam	3	3B	39-41	eulachon
Columbia River between Bonneville dam and Dalles dam	6	6C	154-155	white sturgeon
Columbia River between Dalles dam and John Day dam	7	7B,D	203-207	walleye
		7A	197.5	white sturgeon
Columbia River between John Day dam and McNary dam	8	8B,D,E,F,G,H,I	216-292	largescale sucker, white sturgeon, fall chinook salmon, steelhead trout
Columbia River below confluence with Snake River	9 L	9A,B,C,D	295-304	white sturgeon
Columbia River (Hanford Reach)	9 U	9 E,F,G, H, I,	369-372	largescale sucker, white sturgeon
		9 N,O, P, Q	389-393	mountain whitefish
Columbia River just below Priest Rapids Dam	14	14 hatchery	396	fall chinook salmon
Wind River	63	63 hatchery	18	spring chinook salmon
Little White Salmon River	62	62 hatchery	1	spring chinook salmon
Fifteen mile Creek	24	24	0.2-0.5	Pacific lamprey
Hood River	25	25	4	steelhead
Willamette Falls	21	21	26.6	Pacific lamprey
MF Willamette River	21B	21B-hatchery	203.6	spring chinook salmon
Deschutes River	98	98 A,B,C,D,E	55-59	mountain whitefish, rainbow trout, largescale sucker
Umatilla River at the mouth	30	30	3	spring chinook salmon, coho salmon, fall chinook salmon
		30A , 30B	0-1	largescale sucker, walleye,
Umatilla River upper river	101	101,101A	88.5-89.5	mountain whitefish, rainbow trout
Thomas Creek		101B	1.5-2.5	mountain whitefish, rainbow trout
Meacham Creek		101C	2-2.5	rainbow trout
Yakima River below Roza Dam	48	48 F, G	47.1	bridgelip sucker, largescale sucker, spring chinook salmon, fall chinook salmon, steelhead, mountain whitefish,spring chinook salmon,
		48 H, I, J	81-85	largescale sucker
Yakima River above Roza Dam	49	49	139-141	largescale sucker, rainbow trout
Klickitat River	56	56	2.2	fall chinook salmon, steelhead
		56A hatchery	42.5	spring chinook salmon
		56 B, F	64-84	rainbow trout
Snake River below Hell's Canyon Dams	13	13C,D,E,F	128-135	largescale sucker, white sturgeon
Snake River above Hell's Canyon Dams	93	93A hatchery	270	steelhead
Clearwater - Snake River	96	96 hatchery	40.5	steelhead
Looking Glass Creek - Grand Ronde	94	94 hatchery	0.1	spring chinook salmon
Icicle Creek - Wenatchee River	51	51 hatchery	2.8	spring chinook salmon

1-6

1.5 Fish Species

A total of 281 fish samples were collected including 132 whole body, 129 fillet, 11 egg, and 9 field duplicates (Table 1-2a,b). The fish species included anadromous fish species (Pacific lamprey, eulachon, coho salmon, fall and spring chinook salmon, steelhead) and resident fish species (largescale sucker, bridgelip sucker, mountain whitefish, rainbow trout, white sturgeon, walleye). These species were selected because of their importance to CRITFC's member tribes.

Table 1-2a. Resident fish species collected from the Columbia River Basin, 1996 -1998. The sample location and identification number and number of replicates are given for each species.

Fish species	Study Site	Replicates F	Replicates W	Dup
White Sturgeon- *Acipenser transmontanus*	Columbia River - 6	3		1 fillet
16 single fillets without skin, BW = 9,525g - 34,927 g	Columbia River - 7	3		
8 single whole body, BW = 8,108g - 22,380 g	Columbia River - 8	3	3	
4 duplicates of single fish each	Columbia River - 9L	3	3	1 fillet
White sturgeon samples were individual fish.	Columbia River - 9U	1	2	1 fillet
	Snake River - 13	3		1 fillet
Rainbow Trout -*Oncorhynchus mykiss*	Deschutes River - 98	4	3	
7 fillet composites with skin; BW = 318g - 551 g	Umatilla River - 101		4	
Number in each composite = 7-11	Yakima River - 49	3	3	
12 whole body composites; BW = 47g - 475 g	Klickitat River - 56		2	
Number in each composite = 7 - 30				
Largescale Sucker - *Catostomus macrocheilus*	Columbia River - 8		2	
19 fillet composites with skin; BW = 809g- 1541 g	Columbia River - 9 U	3	3	
Number in each composite = 4 - 12	Umatilla River - 30	4	3	
23 whole body composites ; BW = 395g - 1,764 g	Deschutes River - 98	3	3	
Number in each composite = 5 - 12	Yakima River - 48	3	6	
	Yakima -River - 49	3	3	
	Snake River - 13	3	3	
Bridgelip sucker - *Catostomus columbianus*	Yakima River - 48		3	
3 whole body composites; BW = 588g - 637g;				
Number in each composite = 7				
Walleye -*Stizostedion vitreum*	Columbia River - 7		2	
3 fillet composites with skin; BW = 822g - 850g	Umatilla River - 30	3	1	
Number in each composite = 8				
3 whole body composites; BW = 749g - 1503g				
Number in each composite = 4 - 8				
Mountain Whitefish - *Prosopium williamsoni*	Columbia River - 9U	3	3	
12 fillet composites with skin; BW = 247g - 517g	Deschutes River - 98	3	3	1 fillet
Number in each composite = 9 - 35	Umatilla River - 101	3	3	
12 whole body composites; BW = 247g - 428 g	Yakima River - 48	3	3	
Number in each composite = 9 - 35				
1 duplicate composite				

BW = Body weight; F= fillet WB = whole body ; Dup = duplicate

Table 1-2b. Anadromous fish species collected from the Columbia River Basin, 1996 -1998. The sample location and identification number are given for each species. The number of replicates for each tissue type are listed after the location.

		Replicates			Dup
Fish Species	**Study Site**	**F**	**WB**	**Egg**	
Coho salmon - *Oncorhynchus kisutch*	Umatilla River 30	3	3	3	
3 fillet with skin composites; BW = 3,647g -3,960g					
Number in each composite = 6					
3 whole body composite; BW = 2,855g - 3,455g					
Number in each composite = 4					
Fall chinook salmon - *Oncorhynchus tshawytscha*	Columbia River - 8	3	3	1	1 fillet
15 fillet composites with skin; BW = 3,790g - 10,970g	Columbia River - 14*	3	3		
Number in each composite = 4	Umatilla River - 30	3	3		
15 whole body composites; BW = 4,160g - 8,623g	Yakima River - 48	3	3		
Number in each composite = 6	Klickitat River - 56	3	3		1 fillet
1 egg composite ;					
2 duplicate fillet composites					
Spring chinook salmon - *Oncorhynchus tshawytscha*	Little White Salmon River - 62*	3	3		
24 fillet composites with skin; BW = 4536g - 9373g	Wind River - 63**	3	3		
Number in each composite = 3 - 5	MF Willamette River - 21B**	3	3		
24 whole body composites; BW = 4,292g - 7,058g	Umatilla River - 30	3	3	3	
Number in each composite = 5	Yakima River - 48	3	3		
6 egg composites;	Klickitat River - 56*	3	3		
1 duplicate composite	Icicle Creek - 51*	3	3		
	Grand Ronde River - 94*	3	3	3	1 fillet
Steelhead - *Oncorhynchus mykiss*	Columbia River- 8	6	6	1	
21 fillet composite with skin; BW = 1,784g - 5,537g	Hood River - 25	3	3		
Number in each composite = 3 - 4	Yakima River - 48	3	3		
21 whole body composite; BW = 1,633g - 6,440g	Klickitat River - 56	3	3		
Number in each composite = 3 - 8	Snake River - 93*	3	3		
1 egg composite sample;	Clearwater River - 96*	3	3		1 fillet
1 duplicate composite					
Pacific Lamprey - *Lampetra tridentata*	Fifteen mile Creek - 24		3		
3 fillet composites with skin; BW = 364g - 430g	Willamette Falls - 21	3	6		
Number in each composite = 20					
9 whole body composites; BW = 334g - 463g					
Number in each composite = 10 - 20					
Eulachon - *Thaleichthys pacificus*	Columbia River - 3		3		
3 whole body composites BW = 37g;					
Number in composite = 144					

* Fish taken from hatchery Dup = duplicate; F= fillet; WB = whole body BW = average body weight of the fish in a composite

With the exception of walleye, all these fish are cold water native species which are stressed by alteration of their natural habitat (Netboy, 1980; Dietrich, 1995; Close, et. al., 1995; Musick, et. al., 2000; DeVore, et. al., 1995; Beamesderfer, et. al.,1995; Coon ,1978; Lepla, 1994). Walleye were introduced to the Columbia River Basin from the late 1800s to the early and mid 1900s and are well established in some of the reservoirs (e.g., the John Day Reservoir).

In order to estimate risks for the general public, it was assumed that these species were also consumed by other people in the basin. While there were no comprehensive surveys of fish consumption by the general public in the Columbia River Basin at the time of this study, there have been surveys in the Middle Fork Willamette River (EVS, 1998), lower Willamette River (Adolfson Associates, Inc., 1996), and Lake Roosevelt (WDOH,1997). The types of fish identified (Table 1-3) in these surveys include some of the same types listed in the CRITFC consumption survey(CRITFC, 1994).

Table 1-3. Recent surveys of types of fish consumed by the general public in the Columbia River Basin.

	EVS 1998	Adolfson Associates	WDOH 1997
Location	Middle Willamette	Lower Willamette	Lake Roosevelt
Tissue Type	primarily muscle some skin, eggs, eyes	muscle	fillets primarily some skin, eggs, fish heads
Fish Type	bullhead	yellow perch	rainbow trout
	carp	brown bullhead	walleye
	sucker	northern pikeminnow	bass
	bass	starry flounder	
	northern pikeminnow	white sturgeon	
	crappie		
	bluegill		
	trout		
	white sturgeon		
	lamprey		
	salmon		
	steelhead		

1.6 Sampling Methods

Sampling methods (Volume 4, Appendix A) for fish included: electrofishing, hand collection, hatchery collection, trapping at dams, dip netting, fish traps, and gill netting. The preferred method was dependent on the conditions at the sampling location, selected species, and legal constraints. A global positioning system (GPS) was used to identify the latitude and longitude for each sampling location (Volume 4, Appendix A).

After retrieval from sampling devices, each fish was identified to the species level by personnel familiar with the taxonomy of the fish in the Columbia River Basin. The length and weight were then measured for each fish to ensure that they met the size class as defined in the Quality Assurance Project Plan (Volume 5). The length and weight data are provided in Volume 2, Appendix A.

Four types of samples were collected: whole-body with scales, fillet with skin and scales, fillet without skin, and eggs. The white sturgeon is the only species where fillet without skin was collected. The armor-like skin of the white sturgeon was considered too tough for ingestion. Whole-body samples were selected to maximize the chances of measuring detectable levels of contaminants of concern and because data presented in the consumption study showed that CRITFC's member tribes may consume several fish parts in addition to the fillet (CRITFC, 1994). Eggs from spring chinook salmon, fall chinook salmon, and steelhead were measured because consumption data show that their eggs were widely consumed by CRITFC's member tribes. The fish were not scaled as recommended in the EPA guidance (USEPA, 1998a). Based on conversations with CRITFC's member tribes, it was assumed that people consume the whole body or fillet with scales intact.

The Columbia River Basin is very large and the number of samples which could be analyzed was relatively small. Due to limited resources, composites were analyzed (with the exception of white sturgeon) instead of individual fish as being a better estimate of the average concentrations of chemicals from a study site. The number of fish in each composite are listed in Volume II, Appendix A-2. It is assumed that by compositing, the error in representativeness would be reduced. However, by using an average of individual fish the true variability in individual fish tissue samples was lost. Thus, the actual residues in individual fish from the Columbia River Basin may be higher or lower than the concentrations reported in this study. Due to the size and difficulty of homogenization, composites were not taken for white sturgeon. Instead, individual fish were sampled and analyzed from each sampling location. Since this study was designed for fish consumption and people eat what they collect, random samples of fish were selected for each composite rather than predetermined age or gender.

An attempt was made to collect three replicate samples for each fish type from each study site to estimate variability between study sites. However, this was not always possible due to availability of fish and problems with sampling gear. The final number of replicates for each fish species and tissue type are listed in Table 1-2 a,b. To reduce differences due to sampling error, replicate samples were collected at the same time and study site.

1.7 Chemical Analysis

The homogenization of samples, the lipid analysis, and chemical analysis of chlorinated dioxins and furans, and dioxin-like PCB congeners were conducted by AXYS Laboratory in Victoria, Canada. The remaining analyses were performed by the EPA Region 10 laboratory at Manchester, WA. Laboratory analytical protocols specified for this study are referenced in Volumes 4 and 5.

Chemical analysis of the fish tissue was completed in 1999. The fish samples were analyzed for 132 different chemicals (Tables 1-4 a,b,c,d,e,f,g), including the following classes: semi-vocatives, chlorinated dioxins and furans, dioxin-like PCB congeners, Aroclors, pesticides and selected trace metals[6].

Of the 132 compounds analyzed, 40 were not detected (Tables 1-4 a,b,c,d,e,f,g). The individual chemical analyses of fish tissue samples are presented in Volume 2, and summarized in Volume 1, App D.

[6] "Metals", as used in this report, also refers to metalloids or semi-metals. Antimony, selenium, boron, and arsenic are in the metalloid groups.

Table 1-4a. 51 semi-volatile chemicals analyzed.

22 detected	29 not detected
1,2-Diphenylhydrazine	Nitrobenzene
2,6-Dinitrotoluene	1,2-Dichlorobenzene
Acenaphthene	1,3-Dichlorobenzene
Acenaphthylene	1,4-Dichlorobenzene
Anthracene	1,2,4-Trichlorobenzene
Benz-a-anthracene	2,4-Dinitrotoluene
Benzo-a-pyrene	2-Chloronaphthalene
Benzo-b-fluoranthene	4-Bromophenyl-phenylether
Benzo-k-fluoranthene	4-Chlorophenyl-phenylether
Chrysene	bis(2-Chloroisopropyl)ether
Dibenz[a,h]anthracene	Hexachlorobutadiene
Fluoranthene	Hexachloroethane
Fluorene	Dibenzofuran
Indeno(1,2,3-cd)pyrene	2-Chlorophenol
Pyrene	4-Chloro-3-methylphenol
Phenanthrene	2,4-Dichlorophenol
Benzo(g,h,I)perylene	2,4-Dimethylphenol
Naphthalene	2,4,5-Trichlorophenol
1-Methyl-naphthalene	2,3,4,6-Tetrachlorophenol
2-Methyl-naphthalene	2,4,6-Trichlorophenol
Phenol	Pentachlorophenol
Retene	4-Chloroguaiacol
	3,4-Dichloroguaiacol
	4,5-Dichloroguaiacol
	4,6-Dichloroguaiacol
	3,4,5-Trichloroguaiacol
	3,4,6-Trichloroguaiacol
	4,5,6-Trichloroguaiacol
	Tetrachloroguaiacol

Table 1-4b. 26 pesticides analyzed.

21 Detected	5 Not Detected
Aldrin	gamma-Chlordene
cis-Chlordane	Heptachlor
gamma-Chlordane	Delta-HCH
oxy-Chlordane	Beta-HCH
cis-Nonachlor	Toxaphene
trans-Nonachlor	
alpha-Chlordene	
o,p'DDT	
p,p'DDT	
o,p'DDE	
p,p'DDE	
o,p'DDE	
p,p'DDE	
DDMU	
Endosulfan Sulfate	
Hexachlorobenzene	
Heptachlor Epoxide	
Alpha BHC	
Gamma-BHC (Lindane)	
Mirex	
Pentachloroanisole	

Table 1-4c. 18 Metals analyzed.

16 detected		2 not detected
Aluminum	Lead	Antimony
Arsenic	Manganese	Silver
Barium	Mercury	
Beryllium	Nickel	
Cadmium	Selenium	
Chromium	Thallium	
Cobalt	Vanadium	
Copper	Zinc	

Table 1-4d. 7 Aroclors analyzed

3 detected	4 not detected
Aroclor 1242	Aroclor 1016
Aroclor 1254	Aroclor 1221
Aroclor 1260	Aroclor 1232
	Aroclor 1248

Table 1-4e. 13 Dioxin-like PCB congeners analyzed. All Detected

PCB 77	PCB 157
PCB 105	PCB 167
PCB 114	PCB 169
PCB 118	PCB 170*
PCB 123	PCB 180*
PCB 126	PCB 189
PCB 156	

Table 1-4f. 7 chlorinated dioxins analyzed. All Detected

2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,4,7,8-HxCDD
1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
OCDD

Table 1-4g. 10 chlorinated furans analyzed. All Detected

2,3,7,8-TCDF
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF
OCDF

1.7.1 PCB analysis

Two methods were used for measuring PCB congeners: 1) congener analysis, and 2) Aroclor analysis. PCB congeners are a group of synthetic organic chemicals that contain 209 individual chlorinated biphenyl compounds. Each molecule of a PCB congener has 10 positions in its ringed structure which can be occupied by a chlorine atom. The placement and number of chlorine atoms into these positions determine the physical and chemical properties and the toxicological significance of the specific PCB congener molecule in question. Each unique arrangement is called a "PCB congener". The congeners which have chlorine atoms substituted in the "para" and "meta" positions acquire a structure which is similar to chlorinated dioxins and furans.

In the congener method only those congeners (Table 1-4e) which are believed to have the same toxicological mechanisms as 2,3,7,8 tetrachlordibenzodioxin (2,3,7,8-TCDD) were measured. Of the 209 possible PCB congeners 13 were analyzed. Of these 13 congeners only 11 were considered in the risk assessment. Two of the congeners (PCB 180 and PCB 170) were included because they were in the original EPA chemical method for measuring dioxin-like PCB congeners. However, subsequent methods do not include these congeners because there was "insufficient evidence on *in vivo* toxicity" to establish toxicity factors for these congeners (Van den Berg, et al., 1998). Although PCB 81 is considered to have the same toxicological mechanism as 2,3,7,8-TCDD, EPA Method 1668 (USEPA, 1997a) did not list it as a target compound. Therefore, it was not included in this study.

Commercially available PCB congener mixtures are known in the United States by their industrial trade name, "Aroclor". The last two digits indicate the percentage of chlorine in the compound (i.e., 42% for Aroclor 1242 and 54% for Aroclor 1254). Each Aroclor mixture is further identifiable by a specific number; i.e., "Aroclor 1242". The "12" portion of this designation refers to the fact that the molecule contains 12 carbon atoms (bound together in two six-sided phenyl rings; e.g., a "biphenyl"). The Aroclor analysis is the most common method for measuring total PCBs.

1.7.2 Mercury and Arsenic analysis

Mercury and arsenic occur in organic and inorganic forms. In this study, the chemical analyses were as total mercury and total arsenic. The fish tissue concentrations that are discussed in Section 2 and Section 9 are based on the measured total mercury and total arsenic. For the purposes of the risk assessment, the total mercury concentrations were assumed to be all methymercury. Arsenic fish tissue concentrations was assumed to be 10% inorganic arsenic in the anadromous fish tissue and 1% inorganic arsenic in the resident fish tissue.

1.7.3 Total Chlordane and Total DDT

The pesticides chlordane and DDT include a series of respective metabolites which are assumed to act in the same manner with respect to human exposure and toxicity. For this study, all forms of chlordane (*cis*-chlordane, *trans*-chlordane, *cis*-nonachlor, *tran*s-nonachlor, and oxychlordane) were summed as total chlordane to estimate tissue concentrations and risk estimates.

1,1,1-trichloro-2,2-*bis*(p-chlorophenyl)ethane (DDT) and its structural analogs and breakdown products: 1,1-dichloro-2,2-*bis*(p-chlorophenyl)ethylene (DDE), and 1,1-dichloro-2,2-*bis*(p-chlorophenyl)ethane (DDD) are organo-chlorine pesticides. DDT, DDE, and DDD also have two isomers: the para (p,p) and ortho- para isomers (o,p). The p,p' and o,p' isomers of each DDT structural analog (DDT, DDD, DDE) were combined into three concentration terms (DDT, DDD, DDE) for fish tissue concentrations, and for the estimate of carcinogenic risks. All the DDT structural analogs (p,p'-DDD, o,p'-DDD, o,p'-DDE, p,p'-DDE, o,p'-DDT, p,p'-DDT) were summed into a single concentration (total DDT) term to estimate non-carcinogenic risks.

Although, 1,1-*bis*(p-chlorophenyl)2 chloro-ethylene (DDMU) is another structural analog or breakdown of DDT it is not believed to exhibit the same toxicity as the other structural analogs. Therefore it was not included in the sum of DDT for fish tissue concentrations and for the risk assessment.

1.7.4. Lead Risk Characterization

Lead is not included in the risk characterization sections for other chemicals. The methods for assessing risks from exposure to lead are unique due to the ubiquitous nature of lead exposure and the reliance upon blood lead concentrations to describe lead exposure, toxicity, and risks. Human health risk assessment methods for lead also differ from other types of risk assessment because they integrate all potential sources of exposure to predict a blood lead level.

1.7.5 Data Quality Validation of Chemical Analyses

A total of 93 data validation reports (Volume 4, Appendix B) were prepared detailing the quality of project data. Data quality assessment involved the following determinations:

1) whether the data met the assumptions under which the data quality objectives described in Volume 5 were developed, and

2) whether the total error in the data was small enough to allow the decision maker to use the data.

No data were rejected in this study.

Nine field duplicate samples consisting of the opposite fillets of the same species and same type of sample were collected to estimate the error in sample preparation and analysis (see Table 1-2a-b for list of field duplicates). The range in duplicate concentrations is discussed in Section 10.

All the chemicals analyzed in fish tissue were within the requirements of the quality assurance limits. In the quality assurance review of the chemical data, certain chemical concentrations were qualified with a "J". The "J" qualifier designates a concentration which is estimated. Therefore, the analytical methodology suggests that the "J" qualified measurement may be inaccurate. We chose to use these data in this study without conditions. No data were rejected.

1.7.6 Detection limits

The detection limits for chemicals were determined by performing a risk-based screening analysis of tissue contaminant data collected within the Columbia River Basin during the last ten years (1984-1994). The screening methods and quantitation limits are described in Volume 5. The analytical methods were chosen to provide detection or quantitation limits which were as low as possible within the constraints of available methods and resources.

The detection limits varied for each sample and each chemical. The concentrations of chemicals which are found at the detection limit could be treated as a zero; alternately they could also be equal to the detection limit or somewhere in between. For this study we assumed that the concentration of a particular chemical was one half of the detection limit. For comparison, the tissue chemical concentrations are presented in Appendix E assuming the concentration for a particular chemical equals 1) zero, 2) the detection limit, or 3) ½ the detection limit

The following rules were used when calculating average chemical concentrations in fish tissue:

1) If a chemical was not detected in any sample for a given fish species and sample type, it was assumed to not be present and was not evaluated.

2) If a chemical was detected at least once in samples for a given fish species and sample type, a concentration equal to one-half the detection limit was assumed for values reported as not detected when calculating the average chemical concentration.

3) The paired duplicate sample concentration for a fish at a site was averaged to obtain one concentration for that fish at that site. In cases where one duplicate was reported as a measured concentration and the paired duplicate as a non-detected concentration, the measured concentration and one-half the detection limit for the non-detected value were averaged to obtain a single estimate of concentration. In cases where both duplicate samples were not detected, one-half the detection limit for each sample was used as the mean chemical concentration.

1.7.7 Statistical Data Summaries

All fish residue data are presented on a wet weight basis. All the data for each sample are included in Volume II, Appendix C. The summary statistics (average, minimum, maximum, and standard deviation) for each site and the basin are included in Volume 1, Appendix D.

The following statistical summaries include the non-detect rules described in Section 1.7.6. The data for each fish species were pooled and average chemical concentrations were calculated by site and by basin:

1) Site averages—All replicate samples for a given fish species and tissue type collected

at a given site were pooled to obtain an estimate of the average chemical concentration at each site.

2) Basin averages—All samples for a given fish species and tissue type collected during this study were pooled to obtain an estimate of the average chemical concentration within the basin.

1.8 Lipid Analysis

Most of the organic chemicals measured in this study were lipid soluble to a significant extent. The lipid content of all samples was analyzed as a measure of the likelihood of bioaccumulation of these types of organic chemicals. The percent lipid for each sample is given in Volume 4, Appendix A. The lipid normalized tissue concentrations are included in Volume 2, Appendix A.

Chemical residues were normalized to lipid using the following formula:

(Equation 1-1) *ug chemical / kg lipid = (ug chemical/kg tissue × 100) ÷ percent lipid*

For example if wet weight concentration = 40 ug DDT/kg and the percent lipid = 5%

(40 µg/kg × 100) ÷ 5 = 800 ug DDT/kg lipid

The lipid normalized data were not used in the risk assessment.

1.9 Special Studies

Three additional studies were added after the original study was initiated:

1) fish tissue chemical concentrations in channel catfish and smallmouth bass,

2) exploratory study of acid-labile pesticide analysis using Gas Chromatograph/Atomic Emission Detector (GC/AED) methods for a limited number of samples, and

3) radionuclide analysis for fish possibly exposed to potential releases from the Hanford Nuclear Facility.

1.9.1 Channel Catfish and Smallmouth Bass

Due to interest in comparing the results of this study with other Columbia River Basin surveys, two additional species (channel catfish and smallmouth bass) were added to the initial study when additional resources became available (Table 1-5).

Table 1-5. Sampling study sites and numbers of replicates for survey of chemicals in tissues of smallmouth bass and channel catfish collected in the Columbia River Basin, 1996-1998.			
		Replicates	
Species	**Study site**	**FS**	**WB**
Channel Catfish - *Ictalurus punctatus*	Columbia River - 8	2	3
5 fillet with skin composites; BW = 1,236g - 2,555g	Yakima River - 48	3	3
Number in each composite = 2			
6 whole body composites; BW = 734g - 1,135g			
Number in each composite = 5 - 6			
Smallmouth Bass -*Micropterus dolomie*	Yakima River -48	3	3
3 fillet with skin composites; BW = 1,413g - 1463g			
Number in ,each composite = 3			
3 whole body composites; BW = 1,313g - 1,487g			
Number in each composite = 3			

FS = fillet with skin; WB = Whole body BW= average body weight of fish in a composite

Since these were not species which were consumed in large amounts by CRITFC's member tribes, the assessment of chemicals in these fish were not included in the discussion of fish tissue concentrations in Section 2 or in the risk assessment (Sections 3-8). The results of chemical analyses in these fish are discussed in Section 9.

1.9.2 Acid-Labile Pesticides

In addition to the basic set of chemical analyses, EPA Region 10's laboratory measured 76 acid labile pesticides using advanced EPA Gas Chromatography/Atomic Emission Detection (GC/AED) method 8085 (Volume 5, Table 12). Of the 76 acid-labile pesticides measured only 17 were detected (Table 1-6). Method 8085 is applicable to the screening of semi-volatile organohalide, organophosphorus, organonitrogen, and organosulfur pesticides that are amenable to gas chromatography.

The chemical analytical results are included in Appendix L. Risk estimates were not completed for the acid labile pesticides. These analyses were done to ascertain only the presence or absence of these chemicals. A description of these chemicals is included in the toxicity profiles (Appendix C).

Table 1-6. AED pesticides detected in fish tissue from the Columbia River Basin, 1996-1998.

Atrazine	DACTHAL-DCPA	Endosulfan II	Pentabromodiphenyl ether
Bromacil	Dichlorobenzophenone	Endosulfan Sulfate	Propargite
Chlorpyrifos	Dieldrin	Hexabromodiphenyl ether	Tetrabromodiphenyl ether
Chlorpyrifos-methyl	Endosulfan I	Pendimethalin	Triallate
			Trifluralin

1.9.3 Radionuclide analyses

Due to the possibility of radionuclide contamination of fish in the mainstream Columbia River a subset of fish samples was selected for radionuclide analysis. These samples were collected in the mainstream Columbia River (sites 7, 8, 9L, 9U) and cooling ponds (K ponds) on the Hanford Reservation (Table 1-7). Additional samples were collected from the Snake River (Study Site 13) as a background or reference sample for the samples collected at or in the vicinity of the Hanford Nuclear Facility.

Table 1-7. Radionuclide fish tissue samples including study site, species, and number of replicates from the Columbia River Basin, 1996-1998.

Study Site	Fish species	Replicates* F	Replicates* WB	Duplicate
Columbia River 7	white sturgeon	3		
Columbia River 8	white sturgeon	3	3	
	channel catfish	1	3	
	largescale sucker		2	
Columbia River 9 lower (L)	white sturgeon	3	3	1 whole body
Columbia River 9 upper (U)	white sturgeon	2	2	2 fillet
	mountain whitefish	3	3	1 whole body
	largescale sucker	3	3	
Hanford Reservation cooling ponds - 9K	white sturgeon		3	
Snake River 13	white sturgeon	3		1 fillet

* each replicate was a composites of 4-35 fish except white sturgeon which were single fish; Fillets were with skin, except white sturgeon which were fillets without skin; F - fillet; WB = whole body;

Radionuclides (Table 1-8) were measured by EPA National Air and Radiation Environmental Laboratory (NAERL) in Montgomery, Alabama, and a commercial laboratory (Barringer Laboratory) in Golden, Colorado.

Table 1-8. The radionuclides analyzed in fish tissue collected in the Columbia River Basin 1996-1998.

Uranium -234	Plutonium -239	Bismuth-214	Lead-212	Radon-224	Telllurium-208
Uranium-235+D	Strontium-90+D	Bismuth-212	Lead-214	Radon-226+D	Thorium-228+D
Uranium-238+D	Potassium-40	Cesium 137+D			

NAREL is a comprehensive environmental laboratory managed by the EPA Office of Radiation and Indoor Air. Among its responsibilities, NAREL conducts a national program for collecting and analyzing environmental samples from a network of monitoring stations for the analysis of radioactivity. This network has been used to track environmental releases of radioactivity from nuclear weapons tests and nuclear accidents.

Quality assurance requirements for the 45 samples (see Volume 4, Appendix A, Table A-1) selected for radionuclide measurements are described in the Quality Assurance Project Plan.. The radionuclide data are reported in Volume 1, Appendix K.

The radionuclide fish tissue measurements and risk assessment are discussed in Section 8. Radionuclides were not included with the other chemicals because radionuclides were not analyzed in all fish tissues. Although the method used to assess cancer risk from exposure to radionuclides is similar to that for other chemicals in this risk assessment, there are some unique aspects for radionuclides (e.g., analytical issues, estimation of risk coefficients) that make a separate discussion of them advantageous.

2.0 Fish Tissue Chemical Concentrations

In this section fish tissue chemical residues measured in this study are discussed. The fish tissue and egg samples were all composites with the exception of the white sturgeon which were individual fish. The concentrations discussed in this section include the rules for non-detected chemicals described in Section 1.7.6. In reviewing the results of this study the species were evaluated in two groups: 1) resident fish species (white sturgeon, mountain whitefish, walleye, bridgelip sucker, largescale sucker, rainbow trout) and the anadromous fish species (coho salmon, spring and fall chinook salmon, steelhead, pacific lamprey, eulachon). The resident fish species spend their life cycle in the Columbia River and its tributaries. Their exposure and uptake of chemicals will occur in fresh water in the vicinity of the locations where they were collected. The anadromous species spend most of their life cycle in open ocean. They reproduce in fresh water, but feed at sea. Therefore, their uptake of chemicals is likely to occur at sea rather than at the site where they were collected.

There were not equal numbers of samples of fish species or tissue types (Table 1-2a,b). In particular, the bridgelip sucker, coho salmon and eulachon were each collected at only one location; Pacific lamprey and walleye at only two locations. Thus the data reported for these species were not indicative of concentrations throughout the basin. Bridgelip sucker and eulachon were only collected as whole body fish tissue. Bridgelip sucker were collected opportunistically at this particular site. However, they were not part of the original study design. The eulachon were small fish. Therefore, it was necessary to collect 144 individual fish for each composite to obtain enough tissue for analysis. It was also impractical to attempt to fillet these fish. Therefore only whole body samples were collected. Despite these many variables, general trends in the monitoring of pollutants in these various species and tissues were evident.

he method for combining duplicate samples in this study was to average the duplicates. Thus, the two measurements would be treated as one number for the purposes of this assessment. The non-detects were included in the data summaries at ½ their detection limits. The actual detection limit is noted on the tables and in the text with a symbol for less than (<). See Sections 1.7.6 and 1.7.7 for a detailed description of these methods.

The basin-wide and study site specific average chemical concentrations reported in this section were used as the exposure concentrations in the estimation of risks discussed in Section 6.

2.1 Percent Lipid

The egg samples from the chinook salmon, and steelhead, had the highest percent lipid of all the fish tissue samples (Figure 2-1). The whole body and fillet tissues of Pacific lamprey and spring chinook salmon, and the whole body eulachon had higher percent lipid than the whole body or fillet tissues of any other species. Coho salmon, rainbow trout, walleye fillets, and largescale sucker had the lowest percent lipid.

With the exception of the walleye samples there was not a large difference in lipid content of whole body and fillet samples. The average whole body walleye samples contained 8% lipid as compared to the 1.5% from the walleye fillets. The technique used to fillet the samples was to keep as much of the skin and associated fatty tissue (lipid) intact. Thus, the chance of finding a clear differentiation between fillet and whole body was not preserved.

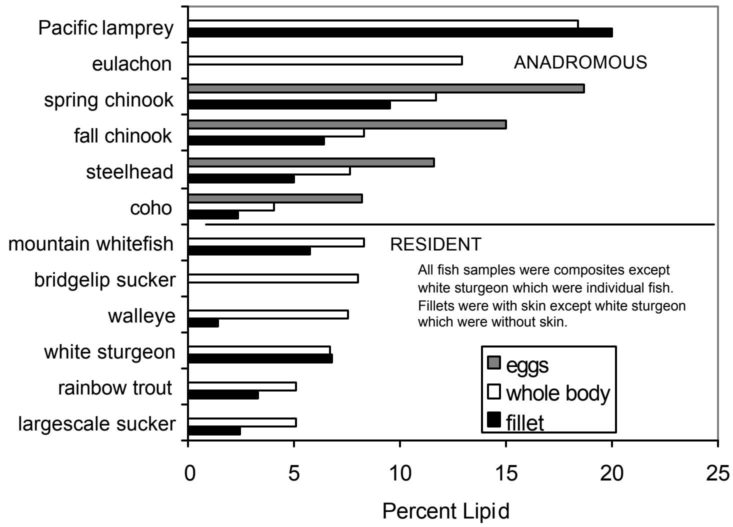


Figure 2-1. Basin-wide average percent lipid in fish collected from the Columbia River Basin. Study sites are described in Table 1-1. Sample numbers for each species are listed in Table 1-2.a,b

2.2 Semi-Volatile Chemicals

The semi-volatile chemicals include the guaicols, ethers, phenols, and polynuclear aromatic hydrocarbons (PAH). The number of samples with detectable levels of the semi-volatile chemicals was quite low (Table 2-1a,b). The guiacols and ethers were not detected in any sample. There were no semi-volatile chemicals detected in the fall chinook salmon or coho salmon tissue samples. The phenols were detected in only one white sturgeon sample from the main-stem Columbia River (study site 8). Many of these semi-volatile chemicals were not detected because they were not in the fish tissue, the detection limits were too high, or the chemicals may have been metabolized or otherwise degraded to chemicals which were not included in this survey.

The average concentrations for the PAHs were quite similar across species and chemicals. Of the PAHs, 2-methyl naphthalene (Table 2-1a,b) had the highest detection frequency. Pyrene was found at the highest concentrations of all the PAHs (450 ppb) in a rainbow trout collected from the upper Yakima River (study site 49). The largescale sucker was the fish species with the most frequent detection of PAHs. This may be due to the large number of largescale sucker samples rather than some unique exposure.

Table 2-1a. Basin-wide composite concentrations* of semi-volatile chemicals detected in resident fish species

Species/Chemical	T	N	F	µg/kg Max	µg/kg Ave
bridgelip sucker					
1,2-Diphenylhydrazine	WB	*3*	*1*	14	7
Naphthalene, 1-methyl-	WB	*3*	*1*	10	5
Naphthalene, 2-methyl-	WB	*3*	*3*	20	16
largescale sucker					
1,2-Diphenylhydrazine	WB	*23*	*1*	120	12
9H-Fluorene	WB	*23*	*1*	26	5
Acenaphthene	WB	*23*	*1*	53	11
Acenaphthylene	WB	*23*	*2*	26	5
Benzo(a)anthracene	FS	*19*	*1*	24	5
Benzo(a)pyrene	*FS*	*19*	*1*	*24*	*5*
Benzo(g,h,i)perylene	FS	*19*	*1*	47	10
Benzo[b]Fluoranthene	FS	*19*	*1*	24	5
Benzo[k]fluoranthene	FS	*19*	*1*	24	5
Chrysene	FS	*19*	*1*	24	5
Dibenz[a,h]anthracene	FS	*19*	*1*	47	10
Indeno(1,2,3-cd)pyrene	FS	*19*	*1*	47	10
Naphthalene	WB	*23*	*1*	67	12
Naphthalene, 1-methyl-	WB	*23*	*2*	26	5
Naphthalene, 2-methyl-	FS	*19*	*2*	24	5
Naphthalene, 2-methyl-	WB	*23*	*7*	26	8
Phenanthrene	WB	*23*	*1*	95	7
Pyrene	WB	*23*	*2*	53	10
Retene	WB	*23*	*2*	200	16
rainbow trout					
Anthracene	WB	*12*	*1*	27	5
Fluoranthene	WB	*12*	*1*	53	12
Naphthalene, 2-methyl-	FS	*7*	*3*	11	5
Naphthalene, 2-methyl-	WB	*12*	*1*	27	6
phenanthrene	WB	*12*	*1*	50	9
Pyrene	WB	*12*	*1*	450	46
Retene	WB	*12*	*1*	53	12
walleye					
Naphthalene, 1-methyl-	WB	*3*	*1*	10	6
Naphthalene, 2-methyl-	FS	*3*	*2*	10	6
Naphthalene, 2-methyl-	WB	*3*	*1*	16	9
white sturgeon					
Naphthalene, 1-methyl-	FW	*16*	*1*	15	4
Naphthalene, 2-methyl-	FW	*16*	*1*	25	5
Phenol	WB	*8*	*1*	530	230
mountain whitefish					
2,6-Dinitrotoluene	WB	*12*	*1*	40	16
Acenaphthene	WB	*12*	*1*	31	9
Naphthalene, 2-methyl-	WB	*12*	*3*	10	5

Table 2-1b. Basin-wide composite concentrations* of semi-volatile chemicals detected in anadromous fish species from the Columbia River Basin, 1996-1998.

Fish Species	T	N	F	µg/kg Max	µg/kg Ave
eulachon					
9H-Fluorene	WB	*3*	*1*	170	56
Naphthalene, 2- methyl	WB	*3*	*1*	11	6
Phenanthrene	WB	*3*	*1*	170	60
Pacific lamprey					
Fluoranthene	WB	*9*	*1*	50	14
Naphthalene, 1- methyl	WB	*9*	*4*	25	12
Naphthalene, 2- methyl	FS	*3*	*1*	77	42
Naphthalene, 2- methyl	WB	*9*	*4*	44	22
Phenanthrene	WB	*9*	*3*	25	10
spring chinook salmon					
Acenaphthene	WB	*24*	*1*	81	13
Naphthalene, 2-methyl	FS	*24*	*4*	29	6
Naphthalene, 2-methyl	WB	*24*	*5*	40	8
Pyrene	WB	*24*	*2*	120	18
steelhead					
1,2-Diphenylhydrazine	FS	*21*	*1*	100	7
1,2-Diphenylhydrazine	WB	*21*	*1*	26	6
2,4-Dinitrotoluene	FS	*21*	*2*	48	9
2,4-Dinitrotoluene	WB	*21*	*1*	52	12
Benzo(a)pyrene	FS	*21*	*1*	*24*	5

.*All samples were composites except white sturgeon which were individual fish;
T= tissue type; N= number of samples; F = detection frequency; FS = fillet with skin; FW= fillet without skin; WB = whole body;
Ave= average; Max = Maximum

2-20

2.3 Pesticides

Of the 26 pesticides that were analyzed the most frequently observed pesticides were hexachlorobenzene, mirex, pentachloronanisole, chlordane and related compounds, and the DDT series of structural analogs (DDT,DDE,DDD).

The basin-wide average concentrations of all pesticide residues were compared across fish species. With the exception of rainbow trout and walleye fillets, the average pesticide residue levels in the resident fish species were higher than in the anadromous fish species (Figure 2-2). The average concentrations of total pesticide residues were highest in white sturgeon (Figure 2-2).

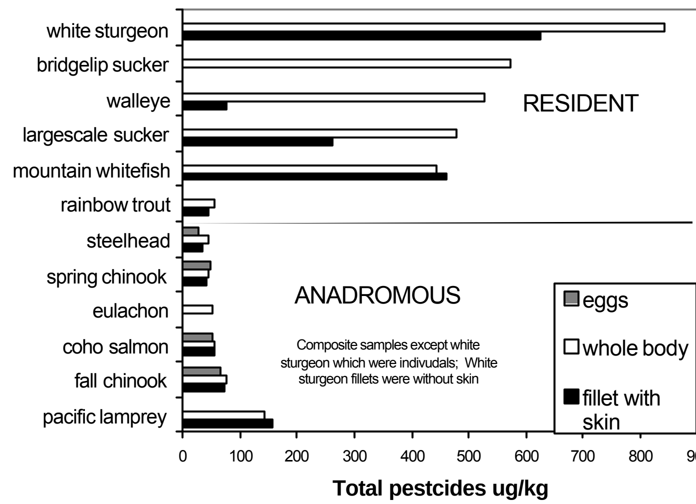


Figure 2-2. Basin-wide average concentrations of total pesticides in composite fish tissue collected from Columbia River Basin. Study sites are described in Table 1-1. Sample numbers are given in Table 1-2a,b.

Of the anadromous fish species, Pacific lamprey had the highest basin-wide average concentrations of total pesticides. Pacific lamprey also had the highest lipid content of any anadromous fish species (Figure 2-1). The concentrations of pesticides in the Pacific lamprey may have been due to this high lipid content. However, egg samples which had high lipid concentrations (Figure 2-1) did not have high pesticide concentrations as one would expect for lipophilic compounds.

2.3.1 DDMU, Hexachlorobenzene, Aldrin, Pentachloroanisole, and Mirex

DDMU, Aldrin, pentachloroanisole, and mirex were detected infrequently. The highest concentration (40 µg/kg) of DDMU was in fish tissue from largescale sucker and mountain whitefish. Aldrin was detected in only 2 species: mountain whitefish and white sturgeon (Table 2-2a). The maximum concentration (6 µg/kg) of aldrin occurred in mountain whitefish from the Hanford Reach of the Columbia River (study site 9U). The maximum concentration of pentachloroanisole occurred in largescale sucker (5 µg/kg). Mirex was only detected 9 times in all the fish tissue from this study. The maximum concentration of mirex (13 µg/kg) was detected in mountain whitefish. Hexachlorobenzene was detected over 100 times; most frequently in white sturgeon, spring and fall chinook salmon, and steelhead (Table 2-2a,b). The maximum concentration of hexachlorobenzene (19 µg/kg) occurred in white sturgeon (Table 2-2a).

Table 2.2a. Basin-wide concentrations of pesticides in resident fish tissue from the Columbia River Basin, 1996-1998.

Species/Chemicals	T	N	F	Max (µg/kg)	Ave (µg/kg)
bridgelip sucker					
Endosulfan Sulfate	WB	3	3	5.4	4.6
largescale sucker					
Pentachloroanisole	WB	23	4	5.0	1.1
Pentachloroanisole	FS	19	2	2.6	1.0
Mirex	WB	23	3	5.0	1.2
Mirex	FS	19	1	2.6	1.1
Hexachlorobenzene	WB	23	4	5.0	1.3
Endosulfan Sulfate	WB	23	2	6.5	1.5
Endosulfan Sulfate	FS	19	3	2.6	1.3
DDMU	WB	23	13	40.0	8.8
DDMU	FS	19	8	19.0	4.5
mountain whitefish					
Pentachloroanisole	WB	12	3	3.0	1.3
Pentachloroanisole	FS	12	2	2.4	1.1
Mirex	FS	12	3	13.0	2.9
Mirex	WB	12	3	6.0	2.1
Hexachlorobenzene	WB	12	6	3.0	1.4
Hexachlorobenzene	FS	12	3	2.4	1.0
DDMU	FS	12	6	40.0	14.0
DDMU	WB	12	6	31.0	13.9
Alpha-BHC	WB	12	3	3.0	1.2
Aldrin	FS	12	1	6.0	1.4
Aldrin	WB	12	3	3.0	1.3
white sturgeon					
Hexachlorobenzene	WB	8	7	19.0	9.3
Hexachlorobenzene	FW	16	16	13.0	5.5
Heptachlor Epoxide	FW	16	1	2.0	1.0
DDMU	WB	8	6	16.0	7.8
Alpha-Chlordene	FW	16	1	2.4	1.0
Aldrin	WB	8	4	2.0	1.1
Aldrin	FW	16	4	2.0	1.0
walleye					
Mirex	WB	3	2	4.1	2.8
Hexachlorobenzene	WB	3	2	3.8	2.3
DDMU	WB	2	2	8.3	8.1
rainbow trout					
Pentachloroanisole	WB	12	2	5.4	1.1

*All fish samples were composites except white sturgeon which were individual fish. T= tissue type; N = number of samples; F= detection frequency; Max = maximum; Ave = average; FS= fillet with skin; FW = fillet without skin; WB = whole body

Table 2.2b. Basin-wide concentrations of pesticides in anadromous fish tissue from the Columbia River Basin, 1996-1998. All anadromous fish samples were composites.

Species/Chemicals	Tissue Type	N	F	µg/kg Max	µg/kg Ave
coho salmon					
Hexachlorobenzene	WB	*3*	*3*	1.2	1.2
fall chinook salmon					
Hexachlorobenzene	WB	*15*	*1*	4.5	3.0
Hexachlorobenzene	FS	*15*	*1*	3.4	2.1
DDMU	WB	*15*	*2*	2.4	1.1
DDMU	FS	*15*	*2*	2.0	1.0
spring chinook salmon					
Pentachloroanisole	WB	*24*	*6*	4.2	1.1
Pentachloroanisole	FS	*24*	*1*	3.8	1.1
Hexachlorobenzene	WB	*24*	*1*	3.8	2.3
Hexachlorobenzene	FS	*24*	*1*	3.5	2.1
DDMU	WB	*24*	*2*	4.2	1.2
DDMU	FS	*24*	*2*	3.8	1.1
steelhead					
Hexachlorobenzene	WB	*21*	*2*	3.2	2.2
Hexachlorobenzene	FS	*21*	*1*	2.8	1.6
DDMU	WB	*21*	*9*	2.4	1.3
Endosulfan Sulfate	WB	*21*	*3*	2.1	1.0
Heptachlor Epoxide	WB	*21*	*3*	2.1	1.0
Pentachloroanisole	WB	*21*	*2*	2.1	1.0
Endosulfan Sulfate	FS	*21*	*3*	2.1	1.0
DDMU	FS	*21*	*5*	2.0	1.1
pacific lamprey					
Hexachlorobenzene	WB	*9*	*6*	11.0	6.3
Hexachlorobenzene	FS	*3*	*3*	8.0	7.6
DDMU	WB	*9*	*6*	6.9	3.9
DDMU	FS	*3*	*3*	5.6	4.5
Pentachloroanisole	WB	*9*	*6*	3.6	1.4
Pentachloroanisole	FS	*3*	*3*	1.7	1.6

T= tissue type; N = number of samples; F= detection frequency; Max = maximum; Ave = average; FS= fillet with skin; FW = fillet without skin; WB = whole body

2.3.2 Total Chlordane

Total chlordane is a mixture of several chemically related compounds (oxy-chlordane, gamma, beta and alpha chlordane, *cis* and *trans* nonachlor).

The fillet or whole body samples of bridgelip sucker, rainbow trout, eulachon, and coho salmon had no detectable concentrations of any of the chlordane compounds. The highest concentrations of total chlordane were in egg samples from the spring chinook salmon and the fillet and whole body Pacific lamprey.

The total chlordane concentrations in the whole body fish tissue samples were generally equal to or greater than the fillet samples with the exception of the Pacific lamprey where the fillet samples were slightly higher than the whole body samples (Table 2-3). The walleye samples had the most variation between whole body and fillet.

Table 2-3 . Basin-wide average concentrations of total chlordane (oxy-chlordane, gamma, beta and alpha chlordane, *cis* and *trans* nonachlor) in fish from the Columbia River Basin, 1996-1998.

	Fillet with skin		Whole body		Eggs	
Resident species	***N***	**µg/kg**	***N***	**µg/kg**	***N***	**µg/kg**
white sturgeon*	*16*	23	*8*	29		
walleye	*3*	6	*3*	20		
mountain whitefish	*12*	11	*12*	12		
largescale sucker	*19*	6	*23*	8		
rainbow trout	*7*	<5	*12*	<7		
bridgelip sucker	*NS*		*3*	<8		
Anadromous species						
Pacific lamprey	*3*	43	*9*	33		
eulachon	*NS*	NS	*3*	<10		
spring chinook salmon	*24*	7	*24*	8	*6*	66
fall chinook salmon	*15*	7	*15*	8	*1*	15
steelhead	*21*	6	*21*	7	*1*	15
coho salmon	*3*	<5	*3*	<5	*3*	33

* white sturgeon were single fish and fillets without skin
N = number of samples; NS= not sampled; Ave = average; < = chemicals not detected

2.3.3 Total DDT

Total DDT is the sum of the DDT structural analogs and breakdown products: p,p' and o,p' DDT, p,p' and o,p' DDD, and p,p'and o,p' DDE. DDMU is also a breakdown product of DDT which is not believed to exhibit the same toxicity as the other breakdown products. Therefore it was not included in the total DDT concentrations for fish tissue concentrations.

The concentrations of total DDT (Table 2-4) in the salmonids (chinook, coho, rainbow, and steelhead) and eulachon were much lower than in white sturgeon, largescale sucker, whole body walleye, and mountain whitefish. The Pacific lamprey DDT concentrations were higher than the salmonids but 3 to 8 times lower than the resident species. White sturgeon had the highest concentrations followed by bridgelip sucker. This is the same pattern observed with the total pesticides (Figure 2-2). The concentration of total DDT in walleye fillet was much less than in the whole body, similar to the distribution seen with total chlordane.

The concentrations in egg samples were much lower than the fish tissue of the white sturgeon, bridgelip and largescale suckers, whole body walleye, and mountain whitefish. The concentrations in egg samples from steelhead were higher than the other egg samples and fish tissues of the anadromous species and rainbow trout.

Table 2-4. Basin-wide average concentrations of total DDT (DDT, DDE, DDD) in composite fish tissue samples from the Columbia River Basin, 1996-1998.

	Fillet with skin		Whole body		Eggs	
Resident Species	***N***	**µg/kg**	***N***	**µg/kg**	***N***	**µg/kg**
white sturgeon*	*16*	578	*8*	787		
bridgelip sucker	*NS*	NS	*3*	529		
walleye	*3*	59	*3*	489		
largescale sucker	*19*	241	*23*	450		
mountain whitefish	*12*	424	*12*	405		
rainbow trout**	*7*	29	*12*	38		
Anadromous Species						
pacific lamprey	*3*	95	*9*	90		
coho salmon***	*3*	41	*3*	42	*3*	39
steelhead***	*21*	21	*21*	27	*1*	14
spring chinook salmon	*24*	22	*24*	27	*6*	24
fall chinook salmon****	*15*	21	*15*	25	*1*	14
eulachon****	*NS*	NS	*3*	21		

N= number of samples; NS = not sampled * white sturgeon were individual fish and fillets without skin; ** p,p'-DDE and p,p'-DDT were the only isomers detected; *** p,p'-DDD and p,p'-DDE were the only isomers detected; ****p,p'-DDE was the only isomer detected

DDT found in the environment gradually degrades to DDE. Because of it is ubiquitous, lipophilic, and persistent, DDE can be a useful surrogate in comparing fish species and study sites in terms of estimating general trends of "relative loading" from persistent and agriculturally derived organochlorines. p,p'DDE was the pesticide measured at the highest concentrations of all the DDT structural analogs in fish tissues from this study (Figure 2-3).

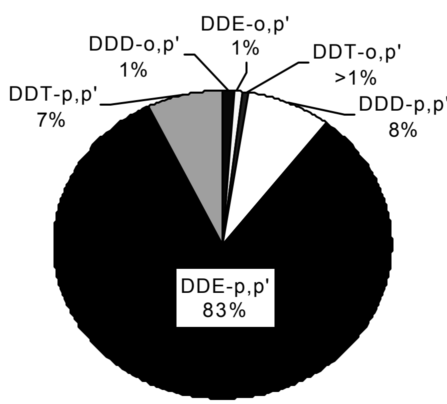


Figure 2-3. Percent contribution of DDT structural analogs to total DDT concentration in whole body largescale sucker. Basin-wide average of 23 fish tissue samples.

With the exception of walleye and rainbow trout fillet samples, the maximum concentrations of p,p'-DDE were higher in the resident fish species than the anadromous fish species (Table 2-5). The maximum concentrations were measured in the white sturgeon fillet (1400 µg/kg) and whole body largescale sucker (1300 µg/kg). The maximum concentration in the anadromous fish species was in the whole body Pacific lamprey (77 µg/kg).

Table 2-5. Basin-wide average and maximum concentrations of p,p'DDE in composite samples of fish from the Columbia River Basin, 1996-1998.

	Fillet With Skin				Whole Body				Egg			
			µg/kg				µg/kg				µg/kg	
	N	*F*	range	Ave	*N*	*F*	range	Ave	*N*	*F*	range	Ave
Resident Species												
white sturgeon*	*16*	*16*	100-1400	470	*8*	*8*	400-1100	620				
largescale sucker	*19*	*19*	14-740	200	*23*	*23*	28-1300	370				
mountain whitefish	*12*	*12*	8-910	360	*12*	*12*	13-770	340				
walleye	*3*	*3*	44-52	47	*3*	*3*	350-440	410				
rainbow trout	*7*	*7*	4-54	22	*12*	*12*	3-84	29				
bridgelip	*NS*		NS	NS	*3*	*3*	310-560	400				
Anadromous Species												
Pacific lamprey	*3*	*3*	46-55	50	*9*	*9*	35-77	53				
fall chinook salmon	*15*	*15*	4-26	12	*15*	*15*	5-53	15	*1*	*1*	6.6	
coho salmon	*3*	*3*	29-35	33	*3*	*3*	31-37	35	*3*	*3*	31-33	32
steelhead	*21*	*21*	5-28	11	*21*	*21*	5-33	15	*1*	*1*	6.5	
spring chinook salmon	*24*	*24*	6-18	12	*24*	*24*	11-22	15	*6*	*6*	10-16	12
eulachon	NS		NS	NS	3	3	10-11	11				

NS = not sampled: N = number of samples; F = detection frequency; Ave= average *White sturgeon samples were single fish and fillets without skin

The chemical concentrations in replicate fish tissue samples were compared across study sites for white sturgeon, largescale sucker, and mountain whitefish (Figure 2-4).

The concentrations across study sites were extremely variable for the three fish species. The highest concentrations of p,p'DDE observed in white sturgeon were from the Hanford Reach of the Columbia River (study site 9U; Figure 2-4a). These samples were duplicate fillets from opposite sides of the same fish. The duplicate sample concentrations were similar (1300 µg/kg and 1400 µg/kg). The concentrations of p,p'DDE in the two whole body samples from this site were much lower: 540 µg/kg and 640 µg/kg. The size of the fish from which the fillets (34,927g) were collected was greater than the two whole body fish samples (-10,000 and 20,000g). This may account for the difference in p,p'DDE concentrations between the whole body and fillets at study site 9U. The fillet samples from study site 9U were quite different than the other sites on the main-stem Columbia and Snake Rivers where white sturgeon were sampled. The duplicate samples from the lower Columbia River (study site 9L; 590 µg/kg, 630 µg/kg), main-stem Columbia River (study site 6; 410 µg/kg, 590 µg/kg) and the Snake River (380 µg/kg, 420 µg/kg) were similar to each other.

The maximum concentration (1300 µg/kg) for the whole body largescale sucker was from the Yakima River below Roza Dam (study site 48; Figure 2-4b). The concentrations of p,p'DDE in whole body largescale sucker from this site ranged from 390 to 1300 µg/kg while the fillets ranged from 430- 680 µg/kg. The largescale sucker composite samples from this study site (48) included 6 replicates. The number of replicates of the largescale suckers may have accounted for the range in concentrations.

Mountain whitefish p,p'DDE concentrations were lower than the white sturgeon and largescale sucker (Figure 2-4c). The highest concentrations occurred in the Hanford Reach of the Columbia River (study site 9U) and Yakima River (study site 48) similar to the largescale sucker and white sturgeon. The p,p'DDE fish tissue concentrations in the Deschutes and Umatilla River sites were much lower than those in the Columbia or Yakima Rivers. The concentrations of p,p' DDE in duplicate fillet samples from the Deschutes River were similar (6.6 µg/kg and 9.4 µg/kg) to each other.

LEGEND
FW = fillet without skin
FS = fillet with skin
WB = whole body

Study sites are listed by number and name and described in Table 1-1. Concentration points on graphs include each duplicate and chemicals at their

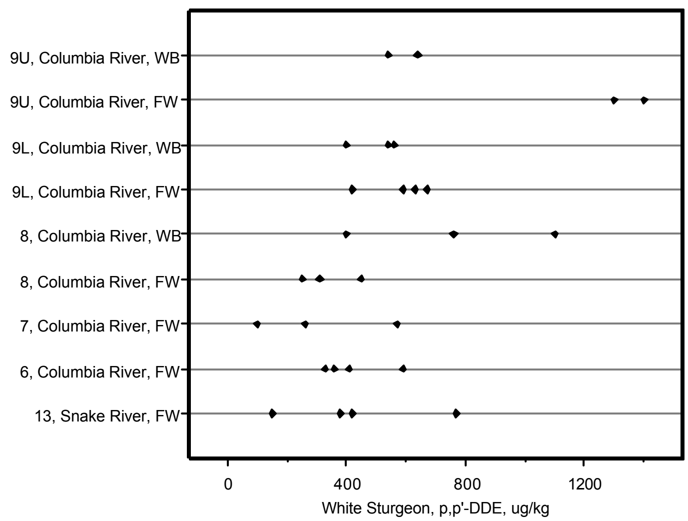


Figure 2-4a. Study site specific concentrations of p,p' DDE in white sturgeon individual fish tissue samples in the Columbia River Basin. Duplicate fillets were collected from study sites 9U, 9L, 6, and 13.

2-27

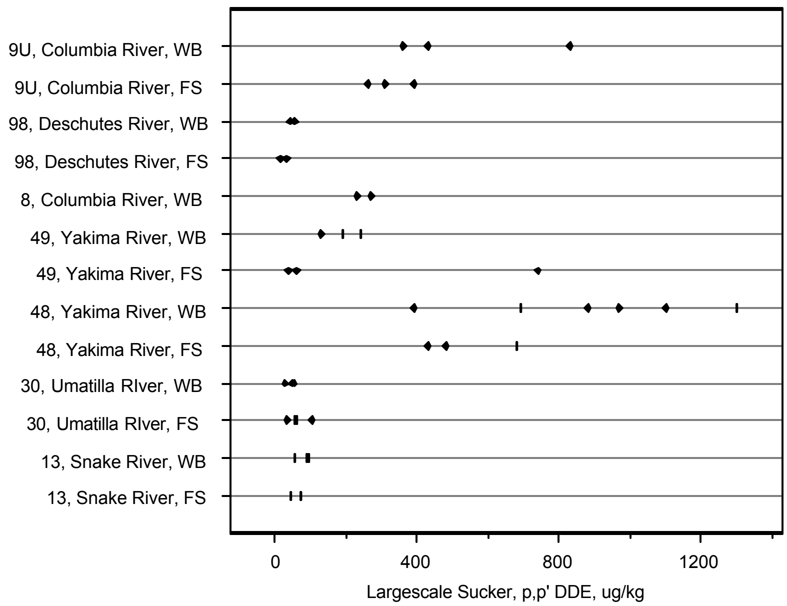


Figure 2-4b. Study site specific concentrations of p,p DDE in largescale sucker composite fish tissue samples from the Columbia River Basin.

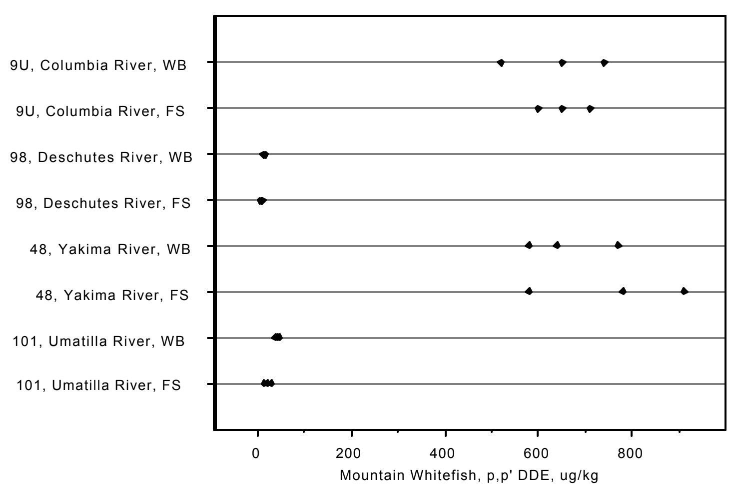


Figure 2-4c. Study site specific concentrations of p,p DDE in mountain whitefish composite fish tissue samples from the Columbia River Basin. Study site 98 includes duplicate fillet samples.

2.4 Aroclors

Of the seven Aroclors analyzed in this study (Aroclors: 1016,1221,1232,1248,1242,1254,1260) Aroclor 1016, Aroclor 1221, Aroclor 1232, and Aroclor 1248 never detected (Table 1-4d). The most frequently observed Aroclors were 1254 and 1260. Aroclor 1242 was only detected in the mountain whitefish samples.

The white sturgeon, mountain whitefish, whole body walleye, and Pacific lamprey had the highest concentrations of Aroclors (Table 2-6). The whole body concentrations of Aroclors in the walleye were higher than the concentrations in fillets. There were no Aroclors detected in the eulachon. The concentrations in the egg samples were similar to the anadromous fish fillet and whole body samples and less than the levels all the resident fish species except rainbow trout.

Table 2-6. Basin-wide average concentrations of total Aroclors (1242, 1254,1260) detected* in composite fish tissue samples from the Columbia River Basin.

	Fillet with skin		Whole body		Eggs	
Resident Species	**N**	**µg/kg**	**N**	**µg/kg**	**N**	**µg/kg**
white sturgeon**	*16*	120	*8*	173		
walleye	*3*	30	*3*	135		
mountain whitefish	*12*	190	*12*	123		
largescale sucker	*19*	52	*23*	78		
bridgelip sucker	*NS*	NS	*3*	70		
rainbow trout	*7*	33	*12*	32		
Anadromous Species						
pacific lamprey	*3*	106	*9*	114		
eulachon	*NS*	NS	*3*	<57		
spring chinook salmon	*24*	38	*24*	40	*6*	43
fall chinook salmon	*15*	37	*15*	40	*1*	31
coho salmon	*3*	35	*3*	38	*3*	34
steelhead	*21*	34	*21*	37	*1*	35

< = detection limitN= number of samples: NS= not sampled.\
*Aroclor 1242 was only detected in mountain whitefish; aroclors 1016, 1221, 1232, and 1248 were not detected in any fish or egg samples
**White sturgeon samples are individual fish and fillets without skin

Aroclors 1254 and 1260 were compared across study sites for white sturgeon (Figure 2-5a,b), largescale sucker (Figure 2-6 a,b), and mountain whitefish (Figure 2-7 a,b).

The maximum concentration for Aroclor 1254 was in the mountain whitefish (930 µg/kg) fillet sample from the Hanford Reach of the Columbia River (study site 9U; Figure 2-7a). The white sturgeon fillet samples from the Hanford Reach of the Columbia River (study site 9U) had the highest concentration (200 µg/kg) of Aroclor 1260 for all species and all sites (Figure 2-5b).

Aroclor 1254 and 1260 were quite similar in white sturgeon samples (Figure 2-5a,b). The highest concentrations for both Aroclors occurred in the fillet samples from the Hanford Reach of the Columbia River (study site 9U). Aroclor 1254 concentrations in the duplicate fillet samples from study site 9U were 170 µg/kg and 210 µg/kg. The whole body concentrations from this study site were much lower (65 µg/kg in both samples). Aroclor 1260 concentrations were 190 µg/kg and 210 µg/kg in the duplicate fillets from study site 9U and 65 µg/kg in the whole body samples. The differences in sizes of the fillet and whole body fish (discussed in Section 2.3.3) from study site 9U, may account for the difference in PCB concentrations in the fillet and whole body samples.

The next highest Aroclor 1254 concentrations were from the main-stem Columbia River (study site 6) where the duplicate concentrations were quite different (47µg/kg and 160 µg/kg; Figure 2-5a). The percent lipid (4.8%) of the duplicate with the higher Aroclor 1254 concentration was higher than percent lipid (3.1%) in the opposite fillet. Thus, the lipid may account for the difference in tissue levels. However, the concentration of Aroclor 1260 in the duplicate fillets from this site were similar (43 µg/kg and 40 µg/kg) to each other (Figure 2-5b).

The Aroclor concentrations in the duplicate fillets for Snake River (study site 13) and for the lower Columbia River (study site 9L) were similar to each other (Figure 2-5a,b).

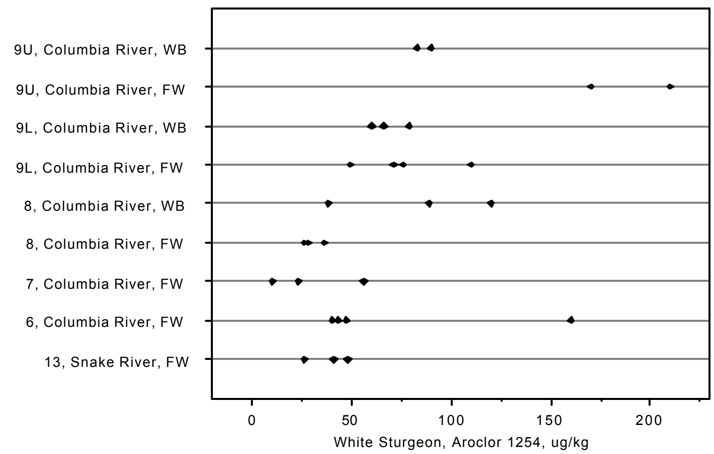


Figure 2-5a. Study site concentrations of Aroclor 1254 in white sturgeon individual fish tissue samples from the Columbia River Basin.

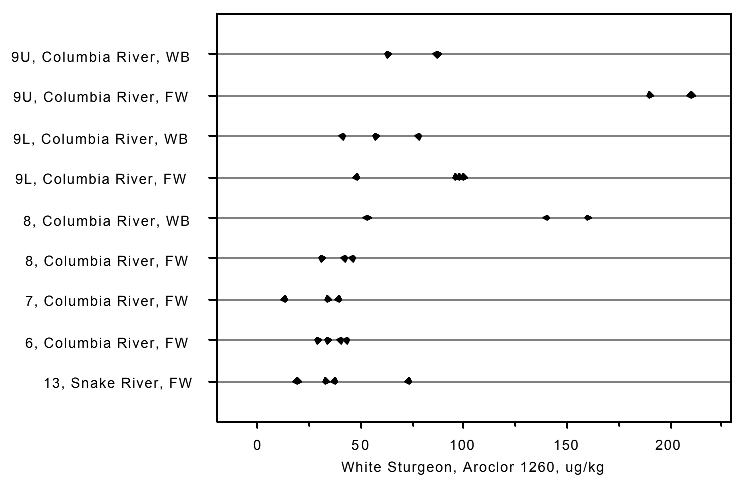


Figure 2-5b. Study site specific concentrations of Aroclor 1260 in white sturgeon individual fish tissue samples from the Columbia River Basin.

LEGEND

FW = fillet without skin
WB = whole body
Study sites are listed by number and name and described in Table 1-1.
Study sites 9u, 9L 6, and 13 include duplicate fillet samples.
Concentration points on graphs include duplicate fillets and chemicals at their detection limits.

The concentrations of Aroclor 1254 and 1260 were variable in largescale sucker. Aroclor 1254 ranged from <18 µg/kg in the fillet composite from the Umatilla River to 65 µg/kg in the whole body sample from the Hanford Reach of the Columbia River (study site 9U; Figure 2-6a).

Aroclor 1260 concentrations ranged from <19 µg/kg in the Snake River (study site 13) and Deschutes River (study site 98) to 100 µg/kg in several whole body samples from the Hanford Reach of the Columbia River 9study site 9U) and the Yakima River (study site 48) (Figure 2-6b).

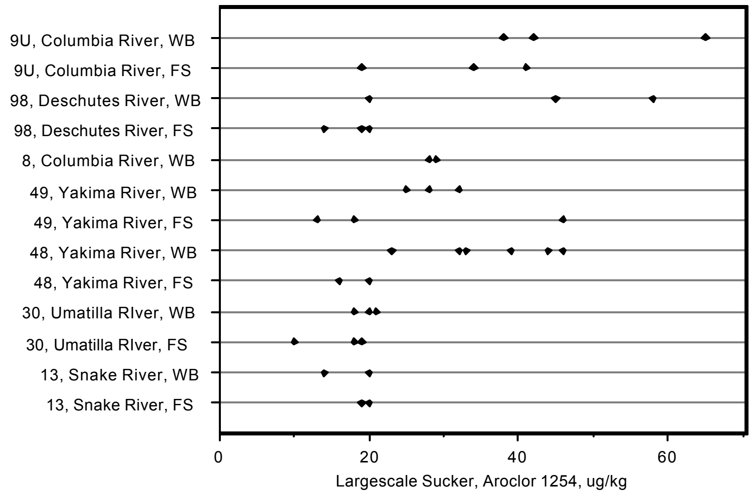
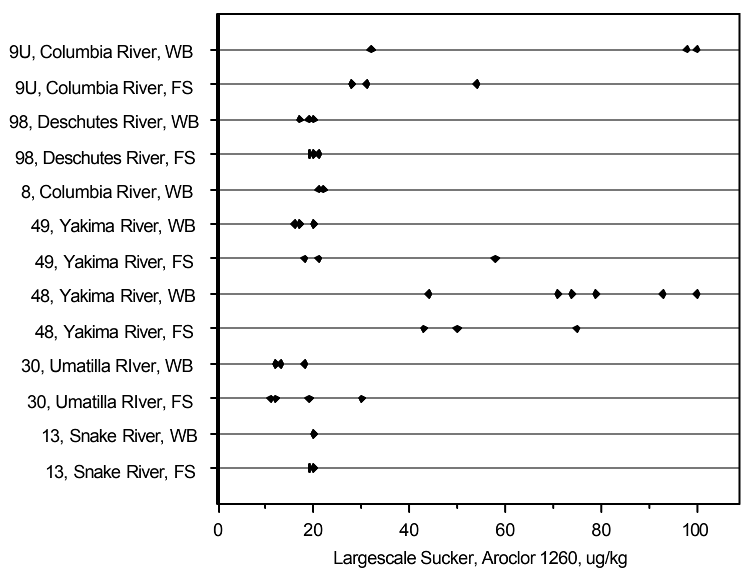


Figure 2-6a. Concentration of Aroclor 1254 in largescale sucker composite fish tissue samples from the Columbia River Basin.



LEGEND
FS = fillet with skin
WB = whole body
Study sites are listed by number and name and described in Table 1-1. Concentration points on graphs include chemicals at their detection limits.

Figure 2-6b. Concentration of Aroclor 1260 in largescale sucker composite fish tissue samples from the Columbia River Basin.

In the mountain whitefish samples Aroclor concentrations from the Deschutes and the Umatilla River sites were low with <17 µg/kg for Aroclor 1254 in the Umatilla River and <16 µg/kg for Aroclor 1260 in the Deschutes River (Figure 2-7a,b). The duplicate fillet samples from the Deschutes River were equal or similar to each other. The maximum Aroclor 1254 concentration of 930 µg/kg in the fillet fish tissue from the Hanford Reach of the Columbia River was much higher than the other fillet and whole body samples from this study site(Figure 2-7a). The three fillet samples from this study site had the same number of fish per composite (35), approximately the same weight (448-515g), length (352-369 mm) and percent lipid (7.9-7.7%). Thus, there was nothing in the fish size or lipid content which could account for the differences in concentrations.

The maximum Aroclor 1260 in the mountain whitefish fillet (190 µg/kg) was from the Yakima River (study site 48; Figure 2-7b).

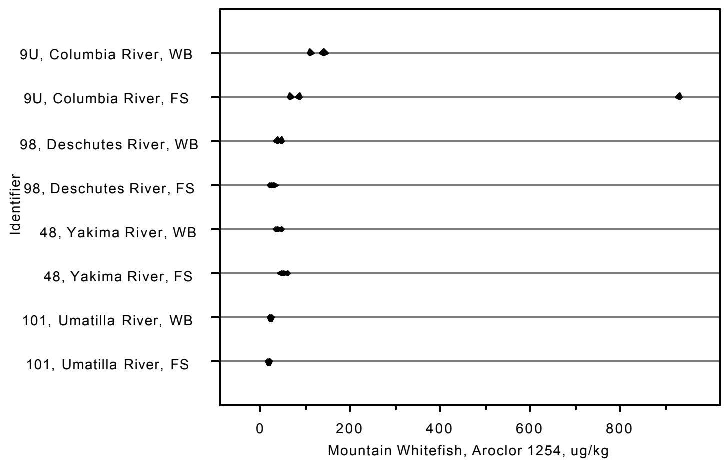


Figure 2-7a. Concentration of Aroclor 1254 in mountain whitefish composite fish tissue samples from the Columbia River Basin.

LEGEND
FS = fillet with skin
WB = whole body
Study sites are listed by number and name and described in Table 1-1
Study site 98 includes duplicate fillet samples.
Concentration points on graphs include duplicate fillets and chemicals on their detection limits. .

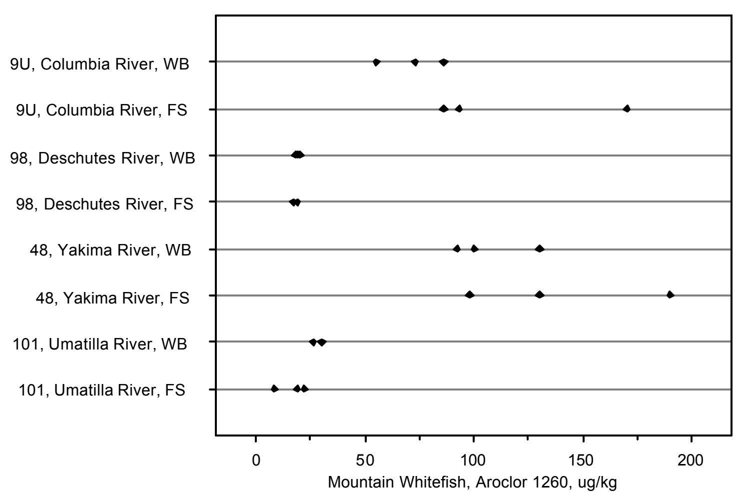


Figure 2-7b. Concentration of Aroclor 1260 in mountain whitefish composite fish tissue samples from the Columbia River Basin.

2.5 Dioxin-Like PCB congeners

When compared across all fish species, mountain whitefish fillet had the highest average concentration (25 µg/kg) of dioxin-like PCB congeners followed by the whole body walleye (11.7 µg/kg, Table 2-7).

There was considerable difference between the whole body walleye samples and the fillets. This was similar to the pattern observed in the walleye for DDT, chlordane, and Aroclors. This may be related to the amount of lipid in the whole body sample since dioxin-like PCB congeners are also lipid soluble similar to the pesticides.

The concentrations of dioxin-like PCB congeners (Table 2-7) in the egg samples from the anadromous fish were similar to the fillet and whole body samples of the coho salmon, eulachon, spring and fall chinook salmon, and steelhead.

Table 2-7. Basin-wide average concentrations of the sum of dioxin-like PCB congeners in composite fish samples from the Columbia River Basin, 1996-1998.

	Fillet With		Whole Body		Eggs	
Resident Species	**N**	**µg/kg**	**N**	**µg/kg**	**N**	**µg/kg**
		ave		ave		ave
mountain whitefish	*12*	25.0	*12*	10.2		
walleye	*3*	1.2	*3*	11.7		
white sturgeon*	*16*	6.5	*8*	10.0		
largescale sucker	*19*	3.1	*23*	5.1		
bridgelip sucker	*NS*		*3*	2.3		
rainbow trout	*7*	2.0	*12*	1.6		
Anadromous species						
Pacific Lamprey	*3*	5.5	*9*	5.5		
coho salmon	*3*	1.3	*3*	1.3	*3*	1.2
steelhead	*21*	1.0	*21*	1.1	*1*	0.6
fall chinook salmon	*15*	0.9	*15*	1.0	*1*	0.4
spring chinook salmon	*24*	0.8	*24*	1.0	*6*	0.8
eulachon	*NS*		*3*	0.5		

N= number of samples; NS = not sampled. * white sturgeon were individual fish; fillets without skin

The concentrations of dioxin-like PCB congeners 118 and 105 were the major contributors to the total dioxin-like PCB congeners (Figure 2-8a,b) for resident and anadromous fish species. PCB congeners 126,169, and 189 each contributed less than 1% to the total dioxin-like PCB congeners in mountain whitefish (Figure 2-8a) and spring chinook (Figure 2-8b). PCB 126, the most toxic dioxin-like PCB congener, was at quite low concentrations with a range of 0.0006-0.096 µg/kg in mountain whitefish fillets and 0.00081- 0.028 µg/kg in whole body. PCB 126 was not detected in 5 of the 12 samples in mountain whitefish. The range of PCB 126 concentrations in spring chinook was 0.00081-0.0046 µg/kg in fillets and 0.00052-0.0047 µg/kg in whole body. Of the 24 samples of spring chinook, 7 fillet and 8 whole body samples were not detectable.

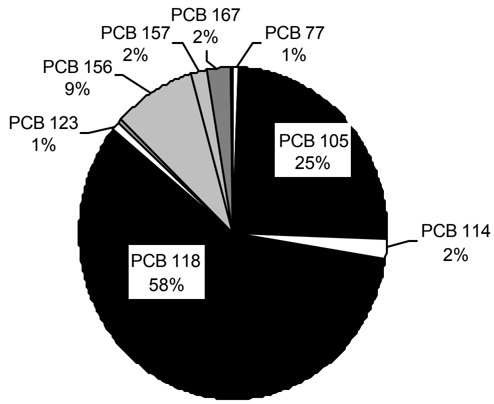


Figure 2-8a. Percent contribution of dioxin-like PCB congeners in mountain whitefish composite fillet samples from the Columbia River Basin.

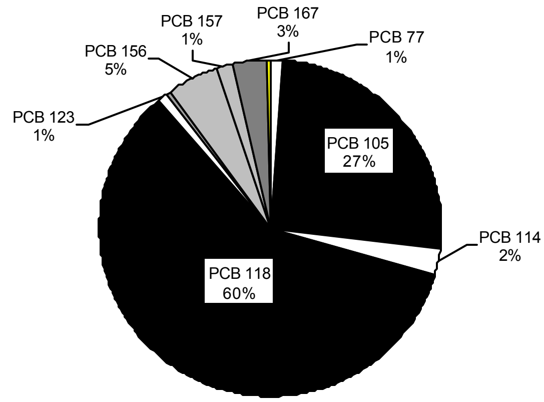


Figure 2-8b. Percent contribution of dioxin-like PCB congeners in spring chinook salmon composite fillet samples from the Columbia River Basin.

The concentrations of dioxin-like PCB congeners (Figure 2-9) were compared across study sites for white sturgeon and mountain whitefish. The average concentrations in mountain whitefish and white sturgeon fillets from the Hanford Reach of the Columbia River (study site 9U) were the highest of all the stations sampled. The levels in the lower Columbia River (study site 9L), Deschutes River, and Umatilla River were lower. The concentrations of dioxin-like PCB congeners in the white sturgeon and mountain whitefish (Figure 2-9) were consistent with the Aroclor tissue residues (Figure 2-5, 2-6, and 2-7). The white sturgeon fillet from the Hanford Reach of the Columbia River was an average of two fillets from the same fish.

The mountain whitefish were an average of three replicate composite samples with 35 fish per composite. The variability of dioxin-like PCB congener concentrations in the mountain whitefish fillets was similar to the distribution of Aroclors (Table 2-6). The mountain whitefish fillet from the Hanford Reach of the Columbia River (study site 9U) had a higher concentration (186 µg/kg) of dioxin-like PCB congeners than other replicates from that site (29µg/kg, 36 µg/kg).

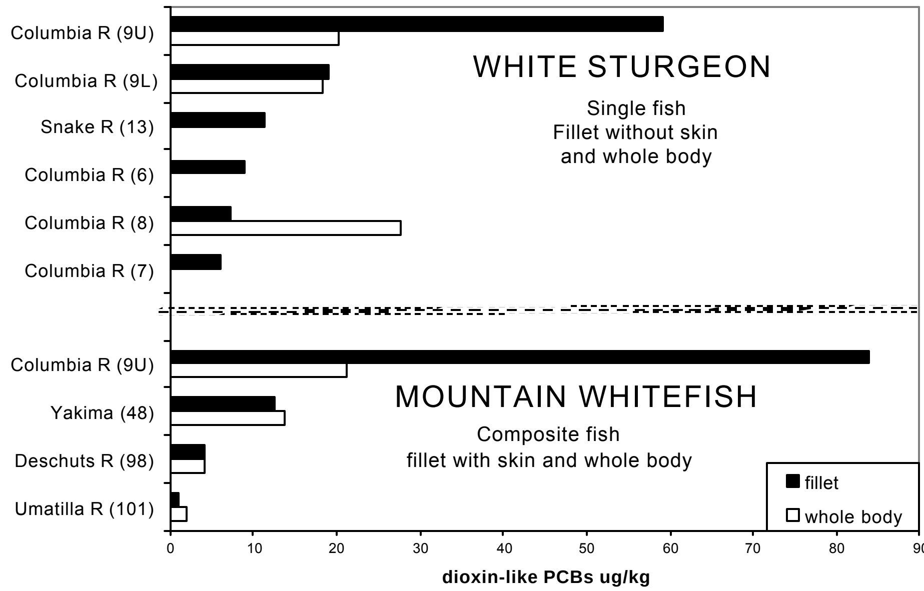


Figure 2-9. Study site average dioxin-like PCB congeners in white sturgeon and mountain whitefish samples from the Columbia River Basin. Study sites are described in Table 1-1. Sample numbers are listed in Table 1-2a,b.

The dioxin-like PCB congeners were highly correlated with Aroclors in whole body samples of fish tissue (Figure 2-10). The coefficient of determination (R^2) for these two variables was 0.94. The coefficient of determination is a measure of the degree of association of two variables. It can range from zero to 1, with 1 being a perfect association (Sokal and Rohlf 1981). The two variables are not dependent upon each other, it is simply that they are both effects of a common cause (Sokal and Rohlf, 1981). It is also evident from this graph that the white sturgeon, walleye, and mountain whitefish had the highest average concentrations of dioxin-like PCB congeners and Aroclors.

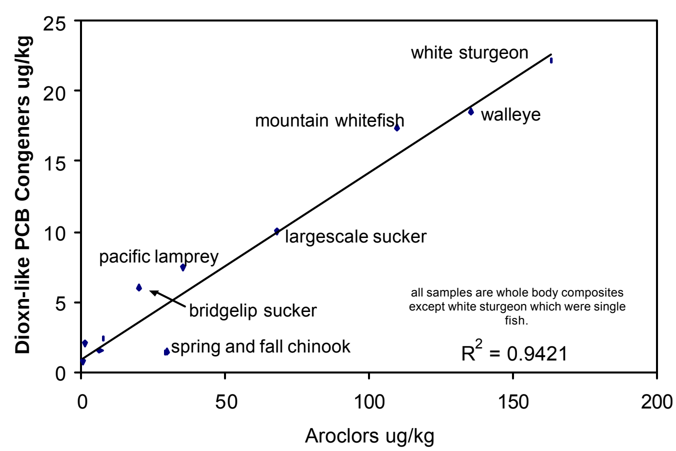


Figure 2-10. Correlation of basin-wide average concentrations of Aroclors 1242,1254,1260 (x axis) with dioxins like PCB congeners (y axis).

2.6 Chlorinated Dioxins and Furans

The average concentrations of chlorinated dioxins and furans in white sturgeon were higher than the all other fish by an order-of-magnitude (Table 2-8). The next highest average concentration was in the mountain whitefish. Coho salmon had the highest average concentrations of chlorinated dioxins and furans for the anadromous fish species although the levels were an order of magnitude lower than the highest white sturgeon concentrations measured in this study. The egg samples from the steelhead and fall chinook were lower than the fillet or whole body fish tissues of all species. The egg samples from the coho salmon were higher than the other egg samples, as well as the fish tissue of spring and fall chinook salmon, steelhead, largescale sucker, and rainbow trout.

Table 2-8. Basin-wide average concentrations of the sum of chlorinated dioxins and furans in composite fish samples from the Columbia River Basin, 1996-1998.

	Fillet with skin		Whole body		Eggs	
Resident Species	**N**	**µg/kg**	**N**	**µg/kg**	**N**	**µg/kg**
white sturgeon*	*16*	0.020	*8*	0.030		
walleye	*3*	0.001	*3*	0.007		
mountain whitefish	*12*	0.006	*12*	0.006		
bridgelip sucker	*NS*	NS	*3*	0.003		
largescale sucker	*19*	0.001	*23*	0.002		
rainbow trout	*7*	0.002	*12*	0.002		
Anadromous Species						
eulachon	*NS*	NS	*3*	0.004		
pacific lamprey	*3*	0.003	*9*	0.004		
spring chinook salmon	*24*	0.002	*24*	0.002	*6*	0.002
steelhead	*21*	0.001	*21*	0.002	*1*	0.0008
fall chinook salmon	*15*	0.001	*15*	0.001	*1*	0.0009
coho salmon	*3*	0.001	*3*	0.008	*3*	0.003

N = number of samples; NS = not sampled . *white sturgeon were individual fish; fillets without skin

Chlorinated dioxins and furans concentrations were compared across study sites for mountain whitefish, white sturgeon, and largescale sucker (Figure 2-11). The largescale sucker samples were quite low compared to the mountain whitefish and the white sturgeon. The largescale sucker concentrations of chlorinated dioxins and furans (Figure 2-11), similar to the Aroclors (Figure 2-6a.b), were much lower than the levels observed in mountain whitefish or white sturgeon. However, the largescale sucker p,p'DDE concentrations (Figure 2-4b) were equal to the levels found in white sturgeon and mountain whitefish.

The total chlorinated dioxins and furans were highest in the white sturgeon fillet from the lower Columbia River (study site 9L, Figure 2-11). The distribution of dioxins and furans in white sturgeon across sites was different than the p,p' DDE (Figure 2-4a) and Aroclor (Figure 2-5a,b) fish tissue residue distribution. The p,p' DDE and Aroclor levels were higher in the Hanford Reach (study site 9U) and study sites 6 and 8 in the Columbia River.

The mountain whitefish chlorinated dioxins and furans concentrations were highest in the Hanford Reach of the Columbia River followed by the concentrations in the Yakima River (Figure 2- 11). This distribution was similar to the p,p' DDE (Figure 2-4c) and Aroclor 1260 levels (Figure 2-7b).

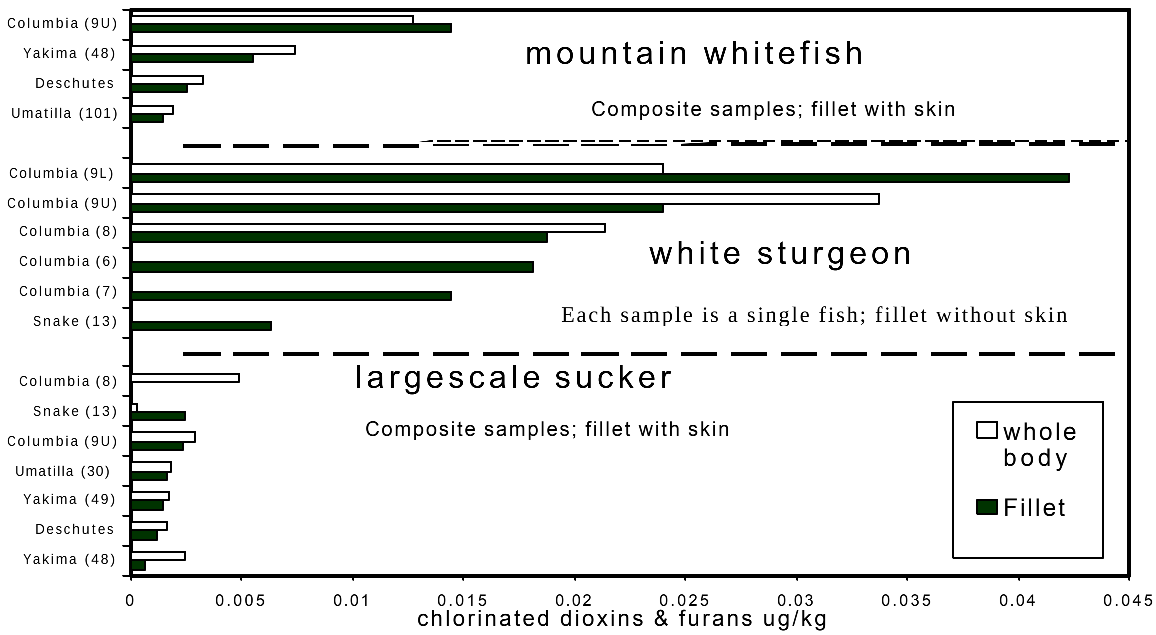


Figure 2-11. Study site average concentrations of chlorinated dioxins and furans in mountain whitefish, white sturgeon, and largescale sucker from study sites in the Columbia River Basin. Study sites are described in Table 1-1). The number of samples are listed in Table 1-2.

2,3,7,8-TCDD, the most commonly studied chlorinated dioxin was generally found at the lowest concentrations in all the samples. The most frequently detected and the highest concentrations of chlorinated dioxins and furans in fish tissue from this study were 2,3,7,8-TCDF and OCDD (Figure 2-12).

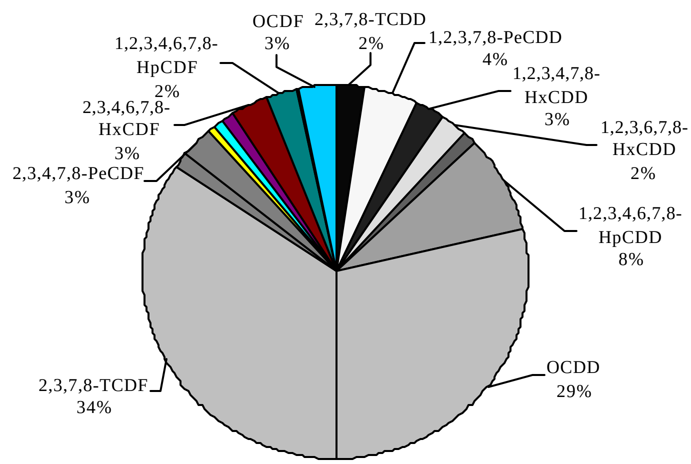


Figure 2-12. Percent contribution of each chlorinated dioxin and furan in largescale sucker. Basin-wide average of 23 composite whole body fish tissue samples. Only those congeners which exceed 1% of total chlorinated dioxin and furan concentrations are shown on the figure.

2-37

The maximum concentration of 2,3,7,8-TCDF was in the white sturgeon (Table 2-9). The fish species tended to cluster into three groups:

1) < 0.001 µg/kg = all the egg samples; walleye fillets, rainbow trout, spring chinook salmon fillets, steelhead, coho salmon, eulachon,
2) > 0.001 to < 0.010 µg/kg = largescale sucker , whole body walleye, bridgelip sucker, Pacific lamprey, fall chinook salmon, and whole body spring chinook salmon, and
3) > 0.010 µg/kg = white sturgeon and mountain whitefish.

Table 2-9a. Basin-wide concentrations of 2,3,7,8-TCDF in composite samples of fish tissue from the Columbia River Basin, 1996-1998.

	Fillet				Whole Body			
	µg/kg				µg/kg			
	N	F	range	Ave	N	F	range	Ave
Resident species								
white sturgeon*	*16*	*16*	0.0025 - 0.054	0.017	*8*	*8*	0.008 - 0.047	0.021
mountain whitefish	*12*	*12*	0.00014 - 0.014	0.0045	*12*	*12*	0.0002 - 0.012	0.0044
largescale sucker	*19*	*18*	<0.0001 - 0.0015	0.0004	*23*	*23*	0.0008 - 0.0036	0.0009
walleye	*3*	*3*	0.0006 - 0.0008	0.0007	*3*	*3*	0.0038 - 0.0055	0.0046
rainbow trout	*7*	*7*	0.0001 - 0.0003	0.0002	*12*	*11*	0.0004 - 0.0005	0.0002
bridgelip sucker	*NS*				*3*	*3*	0.0008 - 0.001	0.001
Anadromous species								
Pacific lamprey	*3*	*3*	0.0012 - 0.0017	0.0014	*9*	*9*	0.0011 - 0.0032	0.0020
fall chinook salmon	*15*	*14*	<0.0003 - 0.0014	0.0007	*15*	*15*	0.0004 - 0.0014	0.0008
spring chinook salmon	*24*	*24*	0.0004 - 0.0007	0.0006	*24*	*24*	0.0006 - 0.0011	0.0007
eulachon	*NS*				*3*	*3*	0.0006 - 0.0008	0.0007
steelhead	*21*	*21*	0.0002 - 0.0007	0.0004	*21*	*21*	0.0003 - 0.0006	0.0004
coho salmon	*3*	*3*	0.0004 - 0.0005	0.0005	*3*	*3*	0.0004 - 0.0005	0.0004

N = number of samples; F = detection frequency; NS=not sampled; < = detection limit
*white sturgeon were individual fish and fillets without skin

Table 2-9b. Basin-wide concentrations of 2,3,7,8-TCDF in composite samples of eggs from anadromous fish species in the Columbia River Basin, 1996-1998.

	Egg			
	µg/kg			
	N	F	range	Ave
fall chinook salmon	*1*	*1*	0.00043	
spring chinook salmon	*6*	*6*	0.0004 - 0.0007	0.0005
steelhead	*1*	*1*	0.0002	
coho salmon	*3*	*3*	0.0003 - 0.0007	0.0005

N = number of samples; F = detection frequency

2.7 Toxicity Equivalence Concentrations of Chlorinated Dioxins and Furans, and Dioxin-Like PCB congeners

Chlorinated dioxins and furans are found in the environment together with other structurally-related chlorinated chemicals, such as some of the various dioxin-like PCB congeners. Therefore, people and other organisms are generally exposed to mixtures of these structurally similar compounds, rather than to a single chlorinated dioxin or furan, or dioxin-like PCB congener.

In order to estimate risks for exposure to dioxin-like chemicals (Table 1-4e,f,g) a method was developed to estimate a toxicity equivalence concentration (Van den Berg et al., 1998). In this methodology the toxicity equivalence factor for 2,3,7,8-TCDD is equal to 1; all other dioxin, furan, and dioxin-like PCB congeners are calculated as some relative percent of 1. The toxicity equivalence factors (Table 2-10) were derived by a panel of experts using careful scientific judgment after considering all available relative potency data (Van den Berg et al., 1998). Dioxin-like congener-specific toxicity equivalence factors (Table 2-10) are used to convert individual dioxin-like congener concentrations to 2,3,7,8-TCDD equivalents.

Table 2-10. Toxicity Equivalence Factors (TEF) for dioxin-like PCB congeners, dioxins, and furans (from Van den Berg et al., 1998).

PCBs	TEF	Dioxins	TEF	Furans	TEF
PCB 126	0.1	2,3,7,8-TCDD	1	2,3,4,7,8-PeCDF	0.5
PCB 169	0.01	1,2,3,7,8-PeCDD	1	2,3,7,8-TCDF	0.1
PCB 157	0.0005	1,2,3,4,7,8-HxCDD	0.1	1,2,3,4,7,8-HxCDF	0.1
PCB 156	0.0005	1,2,3,6,7,8-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1
PCB 114	0.0005	1,2,3,7,8,9-HxCDD	0.1	1,2,3,7,8,9-HxCDF	0.1
PCB 77	0.0001	1,2,3,4,6,7,8-HpCDD	0.01	2,3,4,6,7,8-HxCDF	0.1
PCB 189	0.0001	OCDD	0.0001	1,2,3,7,8-PeCDF	0.05
PCB 123	0.0001			1,2,3,4,6,7,8-HpCDF	0.01
PCB 118	0.0001			1,2,3,4,6,7,8,9-HpCDD	0.01
PCB 105	0.0001			OCDF	0.0001
PCB 167	0.00001				

The toxicity equivalence concentration is the product of the toxicity equivalence factor multiplied by the concentration for an individual dioxin-like congener as shown in
Equation 2-1:

Equation 2-1) $TEC=(TEF_i\ x\ [congener\ fish\ tissue\ concentration]_i)$

TEF = Toxicity equivalence factor

TEC = toxicity equivalence concentration

The toxicity equivalence concentrations for each dioxin, furan, and dioxin-like PCB congener are then summed to determine the total toxicity equivalence concentration.

The mountain whitefish fillet sample had the highest toxicity equivalence concentration (0.0063 µg/kg) followed by the white sturgeon (Table 2-11). The primary contributors to the mountain whitefish toxicity equivalence concentration were 2,3,7,8-TCDF and dioxin-like PCB congeners (118,126,156). The primary contributor to the high white sturgeon toxicity equivalence concentration was 2,3,7,8-TCDF and dioxin-like PCB congeners (105,118,156). The

Pacific lamprey had the highest concentration of toxicity equivalence concentrations of all the anadromous species. The concentrations 2,3,7,8 TCDF (Table 2-9), dioxinlike PCBs (Table 2-7) Aroclors (Table 2-6, and total pesticides (Figure 2-2) were also higher in Pacific lamprey than in any of the anadromous species.

Table 2-11. Basin-wide average concentrations of the toxicity equivalence concentrations for composite fish samples from the Columbia River Basin, 1996-1998.

	Fillet		Whole body			Fillet		Whole body	
	N	µg/kg	N	µg/kg		N	µg/kg	N	µg/kg
Resident Species					**Anadromous Species**				
white sturgeon*	*16*	0.0043	*8*	0.0051	Pacific lamprey	*3*	0.0027	*9*	0.0035
walleye	*3*	0.00049	*3*	0.0036	spring chinook salmon	*24*	0.0006	*24*	0.0009
mountain whitefish	*12*	0.0063	*12*	0.0033	steelhead	*21*	0.0.0009	*21*	0.0009
largescale sucker	*19*	0.0009	*23*	0.0016	eulachon	*NS*		*3*	0.0007
bridgelip sucker	*NS*		*3*	0.0013	coho salmon	*3*	0.0.0004	*3*	0.0006
rainbow trout	*7*	0.0008	*12*	0.0009	fall chinook salmon	*15*	0.0.0004	*15*	0.0005

N = number of samples: NS = not sampled.; *white sturgeon were individual fish and fillets without skin

2.8 Metals

Of the sixteen metals analyzed, antimony and silver were not detected. Thallium was only detected once in a mountain whitefish. Unlike the organic chemicals the high metal concentrations did not appear to be associated with certain species or locations.

The percent contribution of each of the metals to the sum of metals was compared in fillet samples of largescale sucker (Figure 2-13a) and spring chinook salmon (Figure 2-13b). While there was considerable variability in the percent contribution in fish tissue, zinc and aluminum were found at the highest concentrations in all species (Figures 2-13a,b). Arsenic was generally higher in the anadromous fish species than in the resident fish species.

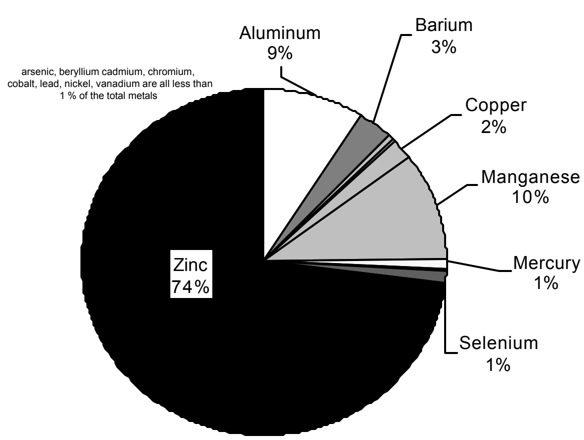


Figure 2-13a. Basin-wide average percent of individual metals in largescale sucker fillets. N= 23.

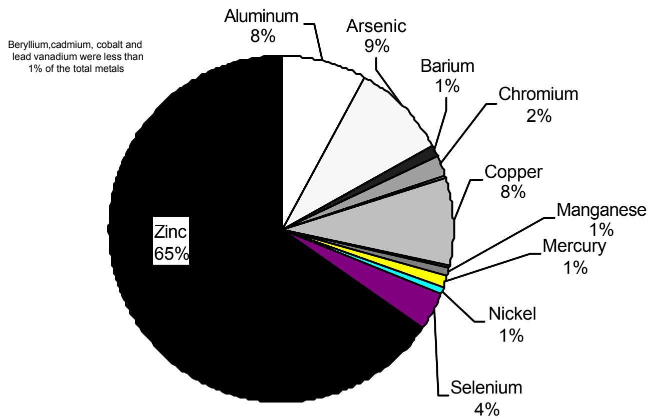


Figure 2-13b. Basin-wide percent of individual metals in spring chinook salmon fillets. N=24.

Basin-wide concentrations of metals were compared across species (Table 2-12, 2-13, 2-14). The maximum concentrations of individual metals (Table 2-12) were generally higher in the whole body fish samples with the exception of arsenic, copper, mercury, selenium, and zinc. Arsenic and mercury were higher in fillet samples while copper, selenium, and zinc were higher in the egg samples from the anadromous fish. The maximum concentrations of barium, cadmium, and manganese were in whole body largescale sucker samples from the Hanford Reach of the Columbia River (study site 9U). The maximum concentrations of chromium and cobalt were measured in the whole body white sturgeon from the main-stem Columbia River (study site 8).

Table 2-12. Basin-wide maximum concentrations * of metals in composite fish tissues measured in the Columbian River Basin, 1996 -1998.

Chemical	Species	N	Tissue type	µg/kg	Study Site**
Aluminum	Largescale sucker	*2*	WB	190000	Columbia River (8)
Arsenic	Steelhead	*3*	FS	1500	Hood River (25)
Barium	Largescale sucker	*3*	WB	4700	Columbia River (9U)
Cadmium	Largescale sucker	*3*	WB	250	Columbia River (9U)
Chromium	White sturgeon	*3*	WB	1000	Columbia River (8)
Copper	Steelhead	*1*	Egg	18000	Snake River (96)
Copper	Fall chinook	*3*	WB	14000	Columbia River (14)
Cobalt	White sturgeon	*3*	WB	420	Columbia River (8)
Lead	Fall chinook	*3*	WB	1200	Columbia River (14)
Manganese	Largescale sucker	*3*	WB	21000	Columbia River (9U)
Mercury	Spring chinook salmon	*3*	FS	510	Klickitat River (56)
Nickel	Steelhead	*3*	WB	17000	Klickitat River (56)
Selenium	Spring chinook salmon	*3*	egg	5500	Umatilla River (30)
Selenium	White sturgeon	*1*	FW	2700	Columbia River (9U)
Vanadium	Rainbow trout	*4*	WB	770	Umatilla River (101)
Zinc	Steelhead	*1*	egg	76000	Snake River (96)
Zinc	Mountain whitefish	*3*	WB	40000	Deschutes (98)

*All samples were composites except white sturgeon which were individual fish.; * *study site name with study site number in parentheses
N = number of samples; FS = fillet with skin; FW = fillet without skin; WB = whole body.

Mercury was not detected in any anadromous egg sample (Table 2-13). The concentrations of copper, manganese, selenium and zinc were higher in the egg samples than any of the anadromous fish tissue samples (Table 2-12;Table 2-14).

Table 2-13. Basin-wide average concentrations of metals in samples of eggs from anadromous fish collected in the Columbia River Basin, 1996-1998. Barium and beryllium were not detected in any egg samples.

Chemical	fall chinook salmon	spring chinook salmon	coho salmon	steelhead
Number of samples	*1*	*6*	*3*	*1*
	Concentration (µg/kg)			
Aluminum	500	950	850	4500
Arsenic	240	460	330	25
Cadmium	<4	35	<4	34
Chromium	<100	100	<100	220
Cobalt	35	43	12	170
Copper	5800	6200	4500	18000
Lead	<10	14	<10	41
Manganese	960	1500	700	2200
Mercury	<50	<79	<100	<43
Nickel	54	78	84	520
Selenium	2400	4200	1200	4500
Vanadium	19	13	28	110
Zinc	36000	43000	31000	76000

< = detection limit

Largescale sucker had the highest basin-wide average concentrations (Table 2-14) of aluminum (69,000 µg/kg), barium (2,300 µg/kg), manganese (14,000 µg/kg), mercury (240 µg/kg), and vanadium (310 µg/kg). White sturgeon had the highest basin-wide average concentrations of beryllium (8 µg/kg), chromium (360 µg/kg), cobalt (260 µg/kg), and selenium (1,100 µg/kg).

The basin-wide average whole body concentrations of cadmium, chromium, cobalt, copper, lead, manganese, nickel, vanadium, and zinc were higher than the fillet concentrations (Table 2-14). This may be due to the concentrations of these chemicals in the internal organs, bones, and skin of the fish. Selenium was generally higher in the whole body fish tissue with the exception of the white sturgeon. The concentrations of barium and aluminum were higher in the whole body tissue of resident fish species. In the anadromous fish species the whole body aluminum and barium concentrations were equal to or less than the fillet.

Table 2-14. Basin-wide average concentrations of metals in composite samples of fish from the Columbia River Basin, 1996-1998.

Chemical	Tissue Type	fall chinook salmon	spring chinook salmon	coho salmon	steelhead	Pacific lamprey	eulachon	largescale sucker	*white sturgeon	mountain whitefish	walleye	rainbow trout	bridgelip sucker
N-FS		*15*	*24*	*3*	*21*	*3*	*NS*	*19*	*16*	*12*	*3*	*7*	*NS*
N-WB		*15*	*24*	*3*	*21*	*9*	*3*	*23*	*8*	*12*	*3*	*12*	*3*
		µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Aluminum	FS	630	790	<1000	1200	500		2400	3800	2600	2500	1100	
Aluminum	WB	510	610	<1000	550	1200	8800	69000	48100	11100	2400	27000	37000
Arsenic	FS	810	850	540	560	310		70	300	100	360	<50	
Arsenic	WB	860	830	500	580	260	890	160	370	140	490	120	280
Barium	FS	130	100	160	220	100		800	250	280	240	390	
Barium	WB	110	110	140	220	100	180	2300	1900	700	670	1200	2000
Beryllium	FS	2	2	2	2	2		3	2	2	2	5	
Beryllium	WB	2	2	2	3	2	2	5	8	2	2	3	5
Cadmium	FS	<4	10	<4	6	24		5	2	7	<4	2	
Cadmium	WB	6	120	22	57	110	9	55	42	28	7	12	29
Chromium	FS	71	180	140	81	80		120	65	130	90	70	
Chromium	WB	100	210	130	140	100	<100	310	360	120	110	93	180
Cobalt	FS	47	21	120	57	33		65	27	51	8	28	
Cobalt	WB	140	110	120	150	96	7	170	260	110	56	88	96
Copper	FS	640	790	1700	720	1200		550	250	620	570	500	
Copper	WB	3400	1400	1300	3200	4500	940	1400	990	1200	2500	1800	1200
Lead	FS	7	14	81	8	<10		29	8	15	<10	<10	
Lead	WB	220	21	15	45	16	500	170	120	35	190	26	54
Manganese	FS	87	90	190	150	380		2700	260	840	370	450	
Manganese	WB	320	370	500	460	390	500	14000	2700	3400	950	3200	18000
Mercury	FS	84	100	120	120	<110		240	150	80	180	77	
Mercury	WB	77	64	100	100	120	<35	130	140	67	180	73	32
Nickel	FS	75	63	54	44	15		110	56	76	260	59	
Nickel	WB	130	270	1200	900	110	50	1100	410	280	260	330	400
Selenium	FS	330	350	290	330	430		260	1100	510	390	220	
Selenium	WB	470	530	360	650	580	290	310	650	960	470	360	280
Vanadium	FS	6	5	7	14	10		11	9	29	5	17	29
Vanadium	WB	24	17	38	66	40	17	310	220	160	14	190	190
Zinc	FS	6700	6300	7100	7900	20000		20000	3800	15000	8700	12000	
Zinc	WB	27000	25000	30000	22000	22000	14000	23000	8200	27500	14000	29000	20000

* white sturgeon were single fish; fillets were without skin N= Number of samples; FS = fillet with skin; WB = whole body; < = detection limit

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2.8.1 Arsenic

Arsenic and mercury are discussed in detail in this report because of their contribution to risk. They are often primary components of risk because of their toxicity as well as their ubiquitous distribution in the environment as natural minerals in soil and from mining activities, smelting (arsenic) and fossil fuel burning (mercury).

With the exception of Pacific lamprey, anadromous fish had higher arsenic concentrations than resident fish (Table 2-14). The whole body concentrations of arsenic were uniformly higher than the fillet concentrations in the resident fish species (Table 2-14). However, there was no consistent pattern in the whole body versus fillet arsenic concentrations in the anadromous fish species (Table 2-14). Pacific lamprey had the lowest arsenic concentrations of all the anadromous species, which was the inverse of the relationship for organic chemicals, where Pacific lamprey had the highest concentrations. The average concentrations (240 - 460 µg/kg) of arsenic in the egg samples (Table 2-14) was similar to the whole body and fillet fish tissue concentrations (70-860 µg/kg) except for the steelhead eggs (25 µg/kg) and rainbow trout fillets (<50) which had the lowest concentrations of all the samples.

Arsenic concentrations were compared across sites for white sturgeon (2-14a) largescale sucker (Figures 2-14b), mountain whitefish (2-14c), spring chinook (2-15a) and steelhead (2-15b)

White sturgeon arsenic concentrations were generally consistent within sites but with considerable variability across sites (Figure 2-14a). For instance, the concentration in whole body samples ranged from 240 µg/kg in the white sturgeon from the Hanford Reach of the Columbia River (study site 9U) to 660 µg/kg in the white sturgeon from the main-stem Columbia River (study site 8). The fillet samples ranged from 150 µg/kg in the Snake River (study site 13) to 640 µg/kg in the fillet sample from main-stem Columbia River (study site 7). The maximum concentration occurred in the whole body sample from the main-stem Columbia River (660 µg/kg; study site 8). The arsenic concentrations in the duplicate fillets were equal or similar to each other.

The highest arsenic concentrations of largescale sucker were measured in whole body and fillet samples from the main-stem Columbia River (200-320 µg/kg; study sites 9U, 8) and the whole body samples from the Snake River (study site 13; 200-270 µg/kg; Figure 2-14b). The lower concentrations ranged from 50-150 µg/kg in whole body and fillet fish tissues from the Deschutes, Yakima, Umatilla Rivers and the fillet fish tissues from Snake River (Figure 2-14b).

Mountain whitefish arsenic concentrations ranged from 100 to 140 µg/kg with the maximum at 180 µg/kg in the whole body sample from the Umatilla River (Figure 2-14c). The lowest concentrations were measured in the Deschutes River fillet samples. There was some variability between fillet and whole body with the whole body samples being higher than the fillet samples from Umatilla River and Deschutes River. The arsenic concentrations in the duplicate fillets from the Deschutes River were similar to each other.

The concentrations of arsenic in spring chinook salmon showed no consistent trend within stations or across stations (Figure 2-15a). The highest concentrations were in the whole body (1200 µg/kg) and fillet (1100 µg/kg)from the Little White Salmon River and the whole body (1100 µg/kg)and fillet (1200 µg/kg)from the Middle Fork of the Willamette River. The arsenic concentrations in the duplicate fillet samples from Looking Glass Creek (study site 94) were similar (777 µg/kg, 783 µg/kg) to each other.

The maximum concentration (1500 µg/kg) of arsenic in all the fish samples was in the fillet sample from the Hood River (Table 1-12 and Figure 2-15b). The maximum whole body concentration from the Hood River was 1200 µg/kg. However there was considerable variability in the replicates for this site with most whole body and fillet samples at about 430 µg/kg. The samples from the other sites were between 290 and 800 µg/kg (Figure 2-15b). The duplicate fillet samples from the Clearwater River were not the same (480 µg/kg, 582 µg/kg) with the higher concentration (582 µg/kg) falling outside the range of the other samples from this site but lower than the maximum observed in the Hood River.

LEGEND
FW = fillet without skin
FS = fillet with skin
WB = whole body
Study sites are listed by number and name and described in Table 1-1
Concentration pints on the graphs include duplicate fillets and chemicals at their detection limits.

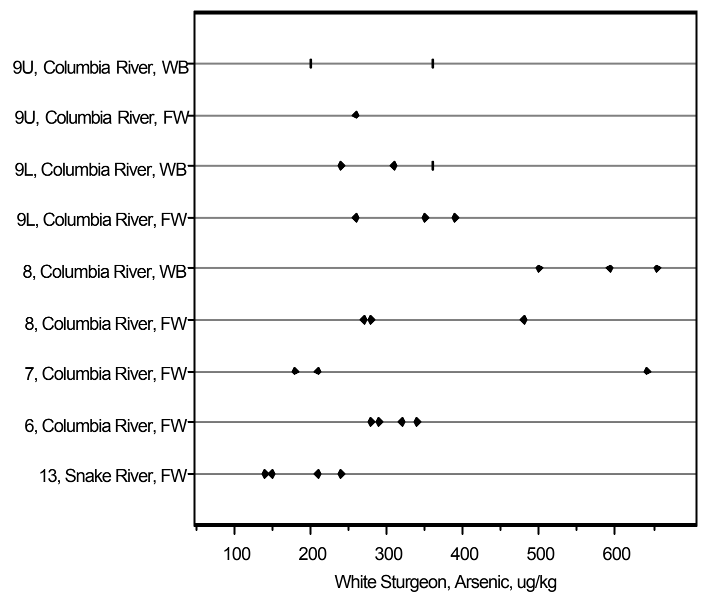


Figure 2-14a. Site specific concentrations of arsenic in white sturgeon individual fish tissue samples from the Columbia River Basin. Study sites 9U, 9L, 6, and 13 include duplicate fillet samples.

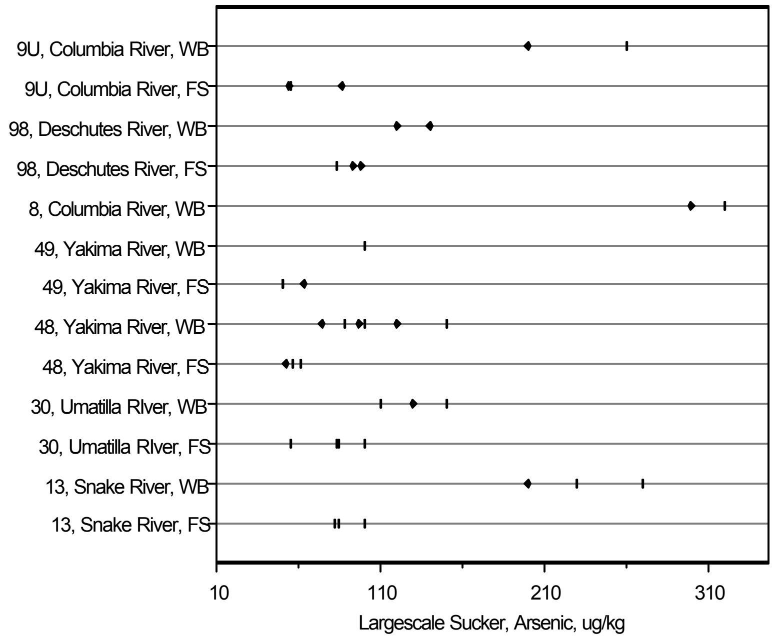


Figure 2-14b. Site specific concentration of arsenic in largescale sucker composite fish tissue samples from the Columbia River Basin.

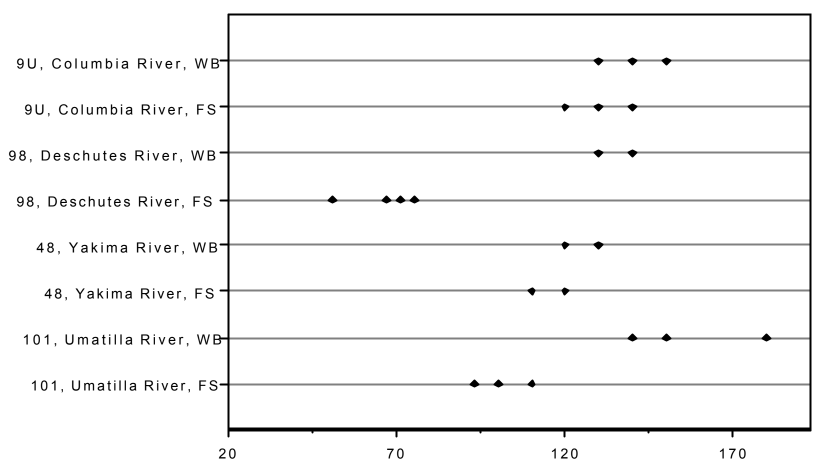
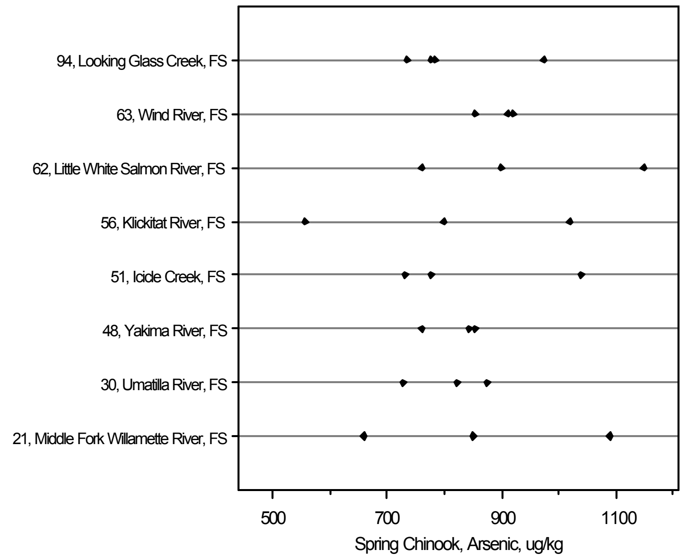


Figure 2-14c. Site specific concentration of arsenic in mountain whitefish composite fish tissue samples from the Columbia River Basin. Study site 98 includes duplicate fillet samples.



LEGEND

FS = fillet with skin
WB = whole body
Study sites are listed by number and name and described in Table 1-1.
Concentration points on graphs include duplicate fillets and chemicals at their detection limits.

Figure 2-15a. Study site concentrations of arsenic in spring chinook composite samples from the Columbia River Basin. Study site 94 includes duplicate fillet samples.

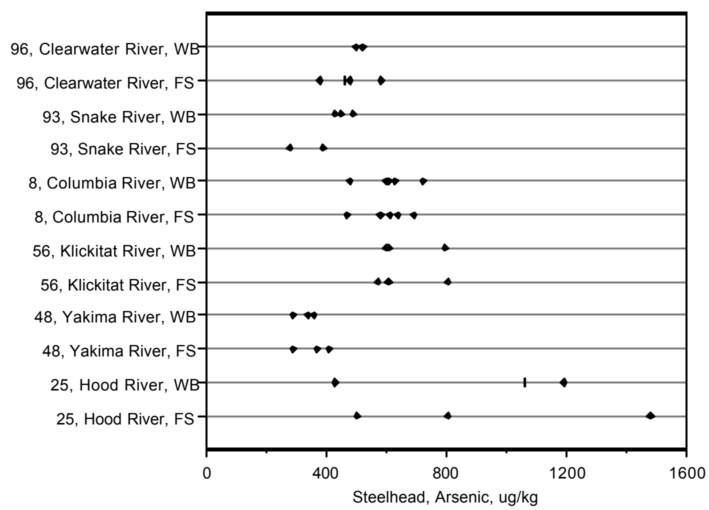


Figure 2-15b. Site specific concentrations of arsenic in steelhead composite fish tissue samples from the Columbia River Basin. Study site 96 includes duplicate fillet samples.

2.8.2 Mercury

The mercury levels in fish samples were extremely variable. The maximum concentration of mercury (510 µg/kg) was in the fillet sample of spring chinook salmon from the Klickitat River (Table 2-12).

There was no consistent pattern in mercury concentrations between whole body and fillet samples in the basin-wide average concentrations (Table 2-14). The average concentrations in fillet samples ranged from <91 µg/kg in the Pacific lamprey to 240 µg/kg in the largescale sucker. The whole body average concentrations ranged from <35 µg/kg in the eulachon to 180 µg/kg in the walleye.

Mercury concentrations were compared across study sites for white sturgeon, largescale sucker, mountain whitefish, spring chinook salmon, and steelhead (Figures 2-16a,b,c and 2-17a,b).

The maximum concentration (617 µg/kg) for white sturgeon was measured in the duplicate fillet from the Snake River (Figure 2-16a). The mercury concentrations in duplicate fillets from the Snake River were quite different from each other (617 µg/kg, 353 µg/kg) and the whole body samples (100 µg/kg) from this site. Since, the duplicate fillets from the same fish were averaged (430 µg/kg) in the data-set for this report, the maximum level of mercury for this study was reported as 510 µg/kg for spring chinook (Table 2-12). The concentrations in the duplicate fillets from study sites 9L, 6, and 13 were similar to each other.

The largescale sucker mercury concentrations were extremely variable across and within study sites. There was no distinct maximum although the fillet samples for the Umatilla and Snake Rivers were higher than the whole body samples from these study sites.

The mountain whitefish mercury concentrations were also variable. The maximum concentrations occurred in the Yakima, and Deschutes Rivers, although there was no difference in average concentrations. The duplicate fillets from the Deschutes River were equal to each other (71 µg/kg).

The concentrations of mercury in spring chinook salmon samples were at or near non-detectable levels, with the exception of the fillet samples from the Klickitat River, where the maximum concentration (510 µg/kg) was measured. This fillet sample also appeared to be an outlier for spring chinook salmon within this site and across all sites. The duplicate fillets from Looking Glass Creek were equal to each other (100 µg/kg).

The maximum concentration (420 µg/kg) was a single whole body sample from the Clearwater River. Except for the whole body sample from the Clearwater River, Steelhead mercury concentrations were all less than 180 µg/kg, with most samples in the 50-110 µg/kg range. The duplicate fillets from the Clearwater River were equal to each other.

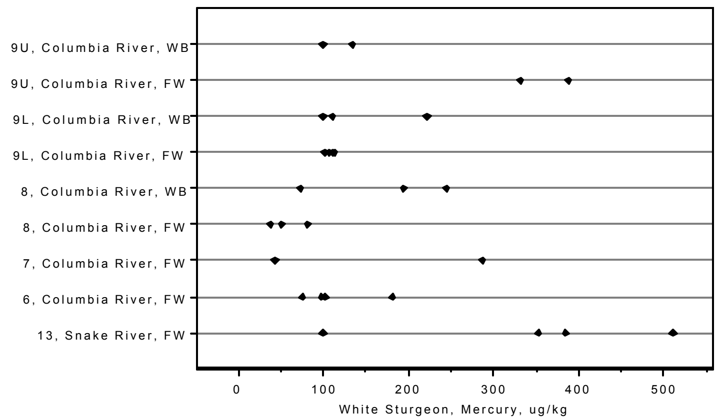


Figure 2-16a. Site specific concentrations of mercury in white sturgeon fish tissue samples from the Columbia River Basin. Study sites 9U, 9L, 13, and 6 include duplicate fillet samples.

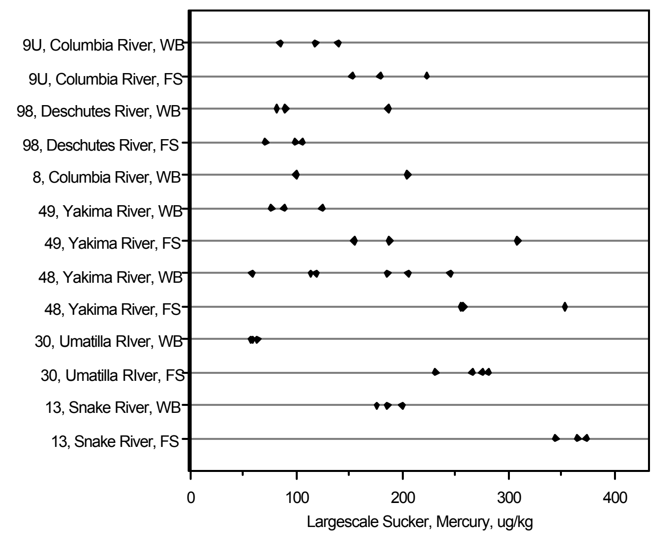


Figure 2-16b. Site specific concentrations of mercury in largescale sucker composite fish tissue samples from the Columbia River Basin.

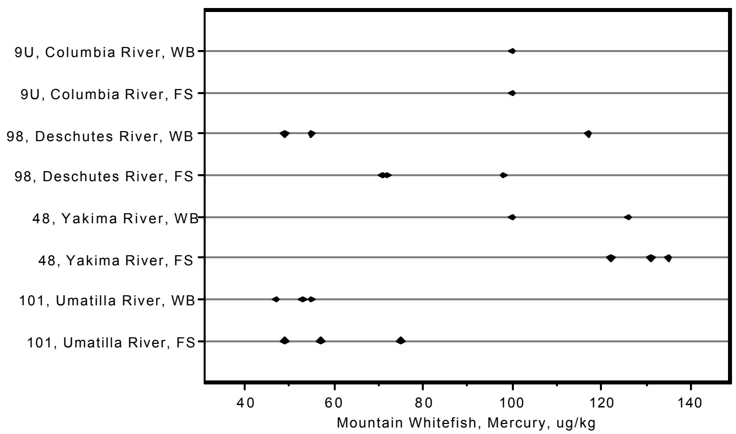


Figure 2-16c. Site specific concentrations of mercury in mountain whitefish composite fish tissue samples from the Columbia River Basin. Study site 98 includes duplicate fillet samples.

LEGEND

FW = fillet without skin
FS = fillet with skin
WB = whole body
Data points represent composite samples of fish tissue except white sturgeon which are individual fish
Study sites are listed by name and number and described in Table 1-1.

Concentration points on graphs include duplicate fillets and chemicals at their detection limits.

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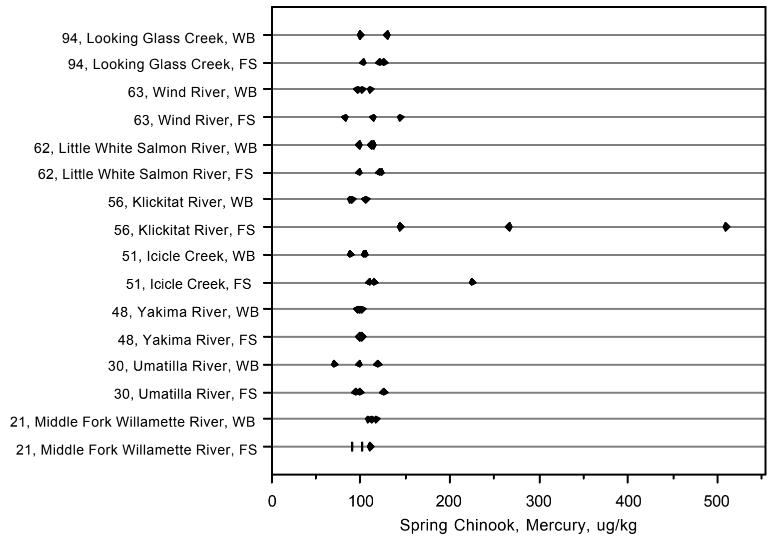

Figure 2-17a. Site specific concentrations of mercury in spring chinook salmon composite fish tissue samples from the Columbia River Basin. Study site 94 includes duplicate fillet samples.

LEGEND

FS = fillet with skin
WB = whole body
Study sites are listed by name and number and described in Table
.Concentration points on graphs include duplicate fillets and chemicals at their detection limits.

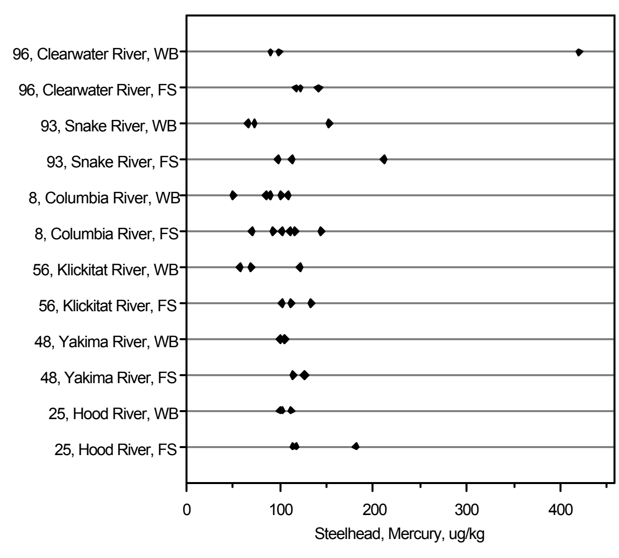

Figure 2-17b. Site specific concentrations of mercury in steelhead composite fish tissue samples from the Columbia River Basin. Study site 96 includes duplicate fillet samples.

3.0 Human Health Risk Assessment

EPA uses risk assessment to characterize the potential cancer risks and non-cancer hazards for individuals exposed to contaminants in environmental media. A systematic framework for risk assessment was first outlined by the National Academy of Sciences (NAS, 1983). Building upon this foundation, EPA has developed risk assessment guidance (e.g., USEPA, 1984, USEPA, 1989; USEPA, 1995) that consists of the following components:

- *Data Collection and Analysis* - involves gathering data to define the nature and extent of contamination in the environmental media of concern.
- *Exposure Assessment* - characterizes how people may be exposed to environmental contaminants and estimates the magnitude of these exposures.
- *Toxicity Assessment* - examines the types of adverse health effects associated with chemical exposure, and the relationship of the magnitude of exposure and the health response.
- *Risk Characterization* - estimates the potential for adverse health effects (both cancer risk and non-cancer hazards) by integrating the information on toxicity and exposure.

The data collection and analysis step for this study have been previously discussed in Section 1. Section 2 provides information on contaminant levels in fish tissues. Section 4 (Exposure Assessment) describes how these contaminant levels are used with other exposure information (e.g. how much fish people eat) to estimate the magnitude of exposure for people consuming fish from the Columbia River Basin. Section 5 (Toxicity Assessment) provides the toxicity information that is used with the exposure estimates to characterize cancer risks and non-cancer hazards in Section 6 (Risk Characterization).

4.0 Exposure Assessment

The objective of this exposure assessment is to estimate the amount of contamination that a person may be exposed to from eating fish caught as a part of this study.

4.1 Identification of Exposed Populations

The potentially exposed populations for this risk assessment include (1) individuals within the general public, and (2) CRITFC's member tribes.

As previously discussed in Section 1 of this report, the basis for the design of this fish study was the fish consumption survey conducted by CRITFC (CRITFC, 1994), which targeted members of the Nez Perce, Umatilla, Yakama, and Warm Springs Tribes (Appendix A). The CRITFC study is the only comprehensive survey of fish consumption that has been conducted for the Columbia Basin and was used to develop tribal fish ingestion rates for this risk assessment.

Three other recent fish consumption surveys have been conducted in the Columbia River Basin: in the middle Willamette River (EVS, 1998), lower Willamette River (Adolfson Associates, Inc., 1996), and in Lake Roosevelt (WDOH, 1997). These three studies are limited in scope and focused on specific regions or populations within the Columbia River Basin. Therefore, the data from them was not used to develop fish ingestion rates for this risk assessment. However, these three surveys as well as the CRITFC survey are discussed in Section 4.5 (Fish Ingestion Rates) because all the surveys illustrate the point that fish consumption practices can vary greatly depending upon the age, gender, cultural practices, and/or socioeconomic status of the anglers surveyed. These variations can include the types and amounts of fish eaten, the frequencies of meals, the portions of the fish that are eaten, and the preparation methods (USEPA, 1998a).

4.2 Exposure Pathway

An exposure pathway describes the course a chemical or physical agent takes from the source to the exposed individual. A complete description of an exposure pathway involves four elements: 1) a source and mechanism of chemical release, 2) movement of the chemical through the environment resulting in contamination of environmental media, 3) a point of potential human contact with these contaminated media (referred to as the exposure point), and 4) an exposure route, such as ingestion, at the point of contact with these media (USEPA, 1989). While several different exposure pathways could conceivably result in human exposure to chemical contaminants within the Columbia River Basin, this risk assessment evaluates only part of one pathway - exposure from consumption of fish. Data on contaminant levels in fish were gathered and potential exposures through fish consumption estimated, but the source of these contaminants and their subsequent movement through the environment into fish were not evaluated.

4.3 Quantification Of Exposure

To characterize the risk from consuming fish, an estimate of the amount of contaminant ingested from eating fish must be estimated. This exposure is estimated using Equation 4-1:

$$\text{(Equation 4-1)} \qquad ADD = \frac{C \times CF \times IR \times EF \times ED}{BW \times AT}$$

where:

ADD	=	Average daily dose of a specific chemical (mg/kg-day)
C	=	Chemical concentrations in fish tissue (mg/kg)
CF	=	Conversion factor (kg/g)
IR	=	Ingestion (consumption) rate (g/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time for exposure duration (days)

As can be seen from this equation, an individual's exposure (average daily dose) depends upon several factors including: the concentrations of contaminants in fish; the amount of fish eaten; how often and how long fish are eaten; and body weight. Because this exposure occurs over time, the total exposure is divided by a time period of interest (the averaging time) to obtain an average exposure rate per unit time. When this average rate is expressed as a function of body weight, the resulting exposure rate is referred to as the average daily dose (ADD) expressed in milligrams of a chemical taken into the body per kilogram body weight per day (mg/kg/day).

As can be seen from Equation 4-1, one individual's exposure may differ from another's because of differences in these exposure factors. Thus, in a population of fish consumers, a wide range of individual exposures would be expected, from those individuals who have little exposure (e.g., because they don't eat much fish and/or eat fish that have low contaminant concentrations) to those who have high exposure (e.g., because they eat highly contaminated fish and/or eat large amounts of fish). For this risk assessment, several of the exposure factors (fish ingestion rate, exposure duration, and body weight) were varied to estimate a possible range in exposures among individual fish consumers (adults and children). For example, the use of average exposure factors in Equation 4-1 is expected to result in a daily dose that is more representative of the average exposure in a population while the use of a mixture of average and high-end exposure factors is more representative of those members of the population who have higher exposures. The selection of these exposure parameters was made to ensure that, at a minimum, cancer risks and non-cancer health impacts for those individuals with more average exposures as well as those with much higher exposures are calculated.

For this risk assessment, exposures were estimated for adults and children for both the general public and CRITFC's member tribes. The exposure values selected for estimating exposure with Equation 4-1 are shown in Table 4-1 (non-cancer) and Table 4-2 (cancer) and are discussed in more detail in Sections 4.4 through 4.9. The same tissue chemical concentrations are used to estimate exposure for all of the populations, for cancer and non-cancer endpoints. However, other exposure parameters differ. For example, cancer risks are estimated for lifetime exposures only. Therefore, only exposure parameters for adults are included in Table 4-2. Four different fish ingestion rates were used for adults (for estimating both cancer risks and non-cancer hazards) and four for children (for estimating non-cancer hazards). These rates were based on two surveys discussed in Section 4.5. The body weights used for each population correspond to the age of the person for which consumption data was obtained in the two fish consumption surveys. For adults for both cancer and non-cancer endpoints, a 70 kilogram body weight is used. However, data were collected on children of different ages in the two surveys (children less than 15 years of age for the survey used for the general public and children less than 6 years of age for the survey used for CRITFC's member tribes), so the body weights also differ.

Table 4-1. Exposure parameters used to calculate average daily dose for assessing noncarcinogenic health effects for potentially exposed populations

Exposure Parameter	Abbreviation	Potentially Exposed Population: General Public AFC	General Public HFC	CRITFC's member tribes AFC	CRITFC's member tribes HFC
Tissue chemical concentration	C	Average	Average	Average	Average
Ingestion rate of fish tissue (g/day)	IR				
Adults		7.5[a]	142.4[b]	63.2[c]	389[d]
Children <15		2.83[a]	77.95[b]	–	–
Children <6		–	–	24.8[c]	162[d]
Exposure frequency (days/yr)	EF	365	365	365	365
Exposure duration (yrs)	ED				
Adults		30[e]/70[f]	30[e]/70[f]	30[e]/70[f]	30[e]/70[f]
Children <15		15	15	–	–
Children <6		–	–	6	6
Body weight (kg)	BW				
Adults		70[g]	70[g]	70[g]	70[g]
Children <15		30[h]	30[h]	–	–
Children <6		–	–	15[i]	15[i]
Averaging time (days)	AT				
Adults		10,950/ 25,550	10,950/ 25,550	10,950/ 25,550	10,950/ 25,550
Children <15		5,475	5,475	–	–
Children <6		–	–	2,190	2,190

AFC - average fish consumption ; HFC - high fish consumption

[a] Mean U.S. per capita consumption rate of uncooked freshwater and estuarine fish (USEPA, 2000b).

[b] 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish (USEPA ,2000b).

[c] Mean consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin (CRITFC, 1994)

[d] 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin (CRITFC, 1994).

[e] 90th percentile length of time an individual stays at one residence (USEPA, 1997b)

[f] Average life expectancy of the general public (USEPA, 1989).

[g] Average body weight for adults (male and female) in the general public (USEPA, 1989).

[h] Average body weight for children of both sexes of age 6 months to 15 years in the general public (USEPA, 1997c). Corresponds to ingestion rate data for children taken from USEPA 2000b.

[i] Average body weight for children of both sexes frm the age of 6 months through 5 years in the general public (USEPA, 1997c). Corresponds to ingestion rate data for children in CRITFC, 1994.

Table 4-2. Exposure parameters used to calculate average daily dose for assessing carcinogenic risks for potentially exposed populations.

		Potentially Exposed Population			
		General Public		CRITFC's member tribes	
Exposure Parameter	**Abbreviation**	**AFC**	**HFC**	**AFC**	**HFC**
Tissue chemical concentration	C	Average	Average	Average	Average
Ingestion rate of fish tissue (g/day)	IR				
Adults		7.5[a]	142.4[b]	63.2[c]	389[d]
Exposure frequency (days/yr)	EF	365	365	365	365
Exposure duration (yrs)	ED				
Adults		30[e]/70[f]	30[e]/70[f]	30[e]/70[f]	30[e]/70[f]
Body weight (kg)	BW				
Adults		70[g]	70[g]	70[g]	70[g]
Averaging time (days)	AT	25,550	25,550	25,550	25,55

AFC - average fish consumption ; HFC - high fish consumption

[a] Mean U.S. per capita consumption rate of uncooked freshwater and estuarine fish (USEPA, 2000b).

[b] 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish (USEPA ,2000b).

[c] Mean consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin (CRITFC, 1994)

[d] 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin (CRITFC, 1994).

[e] 90th percentile length of time an individual stays at one residence (USEPA, 1997b)

[f] Average life expectancy of the general public (USEPA, 1989).

[g] Average body weight for adults (male and female) in the general public (USEPA, 1989).

4.4 Exposure Point Concentrations (Chemical Concentrations in Fish)

The exposure point concentrations for this risk assessment are the average chemical concentrations in uncooked fish tissue. Exposure point concentrations for fish tissue or shellfish are commonly based on average concentrations (USEPA, 1989). The average concentrations are assumed to be representative of the chemical concentrations to which fish consumers would most likely be exposed over the long exposure durations being used in this risk assessment.

Ideally, the concentrations used as the exposure point concentrations for an individual should represent the average chemical concentrations in fish found at study sites where fish are collected for consumption during the exposure duration. Fishing study site preferences within the Columbia River Basin are available for members of the Nez Perce, Umatilla, Yakama, and Warm Springs Tribes (CRITFC, 1994); these preferences were used in designing the sampling plan for this study. However, similar information is not available for the general public. To try and maximize the information conveyed in this risk assessment and allow individuals to assess their own risks based on their fishing practices, the data for each fish species were pooled by (1) study site - all replicate samples for a given fish species and tissue type collected at a study site were averaged to produce a "study site" average and (2) basin-wide all samples for a given fish species and tissue type collected in the Columbia River Basin during this study were averaged to calculate the "basin-wide" averages. The calculation of these study site and basin-wide averages were previously discussed in Section 1.

4.5 Fish Ingestion Rates

4.5.1 Fish Ingestion Rates for the General Population

Three fish consumption surveys were completed in the Columbia River Basin: two for the Willamette River, Oregon and one for Lake Roosevelt, Washington (EVS, 1998; Adolfson Associates, Inc., 1996; WDOH, 1997). A brief description of these surveys is presented in this section. Although these three surveys do not provide fish ingestion rates that can be used for this risk assessment, they do provide useful information on the species of fish consumed in different parts of the basin and on the parts of the fish that are eaten.

In 1998, EVS Environment Consultants (EVS, 1998) conducted a qualitative fish consumption survey for a 45-mile stretch of the Willamette River extending downstream from Wheatland Ferry to the Willamette Falls near Oregon City, Oregon. Information on fish consumption was obtained by conducting phone interviews with individuals representing various community centers, fishing guide services, ethnic associations, fishing-related government agencies and businesses. The survey indicated that anglers are consuming bullhead, carp, sucker, bass, northern pikeminnow, crappie, bluegill, trout, white sturgeon, lamprey, salmon, and steelhead from this section of the Willamette River. All respondents indicated that muscle tissue was the most commonly consumed portion of the fish, although some respondents indicated that the skin, eggs, eyes, and the entire fish were being consumed (EVS, 1998).

In 1995, Adolfson Associates (Adolfson Associates, Inc., 1996) conducted a fish consumption survey by interviewing anglers along the Columbia Slough and Sauvie Island at the mouth of the Willamette River, Oregon This survey found that Caucasians made up the majority of individuals consuming fish from these locations. The ethnic descent of Columbia Slough anglers was 47% Caucasians of eastern European descent, 22% Hispanic, 19% African American, 8% Caucasian (excluding eastern Europeans), and 3% Asian. The most commonly caught fish was carp, followed by yellow perch and banded sculpin. The ethnic descent of Sauvie Island anglers was 67% Caucasian (excluding eastern Europeans), 16% Asian, 8% African American, and 2% Hispanic. The most commonly caught fish was yellow perch, followed by brown bullhead, northern pikeminnow, starry flounder, and white sturgeon. Anglers from both locations indicated the most commonly consumed portion of fish was muscle tissue.

In 1994, the Washington State Department of Health (WDOH, 1997), in cooperation with the Spokane Tribe of Indians, conducted a fish consumption survey of anglers fishing within Lake Roosevelt, Washington, a 151-mile stretch of water extending upstream from the Grand Coulee Dam on the Columbia River to the United States-Canada border. Fish consumption data were collected using a survey form and from creel surveys. The majority of anglers surveyed consisted of individuals who repeatedly fish from Lake Roosevelt. Surveyed anglers were mainly male (90%), Caucasian (97%), and over fifty years of age (60%). The most frequently consumed species were rainbow trout, followed by walleye, kokanee, and bass. The average annual number of fish meals consumed by respondents was 42 meals per year. Assuming a typical meal size of 8 ounces, this average consumption rate corresponds to a daily fish consumption rate of 26 g/day. Fillets were the primary portion of the fish consumed; few anglers consumed fish skin, eggs, or fish head.

Because these three studies provide only a limited amount of information on fish consumption rates for the general public within the Columbia River Basin, a recent EPA fish consumption report (USEPA, 2000b) was used to select the fish consumption rates for this risk assessment that may be representative of adults and children within the general public that consume average and high amounts of fish. The fish consumption rates reported by EPA are based on data collected from the combined 1994, 1995, and 1996 Continuing Survey of Food Intakes by Individuals (CSFII), conducted annually in all 50 states by the United States Department of Agriculture. The CSFII was conducted by interviewing over 15,000 respondents according to a stratified design that accounted for geographic location, degree of urbanization, and socioeconomics. Eligibility for the survey was limited to households with gross incomes at or less than 130% of the federal poverty guidelines. The mean daily average per capita (fish consumers and non-consumers) fish consumption rates of freshwater and estuarine fish (uncooked) reported by EPA (USEPA, 2000b) for adults (7.5 g/day) and children (14 years of age and younger, 2.83 g/day) were selected to be representative of average fish consumption by the general public within the Columbia River Basin. The 99^{th} percentile per capita fish consumption rates of freshwater and estuarine fish (uncooked) reported by EPA (USEPA, 2000b) for adults (142.4 g/day) and children (14 years of age and younger, 77.95 g/day) were selected to be representative of high fish consumption by the general public within the Columbia River Basin.

4.5.2 Fish Ingestion Rates for CRITFC's Member Tribes

During 1991-1992, CRITFC conducted a comprehensive survey of fish consumption by members of the Nez Perce, Umatilla, Yakama, and Warm Springs Tribes that possess fishing rights to harvest anadromous fish and resident fish species originating in streams and lakes flowing throughout the Columbia River Basin (CRITFC, 1994). The survey data were collected by interviewing a total of 513 adult tribal members. Information obtained in this survey included age-specific fish consumption rates, the fish species and parts of the fish consumed, and the methods used to prepare the fish for consumption. Salmon and steelhead were consumed by the largest number of adult respondents followed by trout, lamprey and smelt. The survey determined that the average consumption rate of fish by adults and children (5 years of age and younger) who consume fish was 63.2 g/day and 24.8 g/day, respectively. The 99^{th} percentile fish consumption rates of adults and children (5 years of age and younger) who consume fish was 389 g/day and 162 g/day, respectively. The average and 99^{th} percentile fish consumption rates were selected as representative values for average and high fish consumption by CRITFC's member tribes.

The fish consumption survey conducted by CRITFC (1994) showed that fish consumption by

CRITFC's member tribes is considerably higher than that of the general public. The average and 99th percentile fish consumption rates for adults in CRITFC's member tribes are higher by factors of 8.4 and 2.7, respectively, than the corresponding per capita fish consumption rates reported for the general public by EPA (USEPA, 2000b). It should be noted that Harris and Harper (1997) have suggested that a fish consumption rate of 540 g/day represents a reasonable subsistence fish consumption rate for CRITFC's member tribes who pursue a traditional lifestyle. The value of 540 g/day was based on the authors' review of several non-subsistence Native American studies, two subsistence studies, and personal interviews (by the authors or others) of members of the Umatilla and Yakama Tribes. This value of 540 g/day is 1.4 times the 99th percentile fish consumption rate reported by CRITFC (1994) which is used as the high-end consumption rate for CRITFC's member tribes in this risk assessment.

Some individuals may find it difficult to assess their fish consumption in terms of grams per day. Two other common ways to present this information is in terms of 8-ounce fish meals over some period of time or in terms of pounds per year. An 8-ounce meal size is the value recommended by EPA (USEPA, 2000a) for fish meals. This meal size was also the most commonly selected (48.5%) serving size for adult fish meals based on the CRITFC (1994) survey of its member tribes.

Table 4-3 shows the fish consumption rates used in this risk assessment expressed in different units.

Table 4-3. Fish consumption rates expressed in alternative units.

	Consumption Rate Units		
Target Population	**g/day**	**8-oz Meals**	**Lbs/yr**
General public - average fish consumption			
Adults	7.5[a]	12 meals/year	6.0
Children <15	2.83[a]	5 meals/year	2.3
General public - high fish consumption			
Adults	142.4[b]	19 meals/month	114.6
Children <15	77.95[b]	11 meals/month	62.7
CRITFC's member tribes - average fish consumption			
Adults	63.2[c]	2 meals/week	50.8
Children <6	24.8[c]	40 meals/year	20.0
CRITFC's member tribes - high fish consumption			
Adults	389[d]	12 meals/week	313
Children <6	162[d]	5 meals/week	131

[a] Mean U.S. per capita consumption rate of uncooked freshwater and estuarine fish (USEPA, 2000b).
[b] 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish (USEPA , 2000b).
[c] Mean consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin (CRITFC, 1994)
[d] 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin (CRITFC, 1994).

As discussed in Section 1 of this report, a small number of egg samples were collected for some of the anadromous fish species. There are no studies for the Columbia River Basin with quantitative ingestion rates for eggs. Therefore, a risk characterization for eggs was not included in the Risk Characterization Section (Section 6) of this report. However, an example risk characterization for eggs is presented in the Uncertainty Section (Section 10). This example for eggs is very uncertain but serves as a useful comparison to the results for fish tissue.

4.6 Exposure Frequency

An exposure frequency of 365 days per year was assumed for calculation of the average daily dose. While not all fish species analyzed for this risk assessment can be collected by anglers throughout the year, an exposure frequency of 365 days per year was assumed for all fish species since anglers might catch and freeze fish for later consumption or receive fish for consumption from other anglers.

4.7 Exposure Duration

The exposure duration is the length of time over which exposure occurs at the concentrations and ingestion rates specified by the other parameters in Equation 4-1. Specific information on the length of time over which the general public or CRITFC's member tribes may be consuming fish from the Columbia River Basin is not available. Therefore estimates of exposure duration were made for this risk assessment.

4.7.1 Adults

Two exposure durations, 30 years and 70 years, were assumed for calculations of the adult average daily intake in this risk assessment. Thirty years is the national 90th percentile length of time that an individual stays at one residence (USEPA, 1997b). This value is recommended by EPA (USEPA, 1989) as a reasonable maximum exposure duration when assessing the potential health risks for a residential exposure scenario.

A 70-year exposure duration was selected to assess the potential health risk of a lifetime exposure to chemicals detected in fish tissue. The average life expectancy of the general population in the United States is 72 years for males and 79 years for females (USEPA, 1997c). EPA (USEPA, 1997c) suggests that 75 years is an appropriate value to reflect the average life expectancy of the general population. A value of 70 years was selected as a lifetime exposure duration in this risk assessment because this value has been commonly used in other regional human health risk assessments of fish consumption (e.g., Tetra Tech, 1996; EVS, 2000) to represent the exposure duration for those individuals (e.g., tribal members) who fish from one area their entire life. In addition, since a 70-year lifetime is used to derive cancer slope factors (USEPA, 2000c), the use of 70 years avoids the necessity of having to adjust the cancer slope factors used in this risk assessment.

4.7.2 Children

An exposure duration of 15 years was used to estimate the average daily dose for children in the general public. This exposure duration was selected for children because it corresponds to the age range for which the fish consumption rate data were developed for children in the CSFII Survey (USEPA, 2000b).

An exposure duration of 6 years was used to estimate the average daily dose of children for CRITFC's member tribes. This exposure duration was selected because it corresponds to the age range for which fish consumption data were reported by CRITFC (1994) for children up to 6 years of age.

4.8 Body Weight

The value for body weight in Equation 4-1 is the average body weight over the exposure period. Information on the body weights of the individuals reported in the CRITFC consumption survey (CRITFC, 1994) and the CSFII consumption survey (USEPA, 2000b) were not available, therefore data from the studies, discussed in the following sections, were used.

4.8.1 Adults

Existing EPA guidance (USEPA, 1989, USEPA, 2000a) recommends the use of a body weight of 70 kg (kilograms) to calculate adult exposures. A 70 kg adult body weight is assumed for the derivation of cancer slope factors in IRIS. However, a more recent survey data of the population in the United States suggests that a body weight of 71.8 kg may be more appropriate for adults (USEPA, 1997c).

For this risk assessment, a 70 kg body weight was assumed for adults because its use is consistent with EPA risk assessment guidance (USEPA, 2000f), it avoids the necessity of having to adjust cancer slope factors to accommodate the 71.8 kg average body weight, and allows for comparisons with other regional human health risk assessments of fish consumption that also used 70 kg as the adult body weight.

4.8.2 Children

A body weight of 30 kg was used to calculate the average daily dose of children in the general public. This body weight corresponds to the average weight of female and male children ages 6 months through age 14 (USEPA, 1997c). Six months through the age of age 14 is the age group for which fish consumption data were collected in the CSFII Survey.

A body weight of 15 kg was used to calculate the average daily dose of children for the Columbia River Basin tribes. This body weight corresponds to the average weight of female and male children ages 6 months through age 5 (USEPA, 1997c). Six months through age 5 years is the age group for which fish consumption data were collected in the CRITFC fish consumption survey.

4.9 Averaging Time

As discussed earlier, exposure to contaminants in fish occurs over time. Therefore the total exposure is divided by the time period of interest (the averaging time) to obtain an average exposure rate per unit time. When this average rate is expressed as a function of body weight, the resulting exposure rate is referred to as the average daily dose (ADD) expressed in milligrams of a chemical taken into the body per kilogram body weight per day (mg/kg/day).

The averaging time selected depends upon the type of toxic effect being assessed. When evaluating exposures to non-cancer effects, exposures (dose) are calculated by averaging dose over the period of exposure (for this risk assessment - 30 or 70 years for adults; 6 or 15 years for children). Since the averaging time (AT) is always the same as the time period over which exposure occurs for non-cancer effects, exposure duration (ED), the exposure (dose) in mg/kg/day is the same for both exposure durations within a target populations (e.g. the same for both 30 and 70 years exposure duration for general public adults).

For evaluating cancer risks for adults, exposures are calculated by prorating the total dose over a lifetime (70 years). The exposures calculated for cancer risk assuming 30 or 70 years exposure duration are different from each other because the averaging time is always a lifetime or 25,550 days, but the exposure durations assumed for this report for adults are either 30 (10,950 days) or 70 years (25,550 days). Thus, in this report, cancer risks for both exposure durations (30 and 70 years) are presented.

4.10 Multiple-Species Diet Exposures

The cancer risk and non-cancer hazards that are discussed in most of Section 6 assume that people eat only one species of fish. For example, for estimating the cancer risk from consuming white sturgeon, it is assumed that the adults in the general public, with high fish consumption (142.4 g/day), consume 142.4 grams a day of white sturgeon for either 30 years or 70 years.

However, it is likely that many individuals consume more than one species of fish from the Columbia River Basin. When an individual consumes multiple fish species, additional exposure information is needed on the relative amounts of different species in that individual's diet to obtain an estimate of the individual's potential overall health risk. Because fish consumption practices, including the types and amounts of fish eaten, can vary greatly among individuals, within populations because of differences in age, gender, cultural practices, and/or socioeconomic status, it is difficult to generalize about the potential risk of an individual diet that includes the consumption of multiple species. This section includes the methods and the assumptions used in the example of a multiple-species diet. This example is intended to assist individuals to use the data for individual fish species presented in this report to estimate their own risks when consuming multiple species.

The example selected to illustrate the risk associated with consuming multiple species is based on information obtained during the 1991-1992 survey of fish consumption by members of the Nez Perce, Umatilla, Yakama, and Warm Springs Tribes (CRITFC, 1994). The survey included 513 adult participants. The percentage of these adults that consumed 10 fish species were also presented in this survey (CRITFC, 1994; Table 17). These percentages are included in this section in Table 4-4, column A. To simplify the calculations, the responses from the CRITFC survey for fall chinook salmon, spring chinook salmon, coho salmon, and steelhead were combined into one category, salmon. To estimate the hypothetical diet, it was assumed that the data in the CRITFC survey on percentages of adults consuming different fish species could be used to estimate the percent that each fish species contributes to the hypothetical diet. Table 4-4, Column B, shows the percentage of the diet assumed for each fish species. Each species value in Column B was calculated by dividing the percentage of each fish species consumed (based on the CRITFC study and shown in Column A) by the sum of the percentages for all species in Column A. For example, the value of 27.7% shown for salmon in Table 4-4 (Column B) was obtained by dividing the percentage of adults that consume salmon (92.4 in Column A) by the sum of the percentages of consumption for all species (333.5 in Column A) and multiplying the result by 100 to express the fraction as a percentage:

(*Equation 4-2*)

$$\text{Percent of diet composed of salmon} = \frac{\text{percentage of adults that consume salmon}}{\text{sum of the percentages for all species}} \times 100$$

$$27.7\% = \frac{92.4}{333.5} \times 100$$

In Table 4-4, a consumption rate of 63.2 g/day (the average ingestion rate reported for adults in CRITFC's member tribes (CRITFC, 1994), is used along with the percentages of fish in the hypothetical diet to calculate the consumption rates for each species in the hypothetical multiple diet of an adult in CRITFC's member tribes with average fish consumption. Consumption rates for each species were calculated by multiplying 63.2 g/day by the percentage assumed in the hypothetical diet for that species. For example, the consumption rate of 17.5 g/day shown for salmon in Table 4-4 (Column C) was obtained by multiplying the total average consumption rate (63.2 g/day) for adults in CRITFC's member tribes by the percent that salmon was calculated to represent (27.7%) in this multiple-species diet.

(Equation 4-3)

$$\text{Consumption rate for salmon (g/day)} = \text{Percent of hypothetical diet composed of salmon} \times \text{Average adult ingestion rate for all species}$$

$$17.5 \text{ g/day} = 27.7\% \times 63.2 \text{ g/day}$$

This multiple-species diet methodology was used to estimate exposure and to calculate cancer risks and non-cancer hazards for adults in the general public and CRITFC member tribes in Section 6.2.5 for both the average and high fish ingestion rates. The hypothetical diet of multiple-species based on the CRITFC fish consumption study was used for all of the adult populations.

The exposure due to ingestion of each species in the hypothetical diet was calculated by using the same exposure parameters described for adults in Tables 4-1 and 4-2 except that the fish consumption rates for the multiple-species diet scenario replaced those in the tables. For the adults in CRITFC's member tribes with an average fish consumption rate, those ingestion rates in Table 4-4 (Column C) were used. For the other 3 adult populations assessed (high fish consumption rates for adults in CRITFC's member tribes; average and high fish consumption rates for general public adults), species specific consumption rates were calculated using the multiple diet method just described but using total fish consumption rates for that population and the hypothetical multiple-species diet shown in Table 4-4. Exposure for the hypothetical mixed diet is the sum of all of the exposures calculated for each of the eight species that had ingestion rates calculated in Table 4-4.

Table 4-4. Description of the methodology used to calculate exposure for a multiple-species diet.

Species	A Percentage of Adults that Consume Species	B Percentage of Hypothetical Diet	C Consumption Rate[c] (grams/day)
Salmon[a]	92.4	27.7	17.5
Rainbow trout	70.2	21.0	13.3
Mountain whitefish	22.8	6.8	4.3
Smelt	52.1	15.6	9.9
Pacific lamprey	54.2	16.3	10.3
Walleye	9.3	2.8	1.8
White sturgeon	24.8	7.4	4.7
Sucker	7.7	2.3	1.5
Totals	333.5[b]	100.0	63.2

[a] This category includes spring chinook salmon, fall chinook salmon, steelhead and coho salmon.
[b] Although shad and pikeminnow were included in the CRITFC fish consumption survey (CRITFC ,1994), this total does not include values for these species because these two species were not sampled in this study.
[c] a consumption rate of 63.2 g/day (the average ingestion rate reported for adults in CRITFC's member tribes (CRITFC, 1994), is used along with the percentages of fish in the hypothetical diet to calculate the consumption rates for each species

5.0 Toxicity Assessment

The toxicity assessment for a chemical is done in two steps. The first step, hazard identification, summarizes and weighs the available evidence regarding a chemical's potential to cause adverse health effects, such as cancer, birth defects, or organ damage. The second step, dose-response evaluation, provides an estimate of the relationship between the extent of exposure to the contaminant and the likelihood of these adverse effects occurring. As part of the dose-response assessment, toxicity values - reference doses (RfD) and cancer slope factors (CSFs) - are derived. These toxicity factors are used with the exposures calculated using methods described in Section 4 to estimate cancer risks and non-cancer hazards.

For most environmental contaminants of concern, EPA has already performed the toxicity evaluation and has made the results available in databases. For the risk characterization in this section, all of the toxicity information, including the reference doses and cancer slope factors, was obtained from three EPA toxicity databases. Information was preferentially obtained from IRIS (USEPA, 2000c). If data were not available in IRIS, they were obtained from the fiscal year 1997 Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997d), and finally, from the EPA National Center for Environmental Assessment (NCEA).

A toxicity value has not been developed for all chemicals analyzed in this study. Chemicals currently without toxicity values are listed in Table 5-1. The potential health risks associated with exposure to these chemicals were not evaluated.

Table 5-1. Chemicals without oral reference doses and cancer slope factors. (Source: IRIS, NCEA, USEPA, 2000c; USEPA, 1997d)

Acenaphthylene	1-methyl-Naphthalene
alpha-Chlordene	2-methyl-Naphthalene
Benzo(ghi)perylene	4-Bromophenyl-Phenylether
DDMU	4-Chloroguaiacol
delta-HCC	4-Chlorophenyl-Phenylether
Dibenzofuran	3,4-Dichloroguaiacol
gamma-Chlordene	4-Chloro-3-methylphenol
Pentachloroanisole	4,5-Dichloroguaiacol
Phenanthrene	4,6-Dichloroguaiacol
Retene	3,4,5-Trichloroguaiacol
Tetrachloroguaiacol	3,4,6-Trichloroguaiacol
	4,5,6-Trichloroguaiacol

Of the 23 chemicals listed in Table 5-1, only two, 2-methyl naphthalene and pentachloroanisole, were detected in fish at greater than a 10% frequency. Table 1-4 in Section 1 shows both the detected and non-detected chemicals in this study. It should also be noted that although lead does not have toxicity values (RfD, CSF), lead toxicity is well characterized and is discussed in detail in Section 7.

The remainder of this section is divided into three parts. First, the methods used to assess toxicity data and develop reference doses for non-cancer effects are summarized in Section 5.1. Next, the methods used to assess carcinogenicity data and develop cancer slope factors are summarized in

Section 5.2. Finally, those chemicals for which unique assumptions and/or methods were used to estimate the study site and basin-wide averages due to toxicological considerations are discussed in Section 5.3.

5.1 Summary of Toxicity Assessment for Non-Cancer Health Effects

Summaries of the available toxicity information (e.g., results of animal tests and/or human occupational studies) for each chemical are provided in IRIS, HEAST or by NCEA. For those chemicals that were analyzed for in fish in this study and that have toxicity values, a summary of the types of non-cancer effects caused by that chemical is provided in Table 5-2.

In Table 5-2, the effects that can potentially result from exposure to each of these chemicals are designated with a check or a closed circle. For most chemicals, there is more than one type of non-cancer health effect (e.g., effects on metabolism, effects on the immune system) that can result from exposure to that chemical. The number of effects seen and the severity of a given effect depend upon the level of exposure to that chemical, with both the number and severity of effects usually increasing as exposure increases.

The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of the daily exposure to the human population, including sensitive sub-populations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA, 2000c). To derive the RfD, all available studies are first reviewed. If adequate human data are available, this information is used as the basis of the RfD. Otherwise, animal studies are the basis of the RfD. If several animal studies are available, the study on the most sensitive species (the species showing the toxic effect at the lowest dose) is selected as the critical study for the basis of the RfD. The effect associated with the lowest dose which resulted in an observed adverse effect is referred to as the "critical toxic effect". After the critical study and critical toxic effect have been selected, the experimental exposure level at which no adverse effect is demonstrated (the no-observable-adverse-effect-level) for that effect is then defined. The no-observable-adverse-effect-level is used as the basis for deriving the RfD and is in part based upon the assumption that if the critical toxic effect is prevented then all toxic effects will be prevented. For example, for total Aroclors, the RfD was based upon a rhesus monkey study. This study was designated as the critical study and the RfD is based on the critical toxic effects on the immune system that were found in the study. For some chemicals (e.g., methyl mercury), the RfD may be based on more than one critical toxic effect (central nervous system and developmental/reproductive effects). Table 5-2 also contains information on critical health endpoints used to derive the RfD as well as other adverse health effects.

To develop the RfD, the no-observable-adverse-effect-level, or the lowest-observed-adverse-effect-level if no-observable-adverse-effect-level can be determined from the studies, is divided by uncertainty factors and a modifying factor. These factors, which usually consist of multiples of 10 or lower, are applied to account for the different areas of uncertainty and variability that are inherent in the toxicological data. They include:

- An uncertainty factor to account for variations in the sensitivity of the general population. This factor is intended to protect sensitive subpopulations (e.g., the elderly and children).
- An uncertainty factor to extrapolate from animals to humans when animal data is used.
- An uncertainty factor to account for the uncertainty if only a lowest-observed-adverse-effect-level instead of a no-observable-adverse-effect-level is available.
- An uncertainty factor if data from only short term rather than lifetime studies are available.
- A modifying factor to account for additional uncertainties not already addressed (e.g., if there is a lack of data on reproductive or developmental effects in the experimental data).

For each chemical with non-cancer effects, Table 5-3 presents the oral reference dose for that chemical, the confidence in the reference dose, the uncertainty factors and the modifying factor associated with the reference dose, and the toxic effect from the critical study that the reference dose was based upon. For many chemicals, both oral and inhalation reference doses have been developed and are included in EPA toxicity databases. However, because the exposures assessed in this study result from ingestion of fish, only oral reference doses were used.

TABLE 5-2. CHEMICALS CONTRIBUTING TO NON-CANCER HAZARD INDICES (WITH TOXIC EFFECTS OF EACH CHEMICAL DENOTED BY U AND Ž)

GROUP	ANALYTE	Metabolism	Blood and blood formation	Immune system	Cardiovascular	Kidney	Liver	Central Nervous System	Reproduction/development	Gastrointestinal or intestinal lesions	Argyria	Thyroid	Other	Adrenal gland	Clinical signs	Selenosis	Hyperpigmentation/keratosis	No clear critical toxicity endpoint
Metals	Aluminum							(U)										
	Antimony	U			Ž													
	Arsenic				U	Ž		Ž									U	
	Barium				(U)	(U)												
	Beryllium									U								
	Cadmium					U		Ž										
	Chromium (VI)									(U)								
	Cobalt		(U)															
	Copper																	(U)
	Manganese							U										
	Mercury							U	U									
	Nickel	U											Ž					
	Selenium		Ž				U	Ž	Ž							U		
	Silver					Ž	Ž				U							
	Thallium	Ž			Ž	Ž	U	Ž					Ž					
	Vanadium																	(U)
	Zinc	U																
Semivolatiles	2-Chloronaphthalene						U						Ž					
	2,4-Dinitrotoluene		U				U	U										
	2,6-Dinitrotoluene		U			U	U	U										
	1,2,4-Trichlorobenzene													U				
	Acenaphthene						U											
	Anthracene																	(U)
	Benzene, 1,2-dichloro-																	(U)
	Benzene, 1,3-dichloro-						(U)					(U)						

TABLE 5-2. CHEMICALS CONTRIBUTING TO NON-CANCER HAZARD INDICES (WITH TOXIC EFFECTS OF EACH CHEMICAL DENOTED BY U AND Ž)

GROUP	ANALYTE	Metabolism	Blood and blood formation	Immune system	Cardiovascular	Kidney	Liver	Central Nervous System	Reproduction/development	Gastrointestinal or intestinal lesions	Argyria	Thyroid	Other	Adrenal gland	Clinical signs	Selenosis	Hyperpigmentation/keratosis	No clear critical toxicity endpoint
	Benzene, 1,4-dichloro-						(U)		(U)									
	bis(2-Chloroisopropyl)ether		U															
	Fluoranthene		U			U	U											
	9H-Fluorene		U															
	Hexachloroethane					U	Ž		Ž									
	Hexachlorobutadiene					U												
	Naphthalene	U																
	Nitrobenzene		U			U	U							U				
	Pyrene					U												
Guaiacols/ Phenols	2-Chlorophenol						Ž		U									
	2,3,4,6-Tetrachlorophenol						U											
	2,4-Dichlorophenol			U			Ž	Ž										
	2,4-Dimethylphenol		U					Ž							U			
	2,4,5-Trichlorophenol					U	U											
	Pentachlorophenol	Ž				U	U	Ž										
	Phenol	Ž				Ž			U									
Pesticides	Aldrin						U	Ž										
	Chlordane (total)	Ž					U	Ž										
	DDT [a]						U	Ž	Ž									
	Endosulfan sulfate	U			U	U		Ž	Ž									
	Heptachlor						U	Ž					Ž					
	Heptachlor epoxide						U	Ž	Ž									
	Hexachlorobenzene						U	Ž					Ž					
	gamma-HCH					U	U	Ž										
	Mirex				Ž	Ž	U	Ž				U						

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Table 5-2. Chemicals contributing to non-cancer hazard indices (with toxic effects of each chemical denoted by U and Ž)																		
Group	**Analyte**	Metabolism	Blood and blood formation	Immune system	Cardiovascular	Kidney	Liver	Central Nervous System	Reproduction/development	Gastrointestinal or intestinal lesions	Argyria	Thyroid	Other	Adrenal gland	Clinical signs	Selenosis	Hyperpigmentation/keratosis	No clear critical toxicity endpoint
PCBs	Total Aroclors [b]			U			Ž	Ž	Ž									

U - Chronic oral reference dose for this chemical is based on this health endpoint (critical effect). All chemicals with a **U** for a given health endpoint were summed to obtain an estimate of the hazard index.

(**U**) - Chronic oral reference dose has been developed for this chemical but the critical effect used is not clear. Although hazard quotients were calculated for these chemicals and summed into the total hazard index, these chemicals were not summed into endpoint-specific hazard indices.

Ž - Other observed health endpoints

[a] Comprised of DDE, DDD, and DDT.

[b] For each species, total Aroclors is the sum of detected Aroclors, which includes at least one of the following: Aroclor 1242, Aroclor 1254, and Aroclor 1260.

Table 5-3. Oral reference doses (RfDs) used in this assessment, including the level of confidence in the RfD, uncertainty factors (UF) and modifying factor (MF) used to develop the RfD, and the toxic effect(s) from the critical study that the RfD was based upon.

Chemical	Oral RfD (mg/kg-day)	Confidence	UF/MF	Critical Effect	Source
1,2,4-Trichlorobenzene	1.0×10^{-2}	Medium	1000/1	Increased adrenal weight	USEPA, 2000c
2,3,4,6- Tetrachlorophenol	3.0×10^{-2}	Medium	1000/1	Increased liver weights and centrilobular hypertrophy	USEPA, 2000c
2,4,5-Trichlorophenol	1.0×10^{-1}	Low	1000/1	Liver and kidney pathology	USEPA, 2000c
2-Chloronaphthalene	8.0×10^{-2}	Low	3000/1	Dyspnea, abnormal appearance, liver enlargement	USEPA, 2000c
2-Chlorophenol	5.0×10^{-3}	Low	1000/1	Reproductive effects	USEPA, 2000c
2,4-Dichlorophenol	3.0×10^{-3}	Low	100/1	Decreased delayed hypersensitivity response	USEPA, 2000c
2,4-Dimethylphenol	2.0×10^{-2}	Low	3000/1	Clinical signs (lethargy, prostration, and ataxia) and hematological changes	USEPA, 2000c
2,4-Dinitrotoluene	2.0×10^{-3}	High	100/1	Neurotoxicity, Heinz bodies and biliary tract hyperplasia	USEPA, 2000c
2,6-Dinitrotoluene	1.0×10^{-3}	-	3000	Mortality, neurotoxicity, Heinz bodies effects, methemoglobinemia, bile duct hyperplasia, and kidney histopathology	USEPA 1997e
Acenaphthene	6.0×10^{-2}	Low	3000/1	Hepatotoxicity	USEPA, 2000c
Aldrin	3.0×10^{-5}	Medium	1000/1	Liver toxicity	USEPA, 2000c
Aluminum	1.0	–	–	Minimal neurotoxicity	NCEA
Anthracene	3.0×10^{-1}	Low	3000/1	No treatment-related specific toxicological endpoints observed in mice at the doses administered in laboratory studies	USEPA, 2000c
Antimony	4.0×10^{-4}	Low	1000/1	Longevity, blood glucose, cholesterol	USEPA, 2000c
Total Aroclor [a]	2.0×10^{-5}	Medium	300/1	Ocular exudate, inflamed and prominent Meibomian glands, distorted growth of finger- and toenails; decreased antibody (IgG and IgM) response to sheep erythrocytes	USEPA, 2000c
Arsenic, inorganic [b]	3.0×10^{-4}	Medium	3/1	Hyperpigmentation/keratosis and possible vascular complications	USEPA, 2000c
Barium	7.0×10^{-2}	Medium	3/1	Hypertension and kidney effects	USEPA, 2000c
Benzene, 1,2-dichloro-	9.0×10^{-2}	Low	1000/1	None identified	USEPA, 2000c
Benzene, 1,3-dichloro-	9.0×10^{-4}	–	–	No identified critical toxicological endpoint	NCEA
Benzene, 1,4-dichloro-	3.0×10^{-2}	–	–	Liver and reproductive effects	NCEA
Beryllium	2.0×10^{-3}	Low to Medium	300/1	Small intestinal lesions	USEPA, 2000c
bis(2-Chloroisopropyl)ether	4.0×10^{-2}	Low	1000/1	Decrease in hemoglobin and possible erythrocyte destruction	USEPA, 2000c
Cadmium	1.0×10^{-3}	High	10/1	Significant proteinuria	USEPA, 2000c
Chlordane (total) [c]	5.0×10^{-4}	Medium	300/1	Hepatic necrosis	USEPA, 2000c
Chromium (VI)	3.0×10^{-3}	Low	300/3	Gastrointestinal effects	USEPA, 2000c
Cobalt	6.0×10^{-2}	–	–	Polycytemia - too many red blood cells	NCEA
Copper	3.7×10^{-2}	–	–	Unspecified	USEPA 1997e
DDT [d]	5.0×10^{-4}	Medium	100/1	Liver lesions	USEPA, 2000c

Table 5-3. Oral reference doses (RfDs) used in this assessment, including the level of confidence in the RfD, uncertainty factors (UF) and modifying factor (MF) used to develop the RfD, and the toxic effect(s) from the critical study that the RfD was based upon.

Chemical	Oral RfD (mg/kg-day)	Confidence	UF/MF	Critical Effect	Source
Endosulfan sulfate	6.0 x 10^{-3}	Medium	100/1	Reduced body wt. gain, increased incidence of marked progressive glomerulonephrosis in males	USEPA, 2000c
Fluoranthene	4.0 x 10^{-2}	Low	3000/1	Nephropathy, increased liver weights, hematological alterations, and clinical effects	USEPA, 2000c
Fluorene	4.0 x 10^{-2}	Low	3000/1	Decreased red blood cell, packed cell volume and hemoglobin	USEPA, 2000c
gamma-HCH (Lindane)	3.0 x 10^{-4}	Medium	1000/1	Liver and kidney toxicity	USEPA, 2000c
Heptachlor	5.0 x 10^{-4}	Low	300/1	Liver weight increases in males	USEPA, 2000c
Heptachlor epoxide	1.3 x 10^{-5}	Low	1000/1	Increased liver-to-body weight ratio in both males and females	USEPA, 2000c
Hexachlorobenzene	8.0 x 10^{-4}	Medium	100/1	Liver effects	USEPA, 2000c
Hexachlorobutadiene	2.0 x 10^{-4}	–	1000	Renal tube regeneration	USEPA 1997e
Hexachloroethane	1.0 x 10^{-3}	Medium	1000/1	Atrophy and degeneration of the renal tubules	USEPA, 2000c
Manganese	1.4 x 10^{-1}	–	1/1	CNS effects	USEPA, 2000c
Methylmercury [e]	1.0 x 10^{-4}	Medium	10/1	Developmental neurological abnormalities in human infants	USEPA, 2000c
Mirex	2.0 x 10^{-4}	High	300/1	Liver cytomegaly, fatty metamorphosis, angiectasia; thyroid cystic follicles	USEPA, 2000c
Naphthalene	2.0 x 10^{-2}	Low	3000/1	Decreased average terminal body weight in males	USEPA, 2000c
Nickel, soluble salts	2.0 x 10^{-2}	Medium	300/1	Decreased body and organ weights	USEPA, 2000c
Nitrobenzene	5.0 x 10^{-4}	Low	10,000/1	Hematologic, adrenal, renal and hepatic lesions	USEPA, 2000c
Pentachlorophenol	3.0 x 10^{-2}	Medium	100/1	Liver and kidney pathology	USEPA, 2000c
Phenol	6.0 x 10^{-1}	Low	100/1	Reduced fetal body weight	USEPA, 2000c
Pyrene	3.0 x 10^{-2}	Low	3000/1	Kidney effects (renal tubular pathology, decreased kidney weights)	USEPA, 2000c
Selenium	5.0 x 10^{-3}	High	3/1	Clinical selenosis, liver dysfunction	USEPA, 2000c
Silver	5.0 x 10^{-3}	Low	3/1	Argyria	USEPA, 2000c
Thallium [f]	9.0 x 10^{-5}	Low	3000/1	Increased levels of SGOT[g] and LDH[h]	USEPA, 2000c
Vanadium	7.0 x 10^{-3}	–	100	Unspecified	USEPA, 2000c
Zinc	3.0 x 10^{-1}	Medium	3/1	47% decrease in erythrocyte superoxide dismutase (ESOD) concentration in adult females after 10 weeks of zinc exposure	USEPA, 2000c

[a] For each fish species, total Aroclors is the sum of detected Aroclors, which includes at least one of the following: Aroclor 1242, Aroclor 1254, and Aroclor 1260. The toxicity value for Aroclor 1254 was used.
[b] Total arsenic was measured. Inorganic arsenic was assumed to represent 10% of the total arsenic concentration (see Section 5.3.3).
[c] Chlordane (total) is the sum of cis-chlordane, cis-nonachlor, oxychlordane, trans-chlordane, and trans-nonachlor.
[d] Toxicity value for p,p'-DDT used.
[e] Reported as mercury in data set.
[f] Toxicity value based on thallium nitrate.
[g] Serum glutamic oxaloacetic transaminase.
[h] LDH-lactate dehydrogenase.

5.2 Summary of Toxicity Assessment for Cancer

In the hazard identification step for cancer, summaries of the available toxicity information (e.g., results of animal tests and/or human occupational studies) on a chemical are reviewed. For cancer, this review is done to determine if that chemical is likely to cause cancer in humans. Based upon this evaluation, a chemical is classified into one of five weight-of-evidence classes that have been developed by EPA. These classes, shown in Table 5-4, define the potential for a chemical to cause cancer in humans.

Table 5-4. EPA weight-of-evidence classifications for carcinogens. (USEPA, 2000c).

Weight-of-Evidence Classification	Category
A	Human carcinogen
B	Probable human carcinogen
C	Possible human carcinogen
D	Not classifiable as a human carcinogen
E	Evidence of noncarcinogenicity in humans

In the second part of the toxicity assessment, the dose-response assessment, the toxicity values (CSFs) used to estimate cancer risk are developed. Based upon the manner in which some chemicals are thought to cause cancer, no exposure is thought to be without risk. Therefore, in evaluating cancer risks, a "safe" level of exposure cannot be estimated. To develop toxicity values for carcinogens, mathematical models are used to extrapolate from high levels of exposure where effects have been seen in animal studies or human studies to the lower exposures expected for human contact in the environment. The result of this extrapolation is a dose-response line whose slope is known as the cancer slope factor.

Table 5-5 shows the cancer slope factors for the 23 chemicals evaluated for cancer in this risk assessment. Because of the method used to develop these cancer slope factors, they are considered to be a plausible upper-bound estimate of the cancer potency of a chemical. By using these upper-bound estimates for the cancer slope factors, there is reasonable confidence that the actual cancer risks will not exceed the estimated risks calculated with these slope factors and may actually be lower. Table 5-5 also includes the weight-of-evidence classification for each carcinogen, the type of tumor that the cancer slope factor was based upon, and the source of this information. As previously discussed with reference doses, for many chemicals, both oral and inhalation cancer slope factors have been developed and are included in EPA toxicity databases. However, because the exposures assessed in this study result from ingestion of fish, only oral cancer slope factors were used.

Table 5-5. Oral cancer slope factors with their weight of evidence classification with the type(s) of tumor the cancer slope factor is based upon.

Chemical	Cancer Slope Factor (kg-d/mg)	Weight of Evidence	Tumor type	Source
2,3,7,8-TCDD	1.5×10^{5}	B2	Respiratory system and liver tumors	USEPA, 1997d
1,2-Diphenylhydrazine	8.0	B2	Hepatocellular carcinomas and neoplastic liver nodules	USEPA, 2000c
2,4,6-Trichlorophenol	1.1×10^{-2}	B2	Leukemia	USEPA, 2000c
Aldrin	1.7×10^{1}	B2	Liver carcinoma	USEPA , 2000c
alpha-HCH (alpha-BHC)	6.3	B2	Liver tumors	USEPA, 2000c
Adjusted Aroclors [a]	2.0	B2	Hepatocellular carcinomas	USEPA,1996
Arsenic, inorganic	1.5	A	Skin cancer, internal organs (liver, kidney, lung, bladder)	USEPA, 2000c
1,4-dichlorobenzene	2.40×10^{-2}	C	Liver tumors	USEPA, 1997d
Benzo(a)pyrene	7.3	B2	Forestomach, squamous cell papillomas and carcinomas	USEPA, 2000c
beta-HCH (beta-BHC)	1.8	C	Benign liver tumors	USEPA, 2000c
bis(2-Chloroisopropyl)ether	7.0×10^{-2}	C	Liver and lung tumors	USEPA, 1997d
Chlordane (total)[b]	3.5×10^{-1}	B2	Non-Hodgkin''s lymphoma and liver tumors	USEPA, 2000c
DDD (total)[c]	2.4×10^{-1}	B2	Lung, liver, and thyroid tumors	USEPA, 2000c
DDE (total)[c]	3.4×10^{-1}	B2	Liver and thyroid tumors	USEPA, 2000c
DDT (total)[c]	3.4×10^{-1}	B2	Liver	USEPA, 2000c
gamma-HCH (Lindane)	1.3	B2-C	Liver tumors	USEPA, 1997d
Heptachlor	4.5	B2	Hepatic nodules and hepatocellular carcinomas	USEPA, 2000c
Heptachlor epoxide	9.1	B2	Liver carcinoma	USEPA, 2000c
Hexachlorobenzene	1.6	B2	Liver, thyroid, kidney tumors	USEPA, 2000c
Hexachlorobutadiene	7.8×10^{-2}	C	Renal tubular adenomas and adenocarcinomas	USEPA, 2000c
Hexachloroethane	1.4×10^{-2}	C	Hepatocellular carcinomas	USEPA, 2000c
Pentachlorophenol	1.2×10^{-1}	B2	Hepatocellular adenoma/carcinoma, pheochromocytoma/malignant pheochromocytoma, hemangiosarcoma/hemangioma	USEPA, 2000c
Toxaphene	1.1	B2	Hepatocellular carcinoma and neoplastic nodules	USEPA, 2000c

[a] For each fish species, adjusted Aroclors is the sum of detected Aroclors less the sum of detected PCB congeners. Detected Aroclors included at least one of the following: Aroclor 1242, Aroclor 1254, and Aroclor 1260.

[b] Chlordane (total) is the sum of alpha-chlordane, cis-nonachlor, gamma-chlordane, oxychlordane, and trans-nonachlor.

[c] Slope factor for DDD (total), DDE (total), and DDT (total) based on the p,p' isomers.

5.3 Special Assumptions and Methods Used For Selected Chemicals

The average study site and basin fish contaminant levels for some of the chemicals in this risk characterization were calculated using unique assumptions. The need for these assumptions results from the lack of non-cancer toxicity values (reference doses) for each of the isomers of chlordane; for DDE and DDD; and for Aroclors 1242 and 1260 (Section 5.3.1); special methods for calculating cancer risks for chlorinated dioxins/furans, Aroclors and dioxin-like PCB congeners, and PAHs (Section 5.3.2); and the differential toxicity among arsenic species (Section 5.3.3).

5.3.1 Non-Cancer Toxicity Values for Chlordanes, DDT/DDE/DDD, and Aroclors

For non-cancer effects for chlordanes, DDT/DDE/DDD, and Aroclors, the average fish contaminant levels were calculated as summed quantities of individual chemicals in the class of chemicals. This summation methodology was applied to these three classes of chemicals because toxicity values were not available for all individual chemicals in these three classes and these chemicals were commonly detected in fish tissue. Use of this methodology assumes that the mechanisms of action for all of the chemicals in a class of chemicals are the same.

- Total chlordane was calculated as the sum of *cis*-chlordane, *trans*-chlordane, *cis*-nonachlor, *trans*-nonachlor, and oxychlordane. Non-cancer health effects for total chlordane were based on the reference dose for technical chlordane (USEPA, 2000c). Technical chlordane is not a single chemical, but is a mixture of several closely related chemicals, which consist of some of the various chlordane isomers and metabolites, including: cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and chlordenes, and other compounds.

- Total DDT was calculated by summing the ortho-para and para-para isomers of DDT, DDD, and DDE. IRIS contains a reference dose for DDT, but there are no specific reference doses for DDE or DDD. However, because the structures and toxicities of DDD and DDE closely resemble that of DDT (see Toxicity Profiles in Appendix B), for purposes of this risk characterization, it was assumed that they (and their various ortho- and para-isomers) have the same reference dose as DDT.

- Although PCB congeners were analyzed using two different methods: 1) Aroclors and 2) individual PCB congeners, non-cancer health effects were estimated only for Aroclors as EPA has not established an oral reference dose for individual PCBs congeners (USEPA, 2000c). Three Aroclors were detected in fish tissues, depending on the particular fish species, study site, and tissue type: Aroclor 1242, Aroclor 1254, and Aroclor 1260. The types and amounts of specific PCB congeners (each of which have their individual associated toxicity) differ in these three Aroclor mixtures. Only one of the Aroclors detected in this study has an oral reference dose, Aroclor 1254. Therefore, to provide a health protective estimate of non-cancer health impacts, the oral reference dose for Aroclor 1254 was also used for Aroclor 1242 and Aroclor 1260.

5.3.2 Cancer Toxicity for Chlorinated Dioxins/Furans, Dioxin-Like PCB congeners, and PAHs

The toxicity of the chlorinated dioxins/furans and dioxin-like PCB congeners were evaluated using toxicity equivalence factors recommended by WHO (Van den Berg et al., 1998). Table 2-10 (Section 2.7) listed the seventeen 2,3,7,8-substituted dioxin and furan congeners and 11 dioxin-like PCB congeners with 2,3,7,8-TCDD toxicity equivalence factor values. The toxicity equivalence factors were developed using careful scientific judgement after considering all available scientific data and are an order-of-magnitude estimate of the toxicity of these compounds relative to 2,3,7,8-TCDD.

Cancer risks from exposure to polycyclic aromatic hydrocarbons (PAHs) found in fish tissue in this study that are thought to be carcinogens were estimated from methods described in EPA guidance (USEPA, 1993). A cancer slope factor is available for one PAH only, benzo(a)pyrene. Relative potency factors have been developed for six PAHs (benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(ah)anthracene, indeno(1,2,3-cd) pyrene) relative to benzo(a)pyrene (see Table 5-6) (USEPA, 1993). These relative potency factors are used to convert the concentrations of the six PAHs into benzo(a)pyrene equivalent concentrations. As with the toxicity equivalence factors for chlorinated dioxins and furans and dioxin-like PCB congeners, these relative potency factors are order-of-magnitude estimates and, therefore, have inherent uncertainties. However, unlike the toxicity equivalence factors, these relative potency factors for the PAHs are to be considered as an "estimated order of potential potency" because they do not meet all of the guiding criteria for the toxicity equivalence method described by EPA for PCB mixtures (USEPA, 1991).

Table 5-6. Relative potency factors for PAHs (USEPA,1993).

Chemical	Relative Potency Factors
Benz(a)anthracene	0.1
Benzo(a)pyrene	1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(ah)anthracene	1
Indeno(1,2,3-cd)pyrene	0.1

A methodology recommended by EPA for Aroclors was used to calculate cancer risk estimates for study site and basin-wide average fish concentrations (USEPA, 1996a). Because Aroclors consist of a mixture of both dioxin-like and non-dioxin-like congeners, calculating a cancer risk estimate for PCB congeners by summing the risk of both Aroclors and individual dioxin-like PCB congeners would overestimate cancer risk. To reduce this bias, the total Aroclor concentrations were "adjusted" by subtracting the total concentrations of dioxin-like congeners for each sample as shown in Equation 5-1.

(Equation 5-1) adjusted Aroclors = 3Mass of Aroclors – 3Mass of PCB congeners

The resulting adjusted Aroclor concentrations were used in association with a cancer slope factor for Aroclor mixtures to estimate the cancer risk associated with Aroclors detected in the fish samples (USEPA, 1996a). The cancer risk of dioxin-like PCB congeners was determined using the cancer slope factor for 2,3,7,8-TCDD and toxicity equivalence factors for PCB congeners. The cancer risks attributable to total PCBs were estimated by summing the risk estimates based on adjusted Aroclor concentrations and PCB congeners. While this method still likely overestimates the cancer risk of PCB congeners because the cancer slope factors developed for Aroclors include an unknown contribution from dioxin-like PCB congeners, the approach attempts to reduce the bias of double-counting the PCB risk (USEPA, 1996a).

5.3.3 Arsenic Toxicity

Arsenic exists in many chemical forms (chemical species), both organic and inorganic. These chemical species have varying toxicities ranging from practically non-toxic to very toxic. Organic arsenic species (those with carbon molecules bonded to the arsenic) are less toxic and the inorganic arsenic species (those in which the arsenic atom has a 3+ or 5+ charge and no carbon molecules; denoted as As^{3+} or As^{5+}, respectively) are more toxic. EPA considers inorganic arsenic to be a human carcinogen (see Table 5-5 for the oral CSF for inorganic arsenic). An oral RfD for the non-cancer health endpoints of inorganic arsenic has also been developed (see Table 5-3). EPA consensus toxicity values for organic arsenic species are not available at this time.

Fish contain both organic and inorganic arsenic species, with the organic arsenic species predominating. The organic arsenic species identified in fish include arsenobetaine, arsenocholine, arsenosugars, dimethyarsenic (DMA) and monomethylarsenic (MMA) For this risk assessment, fish tissue were analyzed for total (inorganic and organic) arsenic. Since toxicity values are only available for inorganic arsenic, to estimate the cancer risk and potential non-cancer health impacts from exposure to arsenic in this report, an estimate of the percentage of inorganic arsenic in fish had to be made. Of the many studies that have been done worldwide to measure the levels of arsenic in fish, several have included analyses of the various organic and inorganic species (ICF Kaiser, 1996). Most of these studies have been done with saltwater species and report inorganic arsenic levels in fish from zero to a few percent; however, some higher percentages of inorganic arsenic have also been found (e.g., 3.6% for herring, hairtail and saury, and 9.5% for shark). There are very few studies in which inorganic arsenic species have been determined in freshwater fish tissues (ICF Kaiser, 1996).

Inorganic arsenic results are available from two studies in fish from the Columbia River Basin - one in the Lower Columbia River Bi-State Water Quality Program (Tetra Tech, 1996) and a more recent one done on the Willamette River.

In the Lower Columbia River study (Tetra Tech, 1996), composites of fish were collected in 1995 from the mouth of the Columbia River to below the Bonneville Dam on the Columbia River (at River Mile 146) and analyzed for a large suite of chemicals, including inorganic arsenic. Sturgeon samples were skinned and analyzed as individual fish; all other fish were composites of fillets with skin. Table 5-7a shows a summary of the arsenic data from the six fish species collected as a part of this study (coho salmon, chinook salmon, sturgeon, sucker, carp and steelhead). Analyses were done for total arsenic, inorganic arsenic, and the methylated species (MMA, DMA). The percent of inorganic arsenic and the percent of the sum of DMA and MMA were calculated and are also shown in the table.

The percent inorganic arsenic ranged from a low of 0.1% in two of the steelhead composites and one chinook composite (2 of the 3 values of 0.1% are based on non-detect values) to a high of 26.6% in a sucker composite (Table 5-7a). Within the same species the variation between different composite samples was large. For example, percent inorganic arsenic in the sucker composites ranged from 0.6% (based upon a nondetected value) to 26.6%. Individual sturgeon ranged from 1.9% to 18.2% . The average percent inorganic arsenic by species ranged from 0.5% in carp to 9.2% in sturgeon (Table 5-7c) with an overall arithmetic average for all composites of 6.5% (see Table 5-7b).

Average percent inorganic arsenic was also estimated for anadromous fish versus resident fish species (Table 5-7d). As can be seen from this table, the average percent inorganic arsenic in anadromous fish species is about 1% while that from resident fish species is about 9%.

Table 5-7a. Results of arsenic (As) analyses from Lower Columbia River Bi-State Water Quality Program (Source: Tetra Tech, 1996).

Species/Sample	Total As (ug/g WW)	Inorganic As (ug/g WW)	Q*	Percent Inorganic As	DMA & MMA (ug/g WW)	Q*	Percent DMA & MMA
Coho/HCMP1	0.415	0.001	UJ	0.2%	0.056		13.5%
Coho/HCMP2	0.344	0.007	J	2.0%	0.029		8.4%
Coho/HCMP3	0.361	0.001	UJ	0.3%	0.039		10.8%
Chinook/KCMP1	1.235	0.023	J	1.9%	0.038		3.1%
Chinook/KCMP2	0.884	0.001	UJ	0.1%	0.078		8.8%
Chinook/KCMP3	0.760	0.015	J	2.0%	0.034		4.5%
Sturgeon/SIND1	1.793	0.034		1.9%	0.038		2.1%
Sturgeon/SIND2	0.563	0.011		2.0%	0.023		4.1%
Sturgeon/SIND3	0.558	0.047		8.4%	0.019		3.4%
Sturgeon/SIND4	0.533	0.045		8.4%	0.013		2.4%
Sturgeon/SIND5	0.275	0.05		18.2%	0.007		2.5%
Sturgeon/SIND6	0.485	0.047		9.7%	0.009		1.9%
Sturgeon/SIND7	0.395	0.039		9.9%	0.01		2.5%
Sturgeon/SIND8	0.357	0.04		11.2%	0.003		0.8%
Sturgeon/SIND9	0.669	0.043		6.4%	0.01		1.5%
Sturgeon/SIND10	0.748	0.033		4.4%	0.13		17.4%
Sturgeon/SIND11	0.24	0.039		16.3%	0.009		3.8%
Sturgeon/SIND12	0.311	0.041		13.2%	0.01		3.2%
Sucker/LSCMP1-1	0.151	0.017		11.3%	0.007		4.6%
Sucker/LSCMP1-2	0.133	0.024		18.0%	0.004		3.0%
Sucker/LSCMP1-3	0.143	0.038		26.6%	0.007		4.9%
Sucker/LSCMP2-1	0.113	0.012		10.6%	0.004		3.5%
Sucker/LSCMP2-2	0.181	0.008		4.4%	0.007		3.9%
Sucker/LSCMP2-3	0.17	0.004		2.4%	0.011		6.5%
Sucker/LSCMP3-1	0.098	0.006		6.1%	0.001	U	1.0%
Sucker/LSCMP3-2	0.178	0.001	U	0.6%	0.011		6.2%
Sucker/LSCMP3-3	0.168	0.003		1.8%	0.007		4.2%
Carp/CCMP1	0.221	0.001		0.5%	0.02		9.0%
Steelhead/DCMP1	0.677	0.018		2.7%	0.021		3.1%
Steelhead/DCMP2	0.753	0.001		0.1%	0.033		4.4%
Steelhead/DCMP3	0.703	0.001	U	0.1%	0.031		4.4%

Table 5-7b. Mean concentrations of arsenic(As) in all fish species combined**

	Total As (ug/g WW	Inorganic As (ug/g WW)	Percent Inorganic As	DMA & MMA (ug/g WW)	Percent DMA & MMA
Arithmetic mean	0.47	0.02	6.5%	0.02	5.0%
Geometric mean	0.36	0.01	2.9%	0.01	3.9%

Table 5-7c. Arithmetic means of percent inorganic arsenic by species.**

Species	Mean
coho	0.9%
chinook	1.3%
sturgeon	9.2%
sucker	9.1%
carp	0.5%
steelhead	1.0%

Table 5-7d. Arithmetic means ** of percent inorganic arsenic - resident fish versus anadromous fish species.

Species	% Inorganic As
Anadromous only	1.0%
Resident only	9.1%

WW = wet weight; As = arsenic; MMA = momomethylarsenic; DMA = dimethylarsenic
*Q = data qualifiers; Blanks indicate data was not qualified; U = not detected; J= estimated;
**calculations based on Tetra Tech, 1996.
coho/HCMP=coho/coho composite; chinook/KCMP = chinook/chinook composite;
sturgeon/SIND = sturgeon/sturgeon individual; sucker/LSCMP = sucker/largescale sucker composite;
carp/CCMP= carp/carp composite; steelhead/DCMP = steelhead/steelhead composite

For the middle Willamette River study (EVS, 2000), composites of fish (largescale sucker, carp, smallmouth bass, and northern pikeminnow) were collected from a 45-mile section of the Willamette River extending from the Willamette Falls near Oregon City (River Mile 26.5) to Wheatland Ferry (River Mile 72). Total arsenic and inorganic arsenic concentrations were determined in each of the composite fish samples. These samples included composites of whole body, composites of fillet with skin, and composites of that portion of the fish remaining after removing fillets from both sides of the fish. A summary of the arsenic data for whole body and fillet with skin samples is shown in Table 5-8. Percent inorganic arsenic in the individual composites ranged from 2% (carp) to 13.3% (sucker). Only two species had multiple composite samples analyzed for the same body type, whole body for carp and fillet for smallmouth bass. The average percent of inorganic arsenic was 4.2% for the carp (range of 2 to 6.9% in the four whole body composites) and 3.8% for the smallmouth bass (2.7% (not detected) and 6.3% in two fillet composites).

Table 5-8. Summary of Willamette River, speciated arsenic data (EVS, 2000).

Composite	Tissue Type	Total As (ug/kg WW)	Q	Inorganic As (ug/kg WW)	Q	Percent Inorganic As	Q	Average Percent Inorganic As
Sucker/ Comp 1	F	0.08		0.004		5.0%		
Sucker/ Comp 12	WB	0.12		0.016		13.3%		
Carp/ Comp 3	WB	0.16		0.007		4.4%		
Carp/ Comp 4	WB	0.13		0.009		6.9%		
Carp/ Comp 5	WB	0.15		0.005		3.3%		
Carp/ Comp 14	WB	0.15		0.003		2.0%		4.2%[a]
Carp/ Comp 9	F	0.12		0.003	U	2.5%	U	
Bass/ Comp 6	F	0.11		0.003	U	2.7%	U	
Bass/ Comp 7	F	0.08		0.005		6.3%		3.8%[b]
Pikeminnow/ Comp 13	WB	0.05	U	0.003	U	6.0%	U	
Pikeminnow/ Comp 10	F	0.05	U	0.003	U	6.0%	U	

Comp = composite; F= fillet; WW= wet weight; WB = whole body
Q = data qualifier; U = not detected; blanks indicate that data was not qualified
[a]for whole body carp; [b]for bass fillet

Only two species, carp and sucker, were analyzed for inorganic arsenic and total arsenic in both the Lower Columbia River and Willamette River studies. For carp, one composite sample of fillet with skin was analyzed in each of the studies giving inorganic arsenic percentages of 2.5% (Willamette, based on a non-detected value) and 0.5% (Lower Columbia River). For sucker composites, the average for percent inorganic arsenic in the Lower Columbia River study (fillet with skin, 9 composites) is 9.1% compared to that for the one fillet sample from the Willamette of 5.0%. The range of values for the 9 sucker composites from the Lower Columbia River study is large (0.6% to 26.6%).

In deciding what value to assume for inorganic arsenic in fish in this assessment, consideration was given to the Lower Columbia River and Willamette River inorganic arsenic data cited in this study as well as to uncertainties related to 1) arsenic toxicity (i.e., from DMA) and 2) arsenic analyses in fish tissue:

(1) Arsenic toxicity - Because arsenobetaine and arsenocholine are readily absorbed from the human digestive tract and excreted in urine rapidly and unchanged, these arsenic species are considered virtually non-toxic. In contrast, arsenosugars are apparently metabolized in the human body to DMA which is then excreted in urine (Ma and Le, 1998). EPA has classified DMA as a category B2 carcinogen (probable human carcinogen based on sufficient animal but insufficient human evidence) based on tumors in rodents (USEPA, 2001). However, no EPA consensus toxicity values are available for DMA.

Although DMA may be toxic, no DMA data is available on the fish samples collected as a part of this Columbia River Basin study. In addition information on the concentrations of DMA in freshwater fish from other studies are limited. Concentrations of DMA and MMA, combined, are available from the Lower Columbia River Bi-State Water Quality Program (Tetra Tech, 1996) and are shown in Tables 5-7a and 5-7b. The percent of DMA and MMA combined ranged from 0.8% to 17.4% among the composites. The arithmetic mean for the combined levels of MMA and DMA among all six of the fish species analyzed was about 5% (Table 5-7b). However, the values for DMA alone are not available.

Thus, although DMA may be an arsenic species of concern in fish or of concern as a result of metabolism of arsenosugars, it is not possible to evaluate the potential impact on the risk characterization that this compound would have in this study.

(2) Analysis for arsenic in fish - the identity of the chemical species of arsenic in aquatic species is currently an area of active research and rapidly advancing knowledge. Existing analytical methods for the chemical speciation of arsenic have several limitations including, but not limited to, a lack of data on the efficiencies of recovery of arsenic species during analysis, the possible inter-conversion of arsenical species during extraction and analyses and the lack of native standard reference materials for use in determining accuracy, precision and reproducibility.

In the estimating non-cancer hazards and cancer risks from exposure to arsenic in fish tissue (Sections 6.2.1 and 6.2.2) it was assumed that 10% of total arsenic is inorganic arsenic. The value of 10% was chosen after considering:

1) the wide range found in percent inorganic arsenic among the freshwater samples of a given species in the Lower Columbia River and Willamette River studies,
2) the limited data base on concentrations of inorganic arsenic in freshwater fish,
3) the uncertainties in the toxicity and concentrations of DMA in fish, and
4) the uncertainties in the analytical techniques used for the chemical speciation of arsenic.

This value of 10% is expected to result in a health protective estimate of the potential health effects from arsenic in fish.

However, the inorganic arsenic data for anadromous fish species in the Lower Columbia River study suggest that the assumption of a lower percentage (i.e., about 1%, see Table 5-8d) of inorganic arsenic in these anadromous fish species may also be appropriate. This is also consistent with the literature on saltwater species which show inorganic arsenic levels in the low percentages for most saltwater fish. Therefore, in Section 6.2.6 the analyses of cancer risk and non-cancer hazards were presented assuming that inorganic arsenic is only 1% of the total arsenic in anadromous fish species.

Using a range of assumptions for percent inorganic arsenic in anadromous fish species provides information on the potential uncertainties in the risk characterization.

6.0 Risk Characterization

Risk characterization is the final step in the risk assessment process. It combines the information from the Exposure Assessment (Section 4) and Toxicity Assessment (Section 5) to estimate non-cancer hazards and cancer risks. In addition, risk characterization addresses the uncertainties underlying the risk assessment process (Section 10, Uncertainty Evaluation). This risk characterization was prepared in accordance with the EPA guidance on risk characterization (USEPA, 1992b; USEPA, 1995).

The methodology used to quantify potential non-cancer health effects and cancer risks is described in Section 6.1. The estimated non-cancer health hazards are discussed in detail in Section 6.2.1. and the estimated cancer risks in Section 6.2.2. Cancer and non-cancer results are summarized in Section 6.2.3. In Section 6.2.4 the differences in cancer risks and non-cancer hazards are compared between whole body and fillet fish samples collected from each site in the Columbia River Basin. Section 6.2.5 discusses the results of the multiple-species diet calculation, and; Section 6.2.6 shows how assumptions of percent inorganic arsenic impact the risk characterization.

Non-cancer health hazards and cancer risk estimates are calculated separately and reported separately. Because EPA uses different methods to evaluate these endpoints, non-cancer and cancer estimates cannot be combined.

6.1 Risk Characterization Methodology

6.1.1 Non-Cancer Health Effects

For non-cancer health effects, it is assumed that there is an exposure threshold below which adverse effects are unlikely to occur. In this assessment, the evaluation of non-cancer health effects involved a comparison of average daily exposure to chemicals in fish tissue with the EPA reference doses discussed in Section 5. The reference dose is an estimate of the daily exposure to a chemical that is unlikely to cause toxic effects. Potential health hazards from non-cancer effects for a specific chemical are expressed as a hazard quotient (HQ), which is the ratio of the calculated exposure (Section 4) to the reference dose for that chemical.

Both the estimated average daily doses from consuming fish and the reference doses are expressed in units of amount (in milligrams) of a chemical ingested per kilogram of body weight per day (mg/kg-day) (USEPA, 1989):

(Equation 6-1)

$$HQ = \frac{ADD}{RfD}$$

Where:

HQ = Chemical-specific hazard quotient (unitless)
ADD = Average daily dose (mg/kg-day)
RfD = Chemical-specific oral reference dose (mg/kg-day)

In this risk assessment, hazard quotients were first calculated for individual chemicals in each species at each study site and for the basin. These results are found in Appendices G1 and G2. However, because the fish collected for this study contain more than one contaminant, estimating non-cancer hazard by considering only one chemical at a time might significantly underestimate the non-cancer effects associated with simultaneous exposures to several chemicals. Therefore, to assess the overall potential for non-cancer hazards posed by multiple chemicals, the procedures recommended by EPA for dealing with mixtures were applied (USEPA, 1986a; USEPA, 1989).

EPA recommends that a total hazard index value first be calculated by summing all hazard quotients for individual chemicals regardless of the type of health effect that each chemical causes. This approach to assessing mixtures - adding the hazard quotients - is known as dose addition. Dose addition assumes that all compounds in a mixture have similar uptake, pharmacokinetics (absorption, distribution, and elimination in the body), and toxicological processes; and that dose-response curves of the components have similar shapes. Thus, calculating a total hazard index (adding all of the hazard quotients for all of the chemicals in a fish sample regardless of their health endpoint) has several uncertainties since it results in combining chemicals with reference doses that are based upon very different critical effects, levels of confidence, and uncertainty/modifying factors. Because the assumption of dose additivity is most properly applied to compounds that induce the same effect by the same mechanism of action, summing the hazard quotients for all chemicals to calculate a total hazard index could overestimate the potential for effects, and is therefore, only the first step in assessing non-cancer effects from a mixture.

If the total hazard index calculated is greater than one, EPA recommends that the hazard quotient values for chemicals with similar target organs or mechanisms of action (health endpoints) be summed to calculate a hazard index specific for each health endpoint (USEPA, 1986a). If an endpoint specific hazard index is greater than 1, unacceptable exposures may be occurring, and there may be concern for potential non-cancer effects. Generally, the greater the magnitude of the hazard index greater than 1, the greater the level of concern for non-cancer health effects.

For this risk assessment, both the total hazard index and endpoint specific hazard indices were calculated for each study site and for the basin. As previously discussed in Section 5, a total of seventeen non-cancer health endpoints were considered in developing endpoint specific hazard indices. Hazard indices are presented by species in Appendices O (resident fish species) and P (anadromous fish species). The non-cancer hazard discussion in this section (Section 6) further summarizes the information in these appendices, focusing on the range in total and endpoint specific hazard indices among the species and on the chemicals which contribute the most to non-cancer hazards.

6.1.2 Cancer Risk Assessment

The potential cancer risk from exposure to a carcinogen is estimated as the incremental increase in the probability of an individual developing cancer over a lifetime as a result of exposure to that carcinogen (USEPA, 1989). The term “incremental” means the risk due to environmental chemical exposure above the background cancer risk experienced by all individuals in a course of a lifetime. Approximately one out of every two American men and one out of every three American women will have some type of cancer during their lifetime (American Cancer Society, 2002). The risk characterization in this report estimates the cancer risk that may result from only one source - exposure to contaminants as a result of eating fish from the Columbia River Basin. Other cancer risks (i.e., “background” cancer risks) are not evaluated.

Under current risk assessment guidelines, EPA assumes that a threshold dose does not exist for carcinogens and that any dose can contribute to cancer risks (USEPA, 1986b). In other words, the risk of cancer is proportional to exposure and there is never a zero probability of cancer risk when exposure to a carcinogenic chemical occurs. Cancer risk probabilities were estimated by multiplying the estimated exposure level (average daily dose in mg/kg-day, discussed in Section 4) by the cancer slope factor (SF) for each chemical. The cancer slope factors used in this risk characterization were developed by EPA and are discussed in Section 5 and shown in Table 5-5. Cancer slope factors are expressed in units that are the reciprocal of those for exposure (i.e., $(mg/kg\text{-}day)^{-1}$). The cancer risk calculated for a chemical using this method represents the upper-bound incremental cancer risk that an individual has of developing cancer in their lifetime due to exposure to that chemical.

(Equation 6-2) $$Risk = ADD \times SF$$

Where:

Risk = Estimated chemical-specific individual excess lifetime cancer risk (probability; unit-less)
ADD = Chemical-specific average daily dose (mg/kg-day)
SF = Chemical-specific oral cancer slope factor $(kg\text{-}day/mg)^{-1}$

The excess cancer risk estimates in this report are shown in scientific notation format. These values should be interpreted as the upper-bound estimates of the increased risk of developing cancer over a lifetime. For example, 1×10^{-6} or 1E-06 (E=exponent of base 10) is the estimated upper-bound lifetime cancer risk of 1 in 1 million. Because these are upper-bound estimates, the true risks could be lower.

Because the fish collected for this study contain more than one carcinogen, estimating cancer risks by considering only one carcinogen at a time might significantly under-estimate the cancer risk associated with simultaneous exposures to several chemicals. Therefore, to assess the overall potential for cancer risks from exposure to multiple chemicals, the procedure recommended by EPA for dealing with mixtures were applied (USEPA, 1986a; USEPA, 1989).

EPA recommends that to assess the risk posed by simultaneous exposure to multiple carcinogenic chemicals, the excess cancer risk for all carcinogenic chemicals be summed to calculate a total cancer risk. This summing approach for carcinogens, also called response addition, assumes independence of action by the carcinogens in a mixture. The assumption in applying this method is that there are no synergistic or antagonistic interactions among the carcinogens in fish and that all chemicals produce the same effect, which in this case is cancer.

In interpreting cancer risks, different federal and state agencies often have different levels of concern for cancer risks based upon their laws and regulations. EPA has not defined a level of concern for cancer. However, regulatory actions are often taken when the risk of cancer exceeds a probability of 1 in 1,000,000 to 10,000 (i.e., 1 x 10^{-6} to 1 x $10^{-4)}$. A level of concern for cancer risk has not been defined for this risk assessment.

For this risk assessment, the cancer risks for each chemical for a given species and study site were calculated (Appendix I). The cancer risks for each chemical were then summed to calculate the total cancer risks for each study site and for the basin. Appendices O (resident fish species) and P (anadromous fish species) show these total cancer risks by species as well as the contaminants with risks equal to or greater than 1 X 10^{-5} for CRITFC's member tribal adults (average fish consumption, 70 years exposure duration). The cancer risk discussion in this section (Section 6) further summarizes the information in the Appendices focusing on the range in total cancer risk among the species and on the chemicals which contribute the most to cancer risks.

6.1.3 Chemicals Not Evaluated

As previously discussed in Section 1 of this report, a total of 132 chemicals were selected for analyses in all fish in this study. Forty (30%) of these chemicals, including 29 semivolatiles, 5 pesticides, 4 Aroclors, and 2 metals, were never detected in the tissue of any fish samples at the detection limits achieved for this study (Table1-4a-g). Twenty-three chemicals that were analyzed for did not have reference doses or cancer slope factors (see Section 5.0) so that cancer risks and non-cancer hazards using the methods described in Section 6.1.2 and 6.1.3 could not be estimated. A risk characterization was done for only the detected chemicals with toxicity values; a total of 82 chemicals.

6.1.4 Arsenic

As was previously discussed in Section 5.3.3, the non-cancer hazards and cancer risks discussed in Section 6.2.1 and 6.2.2, respectively, and the results presented in the appendices assume that for all fish species (resident fish and anadromous fish) caught in this study, 10% of the total arsenic is inorganic arsenic. Section 6.2.6 includes risk characterization results (using basin-wide data) assuming the alternative assumption that inorganic arsenic is only 1% of total arsenic for anadromous fish species.

6.1.5 Sample Type

In the CRITFC fish consumption study (CRITFC, 1994), respondents were asked to identify the fish parts they consume for each species. For most of the fish species sampled as a part of this study, the majority of the respondents said that they consume fish fillet with skin. However, a smaller proportion consumed other fish parts as well (head, eggs, bones and organs).

Information on the portions of fish that are consumed by the general public is not available. However, as previously discussed in the Exposure Section, respondents to the qualitative fish consumption survey conducted by EVS (EVS, 1998) for the Wheatland Ferry-Willamette Falls

Reach of the Willamette River, which is a part of the Columbia River Basin, indicated that all ethnic groups consume fillet tissue; however, other parts of the fish (eyes, eggs and skin) are also consumed as are whole body fish.

For this study, whole body samples as well as fillets were collected when possible, since the fish consumption surveys show that fillets as well as other body parts may be eaten. Both whole fish and fillet with skin samples were analyzed for all species except white sturgeon, bridgelip sucker, and eulachon. Sturgeon were analyzed as whole fish and fillet without skin (since it is unlikely that sturgeon skin is eaten). For bridgelip sucker and eulachon only whole body samples were collected.

Some of the risk characterization results summarized in Sections 6.2.1 and 6.2.2 are presented for fillet and whole body samples, and others only for fillet with skin samples (except for those species for which fillet with skin data were not available). However, non-cancer hazards and cancer risks were calculated for all samples collected and are included in the Appendices of this report. In addition, the impacts of sample type on the risk characterization results are discussed in more detail in Section 6.2.4, where the risk characterization results for whole body and fillet fish samples are compared using site specific data.

6.2 Risk Characterization Results

A summary and discussion of the non-cancer hazards (for adults and children for both the general public and CRITFC's member tribes) and excess cancer risks (for adults for the general public and CRITFC's member tribes) are presented in this section. More detailed information on the risk characterization results are presented in Appendices G through J and Appendices M through P for each fish species and tissue type analyzed in this study, for both individual study sites and for the Columbia River Basin:

- Appendix G1: Hazard quotients for individual chemicals for adults
- Appendix G2: Hazard quotients for individual chemicals for children
- Appendix H1: Percent contribution from individual chemicals to the total hazard index
- Appendix H2: Percent contribution from individual chemicals to endpoint-specific hazard indices
- Appendix I1: Estimated cancer risks for individual chemicals for adults, assuming 30 years exposure
- Appendix I2: Estimated cancer risks for individual chemicals for adults, assuming 70 years exposure
- Appendix J: Percent contribution of individual chemicals to total estimated cancer risk
- Appendix M: Comparison of the total and endpoint specific hazard indices across sites for a CRITFC tribal child (high fish consumption rate).
- Appendix N: Cancer risks across a range of consumption rates, by site and species
- Appendix O: Summary of risk characterization results (hazard indices and estimated cancer risks) for resident species
- Appendix P: Summary of risk characterization results (hazard indices and estimated cancer risks) for anadromous species

6.2.1 Non-Cancer Hazard Evaluation

6.2.1.1 Non-Cancer Hazard Evaluation for Resident Fish

Six species of resident fish were sampled in the Columbia River Basin: bridgelip sucker, largescale sucker, mountain whitefish, white sturgeon, walleye, and rainbow trout. Because of the large amounts of data that are presented in the appendices on the risk characterization for these species, one species (white sturgeon) was chosen as an example species to be discussed in detail. Data for the other resident fish species will be summarized. Tables 6-1 and 6-2 are identical to Tables 4.1 and 4.2, respectively, in Appendix O for sturgeon.

As previously discussed in Section 1, white sturgeon were collected from six study sites in the Columbia River Basin: 5 study sites in the main-stem Columbia River (study sites 6, 7, 8, 9L, and 9U) and in the Snake River (study site 13). Chemical analyses were performed on two tissue types, fillet without skin and whole body.

Table 6-1 summarizes both the total and end-point specific hazard indices calculated for white sturgeon. Results are presented for each of the six study sites that white sturgeon were caught as well as for the basin.

Table 6-1. Total hazard indices (HI) and endpoint specific hazard indices (at or greater than 1.0) for white sturgeon.

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index						
			Study site[e]						Basin Average
			CR -6	CR-7	CR-8	CR-9L	CR- 9U	SR- 13	
General Public - Adult[a,b]									
AFC	FW	Immune system	–	–	–	–	2.1	–	0.6
		Total HI	0.8	0.6	0.6	1.2	2.9	0.9	0.9
AFC	WB	Immune system	na	na	1.1	–	–	na	0.9
		Total HI	na	na	1.5	1.0	1.2	na	1.3
HFC	FW	Liver	2.3	2.1	2.2	4.0	7.7	2.5	3.1
		Central nervous system	2.4	2.2	1.0	2.2	7.3	6.2	3.1
		Immune system	9.9	5.9	7.1	16	40	7.9	11
		Reproduction/development	2.4	2.2	1.0	2.2	7.3	6.2	3.1
		Total HI	15	11	11	23	55	17	18
HFC	WB	Liver	na	na	4.0	3.2	3.8	na	3.8
		Central nervous system	na	na	3.5	2.7	1.9	na	2.8
		Immune system	na	na	20	13	16	na	17
		Reproduction/development	na	na	3.5	2.6	1.9	na	2.7
		Total HI	na	na	29	20	23	na	24
General Public - Child[a,b]									
AFC	FW	Immune system	–	–	–	–	1.8	–	0.5
		Total HI	0.7	0.5	0.5	1.1	2.6	0.8	0.8
AFC	WB	**Total HI**	na	na	1.3	0.9	1.1	na	1.1
HFC	FW	Liver	2.9	2.6	2.8	5.1	9.8	3.2	4.0
		Central nervous system	3.1	2.9	1.3	2.8	9.4	7.9	4.0
		Immune system	13	7.6	9.1	21	51	10	14
		Reproduction/development	3.1	2.9	1.3	2.8	9.4	7.9	4.0
		Total HI	19	14	14	29	70	22	23
HFC	WB	Liver	na	na	5.1	4.1	4.9	na	4.9
		Central nervous system	na	na	4.5	3.4	2.4	na	3.9
		Immune system	na	na	26	16	21	na	22
		Reproduction/development	na	na	4.4	3.3	2.4	na	3.8
		Total HI	na	na	37	25	29	na	31
CRITFC's Member Tribes - Adult[c,d]									
AFC	FW	Liver	1.0	–	–	1.8	3.4	1.1	1.4
		Central nervous system	1.1	–	–	–	3.3	2.8	1.4
		Immune system	4.4	2.6	3.1	7.2	18	3.5	5.0
		Reproduction/development	1.1	–	–	–	3.3	2.8	1.4
		Total HI	6.6	4.7	4.7	10	24	7.5	7.9
AFC	WB	Liver	na	na	1.8	1.4	1.7	na	1.7
		Central nervous system	na	na	1.6	1.2	–	na	1.2
		Immune system	na	na	9.0	5.7	7.3	na	7.4
		Reproduction/development	na	na	1.5	1.2	–	na	1.2
		Total HI	na	na	13	8.8	10	na	11
HFC	FW	Liver	6.2	5.6	6.1	11	21	6.8	8.5
		Central nervous system	6.6	6.1	2.8	6.0	20	17	8.5
		Immune system	27	16	19	44	108	22	31
		Reproduction/development	6.6	6.1	2.8	6.0	20	17	8.5
		Selenosis	–	1.3	1.5	2.0	–	–	1.2
		Total HI	40	29	29	62	150	46	49
HFC	WB	Liver	na	na	11	8.8	10	na	10

Table 6-1. Total hazard indices (HI) and endpoint specific hazard indices (at or greater than 1.0) for white sturgeon.

Consumption Rate/ Tissue Type		Health Endpoint	Hazard Index: Study site[e] CR -6	CR-7	CR-8	CR-9L	CR- 9U	SR- 13	Basin Average
		Central nervous system	na	na	9.6	7.2	5.1	na	7.6
		Immune system	na	na	56	35	45	na	45
		Reproduction/development	na	na	9.5	7.1	5.1	na	7.5
		Total HI	na	na	79	54	62	na	66
CRITFC's Member Tribes - Child[c,d]									
AFC	FW	Liver	1.8	1.7	1.8	3.2	6.2	2.0	2.5
		Central nervous system	2.0	1.8	–	1.8	6.0	5.1	2.5
		Immune system	8.0	4.8	5.8	13	32	6.4	9.2
		Reproduction/development	2.0	1.8	–	1.8	6.0	5.1	2.5
		Total HI	12	8.6	8.6	18	45	14	14
AFC	WB	Liver	na	na	3.2	2.6	3.1	na	3.1
		Central nervous system	na	na	2.9	2.2	1.5	na	2.5
		Immune system	na	na	17	10	13	na	14
		Reproduction/development	na	na	2.8	2.1	1.5	na	2.4
		Total HI	na	na	24	16	18	na	20
HFC	FW	Liver	12	11	12	21	41	13	16
		Cardiovascular	1.1	1.2	1.2	1.2			1.1
		Central nervous system	13	12	5.5	12	39	33	16
		Immune system	52	32	38	86	210	42	60
		Reproduction/development	13	12	5.5	12	39	33	16
		Hyperpigmentation/keratosis	1.1	1.2	1.2	1.2	–	–	1.1
		Selenosis	–	2.6	2.9	3.8	1.4	1.5	2.3
		Total HI	79	56	56	120	290	89	94
HFC	WB	Liver	na	na	21	17	20	na	20
		Cardiovascular	na	na	1.8	1.1	1.0	na	1.4
		Central nervous system	na	na	19	14	10	na	16
		Immune system	na	na	110	69	87	na	91
		Reproduction/development	na	na	18	14	9.9	na	16
		Hyperpigmentation/keratosis	na	na	1.8	1.1	1.0	na	1.4
		Selenosis	na	na	1.1	1.7	1.4	na	1.3
		Gastrointestinal	na	na	1.1	1.8	–	na	1.1
		Total HI	na	na	150	110	120	na	130

AFC = average fish consumption na =not applicable; sample type not analyzed at this study site
HFC = high fish consumption – = health endpoint <1.0 at that study site
Total HI = the sum of hazard quotients regardless of health endpoint FW - fillet without skin; WB - whole body

[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public (adult) of 7.5 g/day, or 1 8-oz meal per month, and for general public (child) of 2.83 g/day, or 0.4 8-oz meal per month (USEPA, 2000b).

[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month, and for general public (child) of 77.95 g/day, or 11 8-oz meals per month (USEPA, 2000b).

[c] AFC risk based on average consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month, and for child fish consumers of 24.8 g/day, or 3 8-oz meals per month (CRITFC 1994).

[d] HFC risk based on 99th percentile consumption rate for adult fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month, and for child fish consumers of 162 g/day, or 22 8-oz meals per month (CRITFC 1994).

[e] Study sites are described in Table 1-1. CR = Columbia River ; SR = Snake River

For white sturgeon, the endpoints which had hazard indices greater than 1 for most of the populations were the immune system, liver, central nervous system, and reproduction/developmental, with the immune system endpoint having a higher hazard index than the other endpoints (Table 6-1). At the lowest (average) fish ingestion rates for the general public (average fish consumption, adults and children), only the immune endpoint exceeds a hazard index of 1 (high of 2.1). At the higher fish ingestion rates (e.g., the high ingestion rates for CRITFC's member tribal child), other endpoints with hazard indices greater than 1 begin to appear: liver, central nervous system, reproductive/developmental, cardiovascular, hyperpigmentation/keratosis, selenosis, and gastrointestinal.

Table 6-1 also shows that, as expected, the magnitude of both the end-point specific and total hazard indices increases proportionally to the estimated exposure for that population. For adults, the only differences in exposure for the four adult populations (general public, average and high fish consumption; CRITFC's member tribes, average and high fish consumption) are due to the different fish ingestion rates used. Thus, the hazard index increases proportionally to the fish ingestion rate. All other exposure parameters either remain constant for all four adult populations (fish contaminant levels, exposure frequency, body weight) or do not impact the exposure (exposure duration and averaging time) for the reasons discussed in Section 4.9 (Averaging Time). This direct relationship between the hazard index and the fish ingestion rates for adults is shown in Figure 6-1 and Table 6-2.

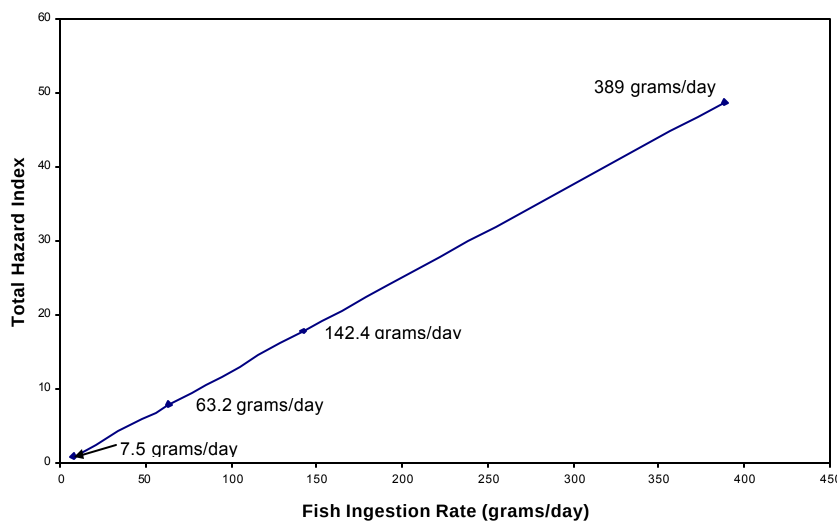

Figure 6-1. Total hazard index versus fish consumption rate for adults. White sturgeon, Columbia River Basin-wide average concentrations (fillet without skin).

Table 6-2. Comparison of Estimated Total Hazard Indices Among Adult Populations. White sturgeon (whole body) from Columbia River, study site 8

Population	Ingestion rate (g/day)	Total hazard index	Approximate ratio of hazard index to that of general public adult with average fish consumption
General public			
average fish consumption	7.5	1.5	1
high fish consumption	142.4	29	19
CRITFC's member tribal			
average fish consumption	63.2	13	9
high fish consumption	389	79	50

Table 6-2 shows the total hazard indices estimated for adults consuming sturgeon at Columbia River study site 8 (whole body samples) at each ingestion rate. Also shown is the ratio of the total hazard indices for CRITFC's member tribes (average and high fish consumption) and the general public (high fish consumption) to that for the general public, average fish consumption. The ingestion rate and exposure for adults is lowest at the average fish consumption rate for the general public and increases proportionally for the other populations as their ingestion rates increase. For example, the ingestion rate for the high fish consumers, general public, is about 19 times higher than that for the average fish consumer. Thus, the exposure estimated and the total hazard indices calculated for the general public, high fish consumer would be expected to be 19 times higher that those calculated for the general public, average fish consumer. This relationship also holds true for the endpoint specific hazard indices calculated for each study site and the basin. The hazard index for the immune system (Table 6-1) was about 1 at Columbia River study site 8 for the general public, average fish consumption (whole body fish) and 20 for the high fish consumption, general public - approximately a 20 fold difference (not exactly 19 fold as shown in the Table 6-2 due to rounding of hazard indices).

A similar comparison can be made for the populations of children assessed in this risk assessment. However, as discussed in Section 4.3, for children, exposures vary by ingestion rate as well as by body weight and exposure duration. This is because of the difference in the ages of the children in the two different fish consumption studies used to estimate fish ingestion rates for children (general public children versus CRITFC's member tribal children). Table 6-3 shows the ratio of hazard indices for three of the child populations (general public, high fish consumption; CRITFC's member tribes, average and high fish consumption) compared to that of the general public child with average fish consumption using data for the Columbia River (study site 8), whole body sturgeon. As can be seen from this table, the hazard indices estimated for CRITFC's member tribal children at the high ingestion rate were over 100 times those estimated for general public children at the average ingestion rate.

Table 6-3. Comparison of Estimated Total Hazard Indices Among Child Populations
White sturgeon (whole body) from Columbia River, study site 8

Population	Ingestion rate (g/day)	Total hazard index	Ratio of hazard index to that of general public with average fish consumption
General public			
average fish consumption	2.83	1.3	1
high fish consumption	77.95	37	28
CRITFC's member tribal			
average fish consumption	24.8	24	18
high fish consumption	162	150	115

A review of Table 6-1 also shows that for the general public at the average ingestion rate, the hazard indices for children were about 0.9 of those for adults; the hazard indices for general public children at the high ingestion rate were about 1.3 times those for general public adults, high ingestion rate. For example, the basin-wide total hazard index was 23 at the high fish consumption rate (77.95 grams/day) assumed for the general public child compared to 18 for the high fish consumption rate (142.2 grams/day) assumed for the general public adult. For CRITFC's member tribes, the hazard indices for children at the average and high fish ingestion rates were both about 2 times those for CRITFC's member tribal adults at the average and high ingestion rates, respectively.

The differences in hazard indices between adults and children as well as the differences among sites and at different fish ingestion rates is shown in Figures 6-2a-d. These figures show a comparison of the total hazard indices for sturgeon (fillet without skin) across sites for both adults and children at different fish ingestion rates (note that the scale of the Y axis increases from Figure 6-2a through Figure 6-2d). Figure 6-2a compares the total hazard indices for general public adults and children at the average fish ingestion rate. The hazard index varies by site with the Hanford Reach of the Columbia River (study site 9U) having the highest values (hazard indices of 2.9 for adults and 2.6 for children). At a given site, the total hazard index for a child is about 0.9 that of that for an adult at the average fish ingestion rate for the general public. Figure 6-2d compares the results for CRITFC tribal adults and children at the high ingestion rate. Again, the total hazard index varies across sites with the Hanford Reach of the Columbia River (study site 9U) having the highest values (hazard indices of 150 for adults and 290 for children). At a given site, the total hazard index for a child is about 2 times that for those of adults at the high fish ingestion rate for CRITFC tribal adults and children.

The chemicals which had hazard quotients at or greater than 1.0 (i.e., exposures for that chemical were greater than the reference dose) for sturgeon for most populations were total Aroclors, total DDT, and mercury (Table 6-4, same as Table O-4.2 in Appendix O). Selenium, arsenic, and chromium were generally greater than 1.0 only at the highest exposures (high fish consumption rates for CRITFC's member tribal adults and children). It is useful to compare the chemicals contributing the most to non-cancer hazard for sturgeon (Table 6-4) with the hazard indices for each endpoint (Table 6-1). Aroclors, which had the highest hazard quotients (Table 6-4) were also the only chemicals contributing to the endpoint of immunotoxicity. Thus the endpoint specific hazard indices for immunotoxicity were also the highest of all hazard indices (Table 6-1).

Mercury was the major contributor to the endpoints of central nervous system and reproduction/developmental, and DDT to the liver endpoint. Thus the hazard quotients calculated for Aroclors, mercury, and DDT (Table 6-4) were the major contributors to (and often equal or close to) the hazard indices for the endpoints of immunotoxicity, central nervous system and reproduction/development, and liver, respectively (Table 6-1). The hazard indices greater than 1.0 for the cardiovascular and hyperpigmentation endpoints (Table 6-1) were primarily a result of exposures greater than the reference dose for arsenic. Selenosis was a result of exposures greater than the reference dose for selenium, and gastrointestinal effects were a result of exposures greater than the reference dose for chromium.

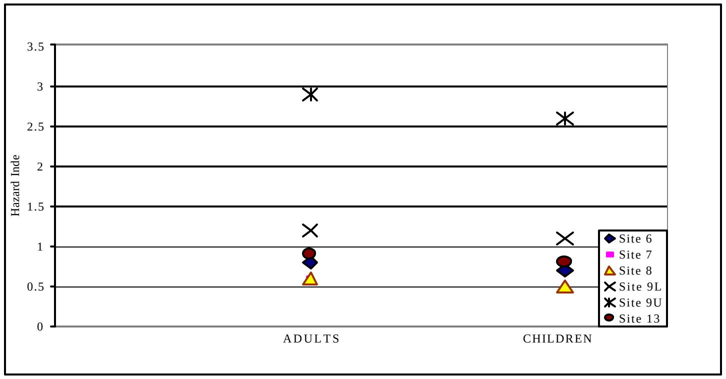

Figure 6-2a. Hazard indices for general public adults and children, average fish consumption rate of white sturgeon fillets. Note that hazard indices are the same at study site 7 and 13.

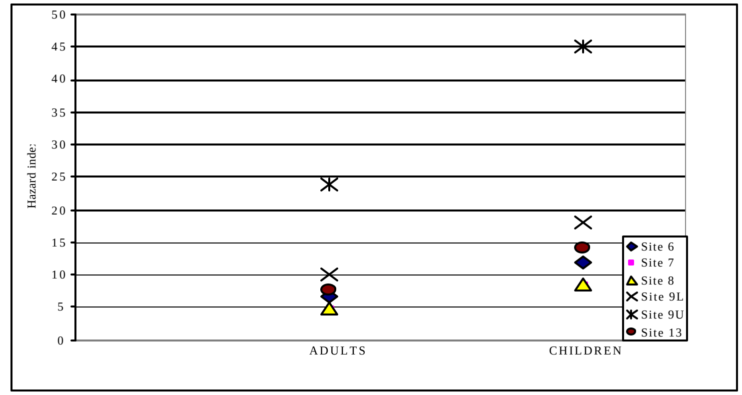

Figure 6-2b. Hazard indices for CRITFC's member tribal adults and children, average fish consumption rate for white sturgeon fillets. Note that hazard indices are the same at study site s 7 and 13.

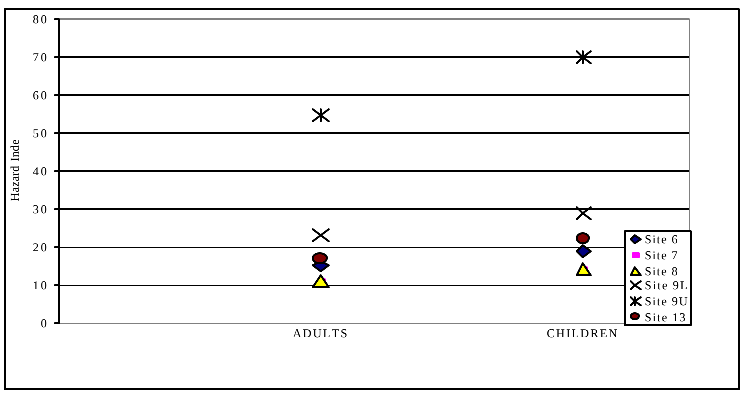

Figure 6-2c. Hazard indices for general public adults and children, high fish consumption rate of white sturgeon fillets. Note that hazard indices are the same for study sites 7 and 13.

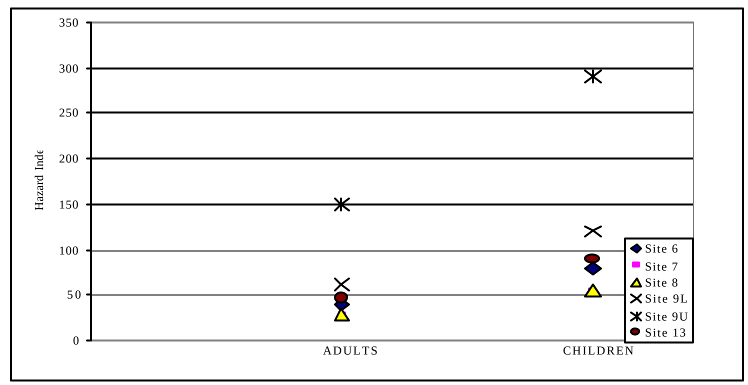

Figure 6-2d. Hazard indices for CRITFC's member tribal adults and children, high fish consumption rate of white sturgeon fillets. Note that hazard indices are the same at study sites 7 ad 13.

It is important to point out that there are no reference doses available for dioxins, furans and dioxin-like PCB congeners. Therefore, hazard quotients could not be calculated for these classes of chemicals and their potential impact on the magnitude of non-cancer hazards (i.e., endpoint specific hazard indices and total hazard indices) could not be evaluated.

Table 6-4. Chemicals having hazard quotients at or greater than 1.0 in white sturgeon.

	Adults				Children		
Tissue Type	**Hazard Quotient**		**Study sites[a] with Values >1**	**Chemical**	**Hazard Quotient**		**Study Sites[a] with Values >1**
	AFC	**HFC**			**AFC**	**HFC**	
General Public							
Fillet without skin							
Total Aroclors	2.1	5.9-40	6[b],7[b],8[b],9L[b],9U,13[b]	Total Aroclors	1.8	7.6-51	6[b],7[b],8[b],9L[b],9U,13[b]
Total DDT	–	1.5-7.1	6,7,8,9L,9U,13	Total DDT	–	1.9-9.1	6,7,8,9L,9U,13
Mercury	–	1.0-7.3	6,7,8,9L,9U,13	Mercury	–	1.3-9.4	6,7,8,9L,9U,13
Whole body							
Total Aroclors	1.1	13-20	8,9L[b],9U[b]	Total Aroclors	–	17-26	8,9L,9U
Total DDT	–	2.6-3.7	8,9L,9U	Total DDT	–	3.4-4.7	8,9L,9U
Mercury	–	1.9-3.5	8,9L,9U	Mercury	–	2.4-4.4	8,9L,9U
CRITFC's Tribal Members							
Fillet without skin							
Total Aroclors	2.6-18	16-110	6[b],7[b],8[b],9L,9U,13[b]	Total Aroclors	4.8-32	32-210	6,7,8,9L,9U,13
Total DDT	1.3-3.2	4.1-20	6,7,8,9L,9U	Total DDT	1.2-5.8	8.0-38	6,7,8,9L,9U,13
Mercury	1.0-3.3	2.8-20	6,7,8[b],9L[b],9U,13	Arsenic	–	1.1-1.2	6,7,8,9L
Selenium	–	1.3-2.0	7,8,9L	Mercury	1.8-6.0	5.5-39	6,7,8[b],9L,9U,13
				Selenium	–	1.4-3.8	7,8,9L,9U,13
Whole body							
Total Aroclors	5.7-9.0	35-56	8,9L,9U	Total Aroclors	11-17	69-110	8,9L,9U
Total DDT	1.2-1.6	7.8-10	8,9L,9U	Total DDT	2.1-3.0	14-20	8,9L,9U
Mercury	1.2-1.5	5.1-9.5	8,9L,9U[b]	Arsenic	–	1.0-1.8	8,9L,9U
				Chromium	–	1.1-1.8	8,9L
				Mercury	1.5-2.8	9.9-19	8,9L,9U
				Selenium	–	1.1-1.7	8,9L,9U

AFC = average fish consumption; HFC = high fish consumption;
- = <1; [A]study sites are described in Table 1-1. [B]HFC only

The summary of the results of the non-cancer hazard evaluation for the other resident fish species are shown in Appendix O by species. Summaries of the endpoint specific and total hazard indices and of the chemicals having hazard quotients at or greater than 1 are shown in Tables 1.1 and 1.2 (bridgelip sucker), 2.1 and 2.2 (largescale sucker), 3.1 and 3.2 (mountain whitefish), 4.1 and 4.2 (white sturgeon), 5.1 and 5.2 (walleye), and 6.1 and 6.2 (rainbow trout). A review of these tables shows that:

- The total hazard indices and endpoint specific hazard indices increase among the general public and CRITFC's member tribal populations as the exposures for that population increase;

- The endpoints which are more frequently greater than a hazard index of 1 are immune system (due to Aroclors), liver (due primarily to DDE for most species), and central nervous system and reproduction/developmental (due primarily to methyl mercury), with the immune system endpoint usually having a higher hazard index than the other endpoints. These hazard indices vary among sites for a given species and among species;

- At the lowest (average) fish ingestion rates for the general public (adults and children), the endpoint-specific hazard indices were at or less than 1 for all of the resident fish with the exception of sturgeon and whitefish at the Hanford Reach of the Columbia River (9U) where hazard indices for immunotoxicity were greater than 1 (high of 3 for whitefish).

- For the more highly exposed populations (e.g., at the high fish ingestion rates for CRITFC's member tribes), endpoint specific hazard indices for reproduction/development and central nervous system, immunotoxicity, and liver are greater than 1 at most sites for most species. For mountain whitefish and white sturgeon, hazard indices for the most contaminated study site (Columbia River, study site 9U) were greater than 100 for the immunotoxicity endpoint.

- At these highest ingestion rates for CRITFC's member tribal adults and children, other endpoints with hazard indices greater than 1 begin to appear for some species. These endpoints include cardiovascular and hyperpigmentation/keratosis, selenosis, gastrointestinal, kidney, and metabolism. These effects were primarily the result of exposures greater than the reference dose for arsenic; selenium; chromium; cadmium; and nickel and zinc, respectively. For walleye, thallium also contributes to the overall hazard index calculated for liver. The highest endpoint-specific hazard index for these endpoints was approximately 4.0.

Table 6-5 is a summary of the ranges in endpoint specific hazard indices across study sites for each resident fish species. Results are shown for both average and high fish consumption rates for the general public and CRITFC tribal member adults. Hazard indices are shown only for those endpoints that most frequently exceed a hazard index of 1 (reproduction/development and the central nervous system, immunotoxicity, and liver). It should be kept in mind that not all fish species were caught at the same sites and that sample numbers varied by species.

Table 6-5 Summary of ranges in endpoint specific hazard indices across study sites for adults who consume resident fish from the Columbia River Basin.

		Non-cancer endpoints which most frequently exceed a hazard index of 1 for all species		
Species	**N**	**Reproductive/ Developmental And Central Nervous System**	**Immunotoxicty**	**Liver**
General Public - Adult				
Average Fish Consumption				
bridgelip sucker	*3*	<1	<1	<1
largescale sucker	*19*	<1	<1	<1
mountain whitefish	*12*	<1	<1 to 3	<1
white sturgeon	*16*	<1	<1 to 2	<1
walleye	*3*	<1	<1	<1
rainbow trout	*7*	<1	<1	<1
High Fish Consumption				
bridgelip sucker	*3*	<1	6	2
largescale sucker	*19*	2 to 7	1 to 8	<1 to 3
mountain whitefish	*12*	<1 to 3	1 to 50	<1 to 4
white sturgeon	*16*	1 to 7	6 to 40	2 to 8
walleye	*3*	4	1	1
rainbow trout	*7*	1 to 2	1 to 2	<1
CRITFC's Member Tribal Adult				
Average Fish Consumption				
bridgelip sucker	*3*	<1	3	1
largescale sucker	*19*	<1 to 3	<1 to 3	<1 to 1
mountain whitefish	*12*	<1 to 1	<1 to 22	<1 to2
white sturgeon	*16*	<1 to 3	3 to 18	<1 to 3
walleye	*3*	2	<1	<1
rainbow trout	*7*	<1	<1	<1
High Fish Consumption				
bridgelip sucker	*3*	2	17	6
largescale sucker	*19*	5 to 20	<1 to 21	<1 to 7
mountain whitefish	*12*	<1 to 7	4 to 140	<1 to 11
white sturgeon	*16*	3 to 20	16 to 108	6 to 21
walleye	*3*	10	4	4
rainbow trout	*7*	4 to 5	3 to 4	<1

N = number of samples; all samples are fillet with skin except white sturgeon which is fillet without skin.
Bridgelip sucker and eulachon are whole body samples.

Figure 6-3 summarizes the total basin-wide hazard indices for resident fish species using average and high fish consumption rates for the general public and CRITFC’s member tribal adult populations. This figure shows that mountain whitefish and white sturgeon had the highest total basin-wide hazard indices, followed by sucker, walleye, and rainbow trout. It also shows that for all species, the total hazard indices are highest for CRITFC’s member tribal adults at the high fish ingestion rates (389 g/day) followed by the general public adult, high ingestion rate (142.4 g/day); CRITFC’s member tribal adults, average ingestion rate (63.2 g/day); and general public adult, average ingestion rate (7.5 g/day).

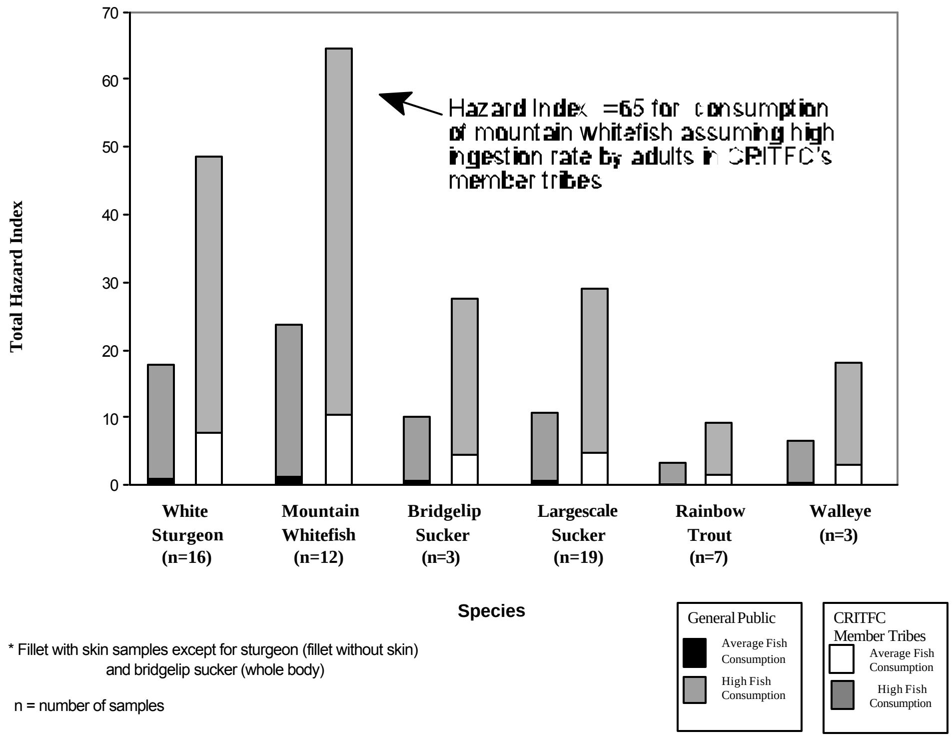

Figure 6-3. Adult total non-cancer hazard indices for resident fish species* using basin-wide average data.

For a more detailed comparison of the total and endpoint specific hazard indices, see Appendix M, where hazard indices are compared for all resident species across study sites for CRITFC's member tribal children with a high fish consumption rate (162 g/day or 5 meals per week).

The contribution from specific chemicals and classes of chemicals to the overall non-cancer hazard for resident fish species is shown in Table 6-6. These results were calculated using Columbia River Basin average concentrations for fillet without skin samples, except for those species where such sample types were not available (bridgelip sucker, whole body; white sturgeon, fillet without skin). The number of samples used to compute the basin-wide averages vary among species, and for some species represent only a few samples (e.g., 3 samples for walleye and bridgelip sucker). The results in Table 6-6, which are also depicted in the charts in Figures 6-4 through 6-9, show that the percent contribution of specific chemicals to the total hazard index differs among the resident fish species. For example, Aroclors contribute 83% to the total non-cancer hazard for mountain whitefish, but only 20% for walleye. Total DDT contribution to the total hazard index ranges from 3-21% among the species and methyl mercury from about 6-54%. Except for thallium for walleye (percent contribution of 14%), the only chemicals contributing greater than 5% to the non-cancer hazards for resident fish species are Aroclors, total DDT, and mercury.

Table 6-6. Percent contribution of contaminant groups to total non-cancer hazards for resident fish species. Based on Columbia River Basin-wide averages.

	white sturgeon	bridgelip sucker	largescale sucker	mountain whitefish	walleye	rainbow trout
Tissue Type	*FW*	*WB*	*FS*	*FS*	*FS*	*FS*
Number of samples	*16*	*3*	*19*	*12*	*3*	*7*
Total metals	**22**	**18**	**50**	**9**	**77**	**55**
Mercury	17	6	45	7	54	46
Arsenic	1	2	<1	<1	4	ND
Chromium	<1	1	1	<1	1	1
Manganese	<1	3	<1	<1	<1	<1
Selenium	2	1	1	1	2	3
Thallium	ND	ND	ND	ND	14	ND
Zinc	<1	1	1	<1	1	2
Other Metals	<1	4	1	<1	1	2
Total Aroclors	**63**	**60**	**40**	**83**	**20**	**42**
Total Pesticides	**15**	**21**	**10**	**8**	**3**	**3**
Total DDT	13	21	9	7	3	3
Other Pesticides	2	<1	<1	1	ND	ND

FW = fillet without skin; FS = fillet with skin; WB = whole body; ND = Not Detected

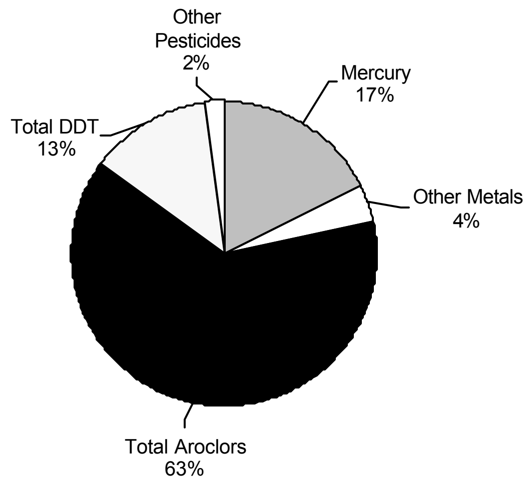

Figure 6-4. Percent contribution of basin-wide average chemical concentrations to non-cancer hazards from consumption of white sturgeon fillet without skin. Number of samples = 16.

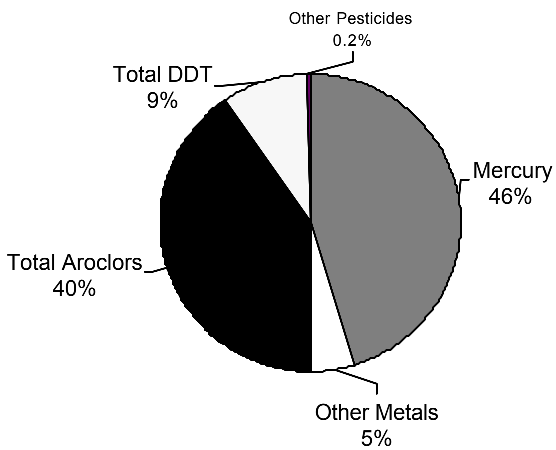

Figure 6-5. Percent contribution of basin-wide average chemical concentrations of non-cancer hazards from consumption of largescale sucker fillets with skin. Number of samples = 19.

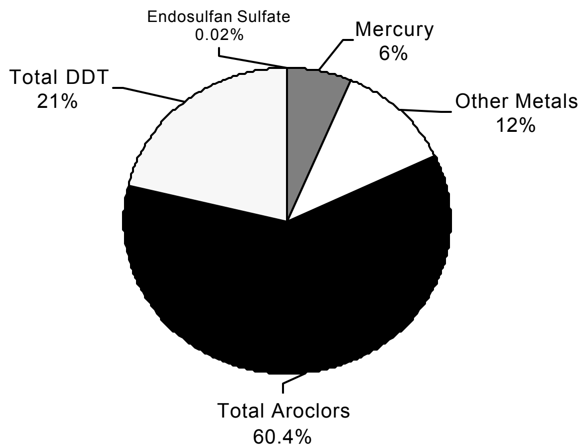

Figure 6-6. Percent contribution of basin-wide average chemical concentrations to non-cancer hazards from consumption of whole body bridgelip sucker. Number of samples = 3.

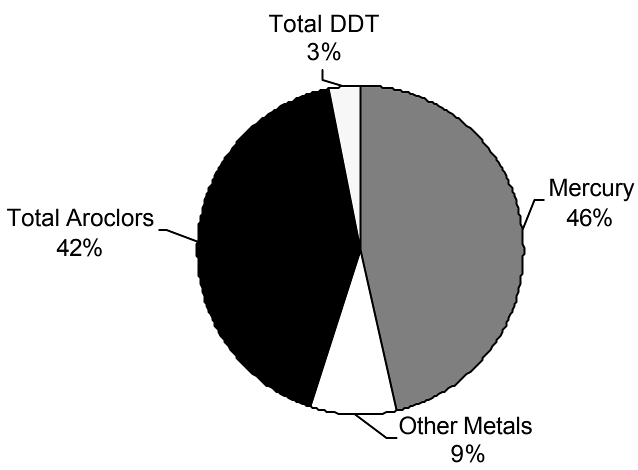

Figure 6-7. Percent contribution of basin-wide average chemical concentrations to non-cancer hazards from consumption of rainbow trout fillet with skin. Number of samples = 7.

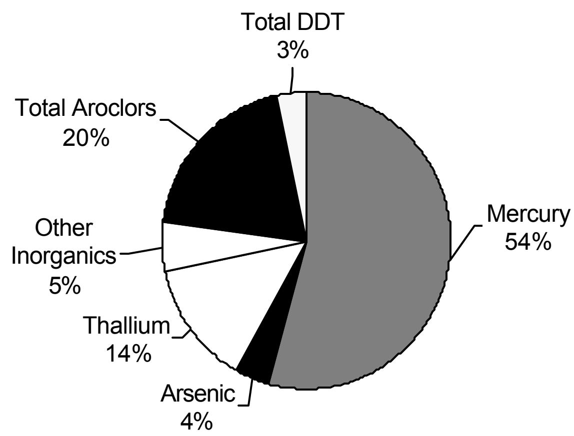

Figure 6-8. Percent contribution of basin-wide average chemical concentrations to non-cancer hazards from consumption of walleye fillet with skin. Number of samples = 3.

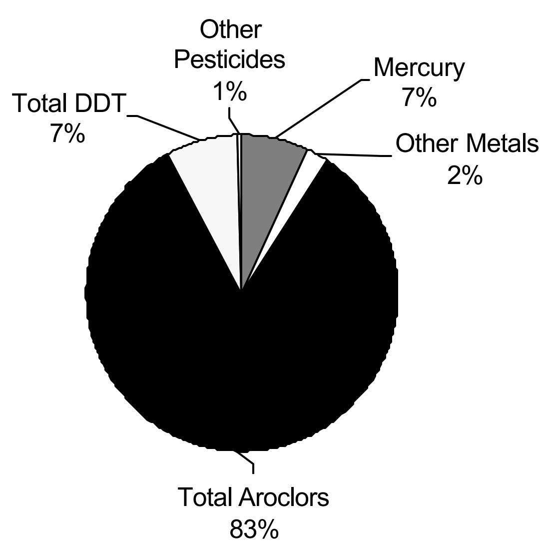

Figure 6-9. Percent contribution of basin-wide chemical concentrations to non-cancer hazards from consumption of mountain whitefish fillet with skin. Number of samples = 12.

6.2.1.2 Non-cancer Hazard Evaluation for Anadromous Fish

The anadromous fish sampled in the Columbia River Basin were coho salmon, fall chinook salmon, spring chinook salmon, steelhead, eulachon, and Pacific lamprey. The summary of the results of the non-cancer hazard evaluation for these anadromous fish species are shown in Appendix P by species. Summaries of the endpoint-specific and total hazard indices and of the chemicals having hazard quotients greater than 1 are shown in Tables 1.1 and 1.2 (coho salmon), 2.1 and 2.2 (fall chinook salmon), 3.1 and 3.2 (spring chinook salmon), 4.1 and 4.2 (steelhead), - 5.1 and 5.2 (eulachon), and 6.1 and 6.2 (Pacific lamprey). As with the resident fish species, the values of the total hazard indices and endpoint-specific hazard indices increase among all of the populations as the exposure to that population increases.

Because the results for coho salmon, fall chinook, spring chinook, and steelhead were similar, they are summarized as a group. The results for eulachon and lamprey are discussed separately.

Tables 1.1 and 1.2 (coho salmon), 2.1 and 2.2 (fall chinook salmon), 3.1 and 3.2 (spring chinook salmon), and 4.1 and 4.2 (steelhead) show that:

- At the average fish ingestion rates for the general public, adults and children, the endpoint specific hazard indices were less than 1.0.

- The endpoints which had hazard indices greater than 1 most frequently for salmon and steelhead were immunotoxicity (due to Aroclors) and reproductive/developmental and central nervous system (due primarily to mercury). In general, the hazard indices for the immunotoxicity endpoint for salmon and steelhead were much lower and did not vary as much across study sites as those for the resident fish species with the highest contaminant levels (largescale sucker, mountain whitefish, and white sturgeon).

- As exposures increase, other endpoints with hazard indices greater than 1 begin to appear. These include: cardiovascular and hyperpigmentation/keratosis; metabolism; selenosis; gastrointestinal; and kidney, resulting primarily from exposures greater than the reference dose to arsenic; nickel and zinc; selenium; chromium; and cadmium, respectively. The highest hazard indices for these endpoints at the highest ingestion rates were at or less than 4. At these exposures, hazard indices for immunotoxicity, reproduction/development, and central nervous system are greater than 1 for most sites.

Pacific lamprey were collected at 2 study sites, Willamette Falls (study site 21) and Fifteen Mile Creek (study site 24). Pacific lamprey results were similar to those for salmon and steelhead in that, at the average fish ingestion rates for the general public, adults and children, the endpoint specific hazard indices never exceed 1.0. In examining endpoint specific hazard indices with increasing exposure, the immune system hazard index is exceeded first. The estimated endpoint specific hazard index for immunotoxicity, which is the largest contributor to the total hazard index for Pacific lamprey is due to exposures greater than the reference dose for Aroclors. At the same ingestion rates, the endpoint specific hazard indices for immunotoxicity were higher for lamprey than for salmon and steelhead.

Eulachon (smelt) were caught at only one study site, Columbia River study site 3, and analyzed as whole body samples. Two endpoint specific hazard indices were exceeded (cardiovascular and hyperpigmentation/keratosis) at the high fish consumption rates for CRITFC's member tribal adults (hazard index of 1.7) and children (hazard index of 3.2) (see Table 5.1). These exceedances were a result of arsenic exposures greater than the reference dose (Table 5.2).

Table 6-7 is a summary of the ranges in endpoint specific hazard indices across study sites for anadromous fish. Results are shown for both average and high fish consumption rates for the general public and CRITFC tribal member adults. Hazard indices are shown only for the three endpoints which frequently exceeded a hazard index of 1: reproduction/development and the central nervous system, immunotoxicity, and liver. It should be kept in mind that not all species were caught at the same study sites and that sample numbers varied by species.

Figure 6-10 shows the relative differences in total hazard indices in the Columbia River Basin for anadromous fish species using average and high fish consumption rates for general public adults and for CRITFC's member tribal adults. The total hazard index is highest for lamprey, followed by salmon and steelhead, which are in the same range, and then eulachon.

For a more detailed comparison of the total and endpoint specific hazard indices across study sites for anadromous fish species, see Appendix M. In this appendix, hazard indices are compared for the population with the highest exposure and non-cancer hazards - CRITFC's member tribal children with a high fish consumption rate (162 grams/day or about 5 meals per week).

Table 6-7 Summary of ranges in endpoint specific hazard indices across study sites for adults who consume anadromous fish species from the Columbia River Basin.

	Species	N	Non-cancer endpoints which most frequently exceed a hazard index of 1 for all species		
			Reproductive/ Developmental And Central Nervous System	**Immunotoxicty**	**Liver**
General Public-					
Average Fish Consumption					
	coho salmon	*3*	<1	<1	<1
	fall chinook salmon	*15*	<1	<1	<1
	spring chinook salmon	*24*	<1	<1	<1
	steelhead	*21*	<1	<1	<1
	eulachon	*3*	<1	<1	<1
	Pacific lamprey	*3*	<1	<1	<1
High Fish Consumption					
	coho salmon	*3*	2	3	<1
	fall chinook salmon	*15*	1 to 2	<1 to 3	<1
	spring chinook salmon	*24*	<1 to 6	1 to 2	<1
	steelhead	*21*	1 to 3	1 to 2	<1
	eulachon	*3*	<1	<1	<1
	Pacific lamprey	*3*	<1	9	<1
CRITFC's Member Tribal					
Average Fish Consumption					
	coho salmon	*3*	1	1	<1
	fall chinook salmon	*15*	<1 to1	1	<1
	spring chinook salmon	*24*	<1 to 3	<1	<1
	steelhead	*21*	<1 to 1	<1 to 1	<1
	eulachon	*3*	<1	<1	<1
	Pacific lamprey	*3*	<1	4	<1
High Fish Consumption					
	coho salmon	*3*	7	7	<1
	fall chinook salmon	*15*	3 to 6	<1 to 8	<1
	spring chinook salmon	*24*	<1 to 17	3 to 6	<1
	steelhead	*21*	4 to 8	3 to 6	<1
	eulachon	*3*	<1	<1	<1
	Pacific lamprey	*3*	<1	24	2

N= number of samples; All samples are fillet with skin except white sturgeon which is fillet without skin. Bridgelip sucker and eulachon are whole body fish samples.

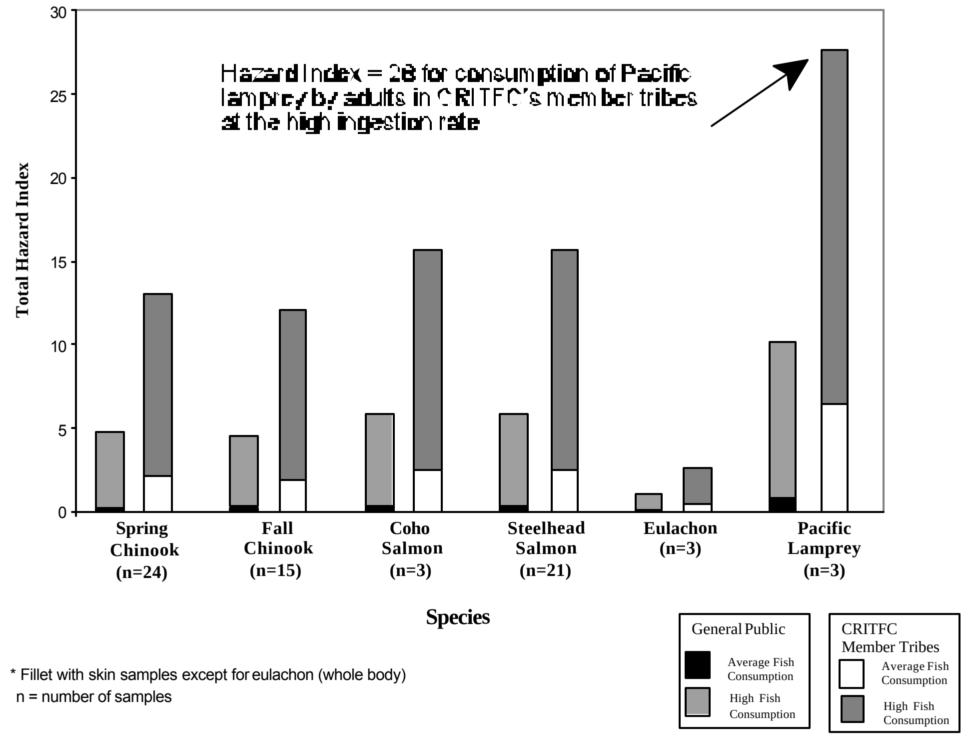

Figure 6.10 Adult total non-cancer indices for anadromous fish species*. Average concentrations for the Columbia River Basin.

Table 6-8 and Figures 6-11 through 6-16 show the major chemicals contributing to the total hazard index for each anadromous fish species (shown for basin-wide data, fillet with skin for all species except eulachon which was whole body). Aroclors and mercury were the primary chemicals of concern for non-cancer hazards for anadromous fish species, followed by arsenic. For eulachon, arsenic was the major contributor to non-cancer hazard. For Pacific lamprey, Aroclors contributed almost 87% to the non-cancer health effects.

Table 6-8. Percent contribution of contaminant groups to total non-cancer hazards for anadromous fish species. Based on Columbia River Basin-wide averages.

	spring chinook	coho salmon	eulachon	fall chinook	Pacific lamprey	steelhead
Number of samples	*24*	*3*	*3*	*15*	*3*	*21*
Tissue type	*FS*	*FS*	*WB*	*FS*	*FS*	*FS*
Total Metals	**65**	**54**	**95**	**58**	**7**	**55**
Mercury	43	41	ND	39	ND	43
Aluminum	<1	ND	2	<1	ND	<1
Arsenic	12	6	62	12	2	7
Cadmium	<1	ND	2	ND	1	<1
Chromium	3	2	ND	1	1	1
Copper	1	2	5	1	1	1
Selenium	3	2	12	3	2	2
Zinc	1	1	9	1	1	1
Other Metals	2	<1	2	<1	<1	<1
Total Aroclors	**34**	**45**	**ND**	**40**	**87**	**43**
Total Pesticides	**2**	**1**	**4**	**2**	**6**	**2**
Chlordane (total)	<1	<1	ND	<1	2	<1
Total DDT	2	1	4	2	4	1
Hexachlorobenzene	<1	ND	ND	<1	<1	<1

FS = fillet with skin; FW = fillet without skin; WB = whole body; ND= not detected

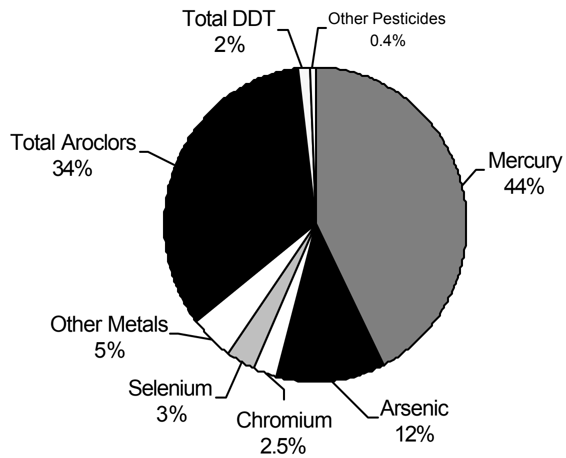

Figure 6-11. Percent contribution of basin-wide average chemical concentrations to non-cancer hazards from consumption of spring chinook fillet with skin. Number of samples = 24.

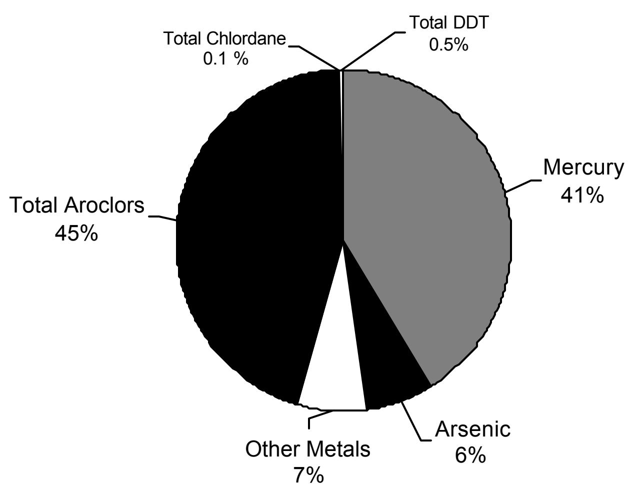

Figure 6-12. Percent contribution of basin-wide chemical concentrations to non-cancer hazards from consumption of coho salmon. Number of samples = 3.

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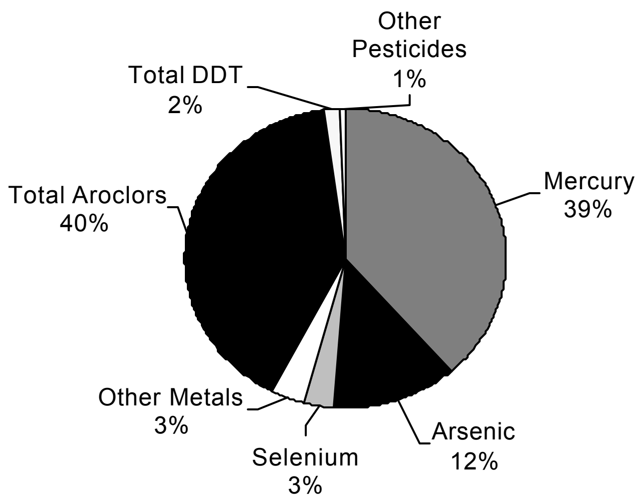


Figure 6-13. Percent contribution of basin-wide average chemical concentrations to non-cancer hazards from consumption of fall chinook fillet with skin. Number of samples = 15.

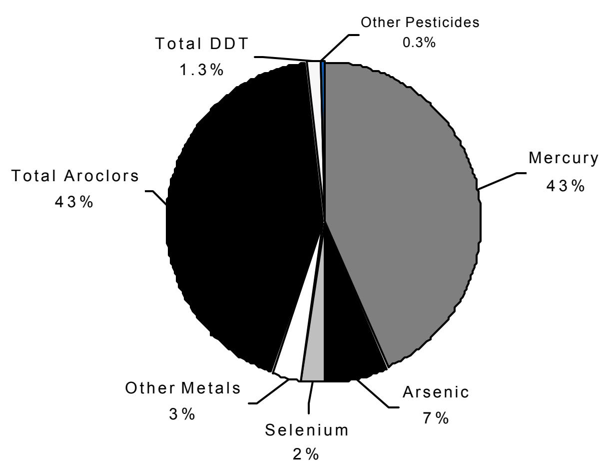


Figure 6-14. Percent contribution of basin-wide average chemical concentrations to non-cancer hazards from consumption of steelhead fillet with skin. Number of samples = 21.

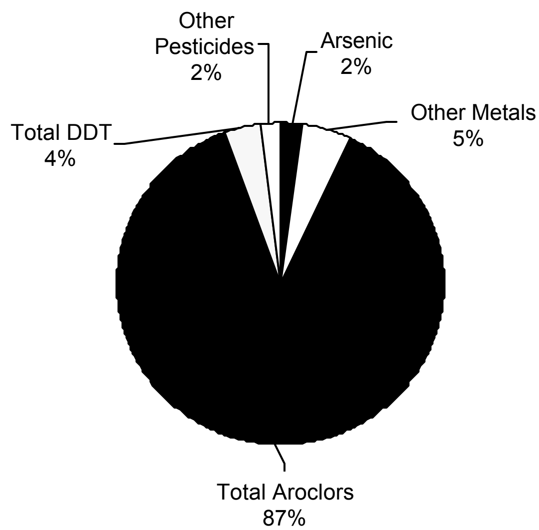


Figure 6-15. Percent contribution of basin-wide average chemical concentrations to non-cancer hazards from consumption of Pacific lamprey fillet with skin. Number of samples = 3.

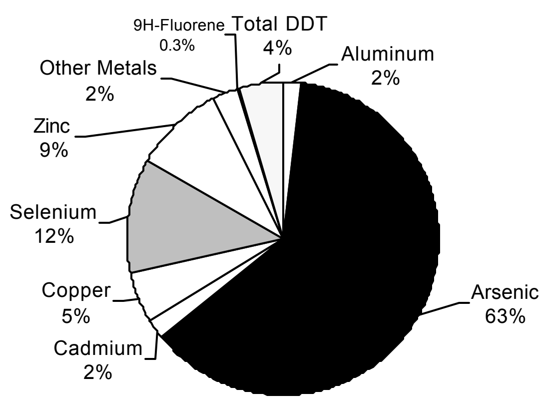


Figure 6-16. Percent contribution of basin-wide average chemical concentrations to non-cancer hazards from consumption of whole body eulachon. Number of samples =3.

6.2.1.3 Comparisons Between Anadromous Fish and Resident Fish Species

A comparison of the total hazard indices, endpoint specific hazard indices, and chemicals with hazard quotients greater than 1.0 among all of the fish species (resident fish and anadromous fish) can be made using the summary tables in Appendices O and P. The conclusions from these comparisons, are limited by the fact that different species were caught at different study sites and that sample numbers and sample types for each species varied.

- The endpoint specific hazard indices that were greater than 1 the most often and that had the highest values for all of the resident fish species were immunotoxicity, central nervous system, reproduction/developmental, and liver, with immunotoxicity usually having the highest endpoint specific hazard index. For resident fish species, endpoint specific hazard indices were rarely greater than 1 for children and adults in the general population with an average fish ingestion rate. The exceptions to this were white sturgeon and mountain whitefish caught in the Hanford Reach of the Columbia River (study site 9U), where endpoint specific hazard indices were greater than 1 (high of 2.7) for the endpoint of immunotoxicity. This was due to exposures to Aroclor greater than its reference dose.

- For salmon and steelhead, three of these endpoints were also the ones that also had the highest hazard indices: immunotoxicity, central nervous system, and reproduction/developmental, with most endpoints specific hazard indices being within a small range among the three salmon and steelhead (the exception is for the Klickitat due to mercury levels in spring chinook). No endpoint specific hazard indices were greater than 1 for children or adults in the general population with an average fish ingestion rate.

- For Pacific lamprey fillet with skin, the major contributor to non-cancer hazards was due to immunotoxicity; for whole body lamprey, it was immunotoxicity as well as central nervous system and reproduction/development endpoints (due to higher levels of mercury in whole body samples of lamprey). There were no endpoint specific hazard indices greater than 1 for the general population (adults or children) with an average fish consumption rate.

- For eulachon, only the endpoints of cardiovascular and hyperpigmentation/keratosis had hazard indices greater than 1 and only at the highest exposures (CRITFC's member tribal adults and children, high fish consumption).

Hazard indices greater than 1 for specific endpoints were primarily a result of elevated hazard quotients for a few chemicals: total Aroclors (immunotoxicity), mercury (central nervous system, and reproduction/developmental), total DDTs (liver), and arsenic (cardiovascular and hyperpigmentation/keratosis). This can be seen in the figures previously discussed for resident fish species (Figures 6-4 to 6-9) and anadromous fish species (Figures 6-11 to 6-16).

Although similar endpoint specific hazard indices were exceeded for many of the fish species tested, the magnitude of both the endpoint specific and total hazard indices vary substantially among the species. Table 6-9 shows a summary of the non-cancer results across all species at the high fish consumption rate for CRITFC's member tribal adults. All of the non-cancer endpoints that exceed 1.0 are shown for each species as are the range in total hazard indices across study sites and the total hazard index for the basin. For this table, fillet with skin data were used except for the species that had no fillet with skin samples (fillet without skin data for sturgeon and whole body for bridgelip sucker and eulachon).

Table 6-9. Summary of endpoint specific hazard indices and total hazard indices (by study site and basin-wide) for CRITFC's tribal member adult, high fish consumption.

			Non-cancer endpoints							
Species	**N**	**Sample type**	**Central nervous system**	**Reproduction/ developmental**	**Immuno-toxicity**	**Liver**	**Cardio-vascular**	**Hyperpig-mentation**	**Range in study site total hazard indices**	**Total basin hazard index**
Resident Species										
Bridgelip sucker	*3*	WB	2	2	17	6	<1	<1	27	27*
Largescale	*19*	FS	5 - 20	5 - 20	<1 - 21	1 - 7	<1	<1	10 - 45	29
Mt. whitefish	*12*	FS	<1 - 7	<1 - 7	4 - 140	<1 -	<1	<1	9 - 150	65
White sturgeon	*16*	FW	3 - 20	3 - 20	16 - 108	6 - 21	<1	<1	29 - 150	49
Walleye	*3*	FS	10	10	4	4	<1	<1	18	18*
Rainbow trout	*7*	FS	4, 5	4, 5	3, 4	<1	<1	<1	8, 10	9
Anadromous species										
Coho salmon	*3*	FS	7	7	7	<1	<1	<1	16	16*
Fall chinook	*15*	FS	3 -6	3 - 6	<1 - 8	<1	1 - 2	1 - 2	6 - 16	12
Spring chinook	*24*	FS	<1 - 17	<1 - 17	3 - 6	<1	2	2	6 - 24	13
Steelhead	*21*	FS	4 - 8	4 - 8	3 - 6	<1	1 - 2	1 - 2	9 - 15	16
Eulachon	*3*	WB	<1	<1	<1	<1	2	2	3	3*
Pacific lamprey	*3*	FS	<1	<1	24	2	<1	<1	28	28*

N= Number of samples; FW = fillet without skin; FS = fillet with skin, WB = whole body
*Columbia River Basin index based on study site.

A review of Table 6-9 (reference to study site specific information can be found in the tables in Appendices O and P) suggests that:

- For *eulachon*, all of the endpoint specific hazard indices were equal to or less than 2. The endpoint specific hazard indices were at or less than 2 for *Pacific lamprey* with the exception of a value of 24 for immunotoxicity. This was due to exposures greater than the reference dose for Aroclors. Total basin-wide hazard indices were 3 and 28, respectively, for eulachon and lamprey.

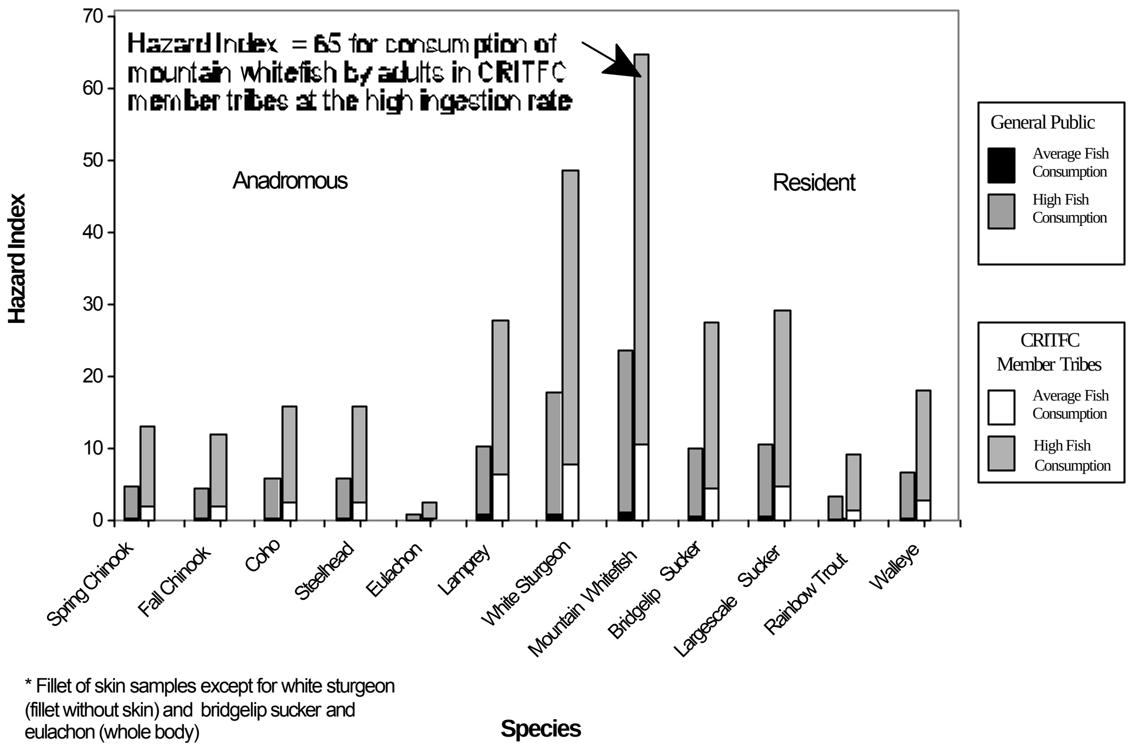
- For the *salmon and steelhead*, all of the study site endpoint specific hazard indices were 8 or less, except for one study site/species (hazard index of 17 for spring chinook for reproduction/development and central nervous system due to mercury in the sample from the Klickitat River). The total basin-wide hazard indices range from 12 to 16 for salmon and steelhead.

- For two of the resident fish species, *walleye* and *rainbow trout*, the endpoint specific hazard indices were at or less than 10. The endpoint specific hazard index for *bridgelip sucker* were less than 6, with the exception of immunotoxicity which had a value of 17. The total basin-wide hazard indices were 9, 18 and 27 for rainbow trout, walleye and bridgelip sucker, respectively.

- For *largescale sucker* the endpoint specific hazard indices for the central nervous system and reproductive/development range from 5 to 20 and for immunotoxicity from <1 to 21. The study site total hazard indices were from 10 to 45 with five of the six study site total hazard indices being greater than 20.

- The resident fish species, *mountain whitefish* and *sturgeon*, had the highest total study site hazard indices which ranged from 9 to 150 and 29 to 150, respectively. For the *whitefish*, total hazard indices were 9 (Umatilla), 13 (Deschutes), 72 (Yakima), and 150 (Hanford Reach of the Columbia, study site 9U)(see Table 3.1). The two highest values (72 for the Yakima and 150 for the Columbia at 9U) were due primarily to the high endpoint specific hazard indices for immunotoxicity (due to Aroclors) at these study sites. For *sturgeon*, all of the study site total hazard indices were greater than 20: hazard indices of 29 (Columbia at study sites 7 and 8); 40 (Columbia, study site 6); 46 (Snake, study site13); 62 (Columbia, study site 9L); and 150 (Columbia, study site 9U)(see Table 4.1). The high values for sturgeon were also in large part also due to exposures greater than the reference dose for Aroclors resulting in high endpoint specific hazard indices for immunotoxicity.
  It is obvious from Table 6-9 that for these 2 species (whitefish and sturgeon), their high endpoint specific hazard indices for immunotoxicity (due to total Aroclors) at some study sites tend to distinguish them from the other species.

Figure 6-17 is a summary of the total hazard indices for each species for all four ingestion rates for adults (general public adult, average and high fish consumption; CRITFC's member tribal adult, average and high fish consumption). Basin-wide fillet with skin data were used for this figure, except for those species that had only whole body samples (bridgelip sucker and eulachon) or fillet without skin (sturgeon) data. As can be seen from this table, the total hazard indices vary by species with white sturgeon and mountain whitefish having the highest total hazard indices among the 12 fish sampled. Largescale sucker, lamprey, and bridgelip sucker had similar but lower total hazard indices followed by the salmon, steelhead, and walleye, then rainbow trout and eulachon.



* Fillet of skin samples except for white sturgeon (fillet without skin) and bridgelip sucker and eulachon (whole body)

Figure 6-17. Adult total non-cancer hazard indices across all species*. Columbia River Basin data.

As was previously discussed for white sturgeon (Figures 6-2a-d), the estimated hazard indices for children were different than those for adults. For the general public, the hazard indices for children at the average fish ingestion were about 0.9 of those for adults at the average ingestion rate; the hazard indices for children at the high ingestion rate were about 1.3 times those for adults at the high ingestion rate. For CRITFC's member tribes, the hazard indices for children at the average and high ingestion rates were both about 1.9 times those for CRITFC's member tribal adults at the average and high ingestion rates, respectively.

Appendix M contains a comparison of the total and endpoint specific hazard indices across sites (anadromous and resident fish species) for CRITFC's member tribal children with a high ingestion rate. This was the population with the highest exposures and hazard indices.

6.2.2 Cancer Risk Evaluation

Because the incremental increase in cancer risks resulting from ingestion of fish was calculated for adults only, only four populations had cancer risk estimates: average and high fish consumption for both the general public adult and CRITFC's member tribal adult. However, for cancer risk, exposure duration does have an impact on the calculations. Therefore, risks were estimated for both 30 and 70 year exposure durations. This results in eight separate cancer risk calculations per study site and in the basin:

Average Fish Consumption

General public adult, 30 years	CRITFC's member tribal adult, 30 years
General public adult, 70 years	CRITFC's member tribal adult, 70 years

High Fish Consumption

General public adult, 30 years	CRITFC's member tribal adult, 30 years
General public adult, 70 years	CRITFC's member tribal adult, 70 years

The cancer risks calculated for each chemical for each study site are shown in Appendices I1 (general public and CRITFC's member tribal adults, 30 year exposure) and I2 (general public and CRITFC's member tribal adults, 70 year exposure). Appendix N shows the species specific cancer risks by study site over a range of fish ingestion rates. Appendices O and P, which were previously used for discussion of the non-cancer results, include summary results for the total cancer risk estimates by fish species and tissue type. Included in Appendices O and P are: (1) tables showing the total cancer risks by study site and basin for all 8 separate cancer risk calculations, and (2) tables showing the cancer risks by study site for those chemicals that were at or greater than a cancer risk of 1×10^{-5} for one population, CRITFC's member tribal adults, average fish consumption, 70 years exposure.

As with the non-cancer summary, a more detailed discussion of cancer risk will be done with one species, white sturgeon. This will be followed by a summary of the cancer risks for the rest of the resident fish species, the anadromous fish species, and finally, a summary across all species.

As previously discussed in Section 6.1.2, all of the cancer risks discussed in this risk characterization should be considered to be upper bound estimates of the increased risk of developing cancer as a result of fish consumption.

6.2.2.1 Cancer Risk Evaluation for Resident Fish

The potential cancer risks associated with consumption of fillet without skin and whole body white sturgeon were assessed by first calculating the risk for all detected chemicals with cancer slope factors (see Appendix I). These chemical specific risks in each sample were then summed to estimate the total cancer risk for a study site and for the basin. For sturgeon, these results are shown in Table 6-10.

Table 6-10. Summary of total estimated cancer risks for white sturgeon.

Consumption Rate/ Exposure Duration	Tissue Type	Total Excess Cancer Risk — Study Site[e]: CR -6	CR -7	CR- 8	CR -9L	CR -9U	SR -13	Basin Average
General Public[a,b]								
AFC/30-yr	FW	$4X10^{-5}$	$3X10^{-5}$	$4X10^{-5}$	$8X10^{-5}$	$1X10^{-4}$	$3X10^{-5}$	$5X10^{-5}$
	WB	na	na	$7X10^{-5}$	$6X10^{-5}$	$7X10^{-5}$	na	$7X10^{-5}$
HFC/30-yr	FW	$8X10^{-4}$	$6X10^{-4}$	$7X10^{-4}$	$1X10^{-3}$	$2X10^{-3}$	$6X10^{-4}$	$9X10^{-4}$
	WB	na	na	$1X10^{-3}$	$1X10^{-3}$	$1X10^{-3}$	na	$1X10^{-3}$
AFC/70-yr	FW	$9X10^{-5}$	$7X10^{-5}$	$8X10^{-5}$	$2X10^{-4}$	$3X10^{-4}$	$7X10^{-5}$	$1X10^{-4}$
	WB	na	na	$2X10^{-4}$	$1X10^{-4}$	$2X10^{-4}$	na	$2X10^{-4}$
HFC/70-yr	FW	$2X10^{-3}$	$1X10^{-3}$	$2X10^{-3}$	$3X10^{-3}$	$5X10^{-3}$	$1X10^{-3}$	$2X10^{-3}$
	WB	na	na	$3X10^{-3}$	$3X10^{-3}$	$3X10^{-3}$	na	$3X10^{-3}$
CRITFC's Tribal Member[c,d]								
AFC/30-yr	FW	$3X10^{-4}$	$3X10^{-4}$	$3X10^{-4}$	$6X10^{-4}$	$1X10^{-3}$	$3X10^{-4}$	$4X10^{-4}$
	WB	na	na	$6X10^{-4}$	$5X10^{-4}$	$6X10^{-4}$	na	$6X10^{-4}$
HFC/30-yr	FW	$2X10^{-3}$	$2X10^{-3}$	$2X10^{-3}$	$4X10^{-3}$	$6X10^{-3}$	$2X10^{-3}$	$3X10^{-3}$
	WB	na	na	$4X10^{-3}$	$3X10^{-3}$	$4X10^{-3}$	na	$3X10^{-3}$
AFC/70-yr	FW	$8X10^{-4}$	$6X10^{-4}$	$7X10^{-4}$	$1X10^{-3}$	$2X10^{-3}$	$6X10^{-4}$	$1X10^{-3}$
	WB	na	na	$1X10^{-3}$	$1X10^{-3}$	$1X10^{-3}$	na	$1X10^{-3}$
HFC/70-yr	FW	$5X10^{-3}$	$4X10^{-3}$	$4X10^{-3}$	$9X10^{-3}$	$1X10^{-2}$	$4X10^{-3}$	$6X10^{-3}$
	WB	na	na	$9X10^{-3}$	$7X10^{-3}$	$8X10^{-3}$	na	$8X10^{-3}$

AFC - average fish consumption HFC - high fish consumption FW - fillet without skin WB - whole body
na - not applicable; sample type not analyzed at this study site
[a] AFC risk based on average U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 7.5 g/day, or 1 8-oz meal per month (USEPA, 2000a).
[b] HFC risk based on 99th percentile U.S. per capita consumption rate of uncooked freshwater and estuarine fish for general public of 142.4 g/day, or 19 8-oz meals per month (USEPA, 2000a).
[c] AFC risk based on average consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 63.2 g/day, or 9 8-oz meals per month (CRITFC 1994).
[d] HFC risk based on 99th percentile consumption rate for fish consumers in the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin of 389 g/day, or 53 8-oz meals per month (CRITFC 1994).
[e] Study site descriptions are in Table 1.1. CR = Columbia River; SR = Snake River

As can be seen from Table 6-10, for white sturgeon the total excess cancer risks range from a low of 3 X 10^{-5} in fillet without skin samples from the Columbia River (study site 7) and the Snake River (study site 13) assuming an average fish consumption rate and a 30 year exposure for the general population adult to a high of 1 X 10^{-2} in fillet without skin samples from the Columbia (study site 9U) assuming a high fish consumption rate and a 70 year exposure duration for CRITFC's member tribal adults.

The estimated upper bound cancer risks differ by study site for sturgeon since contaminant levels vary by study site (Table 6-10). For example, for one exposure - CRITFC's member tribal adult, average fish consumption, 30 year exposure - the ingestion of sturgeon (fillet without skin) from the Columbia River (study sites 6, 7 and 8) and the Snake River (study site 13) results in the same estimated cancer risk, 3 X 10^{-4}, while the risks estimated from consuming fish from the Columbia River, study site 9L (6 X 10^{-4}) and study site 9U (1 X 10^{-3}) were higher. This same difference was seen across all study sites (within a given sample type) for each of the exposure groups evaluated for cancer risk.

As previously discussed for non-cancer effects, the cancer risk at a given study site increases proportionally with increasing exposure. For cancer risks, exposures were lowest for the general public adult, average fish consumption, 30 years exposure and highest for CRITFC's member tribal adult, high fish consumption, 70 years exposure and depend both upon the exposure duration (30 or 70 year) and fish consumption rate. Table 6-11 shows the total cancer risks for all adult populations for white sturgeon (whole body) caught in the Columbia River at study site 8. Also shown are the ratios of the total cancer risks for the general public, average fish consumption at 30 years exposure to that of the other groups assessed in this risk assessment: CRITFC's member tribal adults with average and high fish consumption at both 30 and 70 years exposure; the general public adults with high fish consumption at 30 years exposure, and; the general public adults with average and high fish ingestion at 70 years exposure. As can be seen from this table, for whole body samples of sturgeon at Columbia River study site 8, the estimated upper bound cancer risk from eating fish was 7 X 10^{-5} for the general public, average fish consumption and 30 years exposure and 1 X 10^{-3} for the general public, high fish consumption and 30 years exposure. This was a difference of about 19 fold (when the rounding of the values in this table are accounted for). Likewise, the risks from eating sturgeon for the general public, average fish consumption and 70 years exposure was about 2 times higher than that for general public, average fish consumption and 30 years exposure.

Figure 6-18 shows the differences in cancer risks across sites for sturgeon (fillet without skin) for CRITFC member tribal adults and general public adults at the high fish consumption for both 30 and 70 year exposures. As can be seen, the cancer risks vary by site with the Hanford Reach of the Columbia River (site 9U) having the highest estimated risks.

Table 6-11. Comparison of estimated total cancer risks among adult populations

	Fish ingestion rate (grams/day)	Exposure duration (years)	Total cancer risk for adults for white sturgeon at Columbia River, study site 8 (whole body samples)	Approximate ratio of estimated cancer risks to that of general public with average fish consumption, 30 years exposure
General public	average (7.5)	30	7 X 10^{-5}	1
General public	high (142.4)	30	1 X 10^{-3}	19
CRITFC's member tribe	average (63.2)	30	6 X 10^{-4}	8
CRITFC's member tribe	high (389)	30	4 X 10^{-3}	52
General public	average (7.5)	70	2 X 10^{-4}	2
General public	high (142.4)	70	3 X 10^{-3}	44
CRITFC's member tribe	average (63.2)	70	1 X 10^{-3}	20
CRITFC's member tribe	high (389)	70	9 X 10^{-3}	121

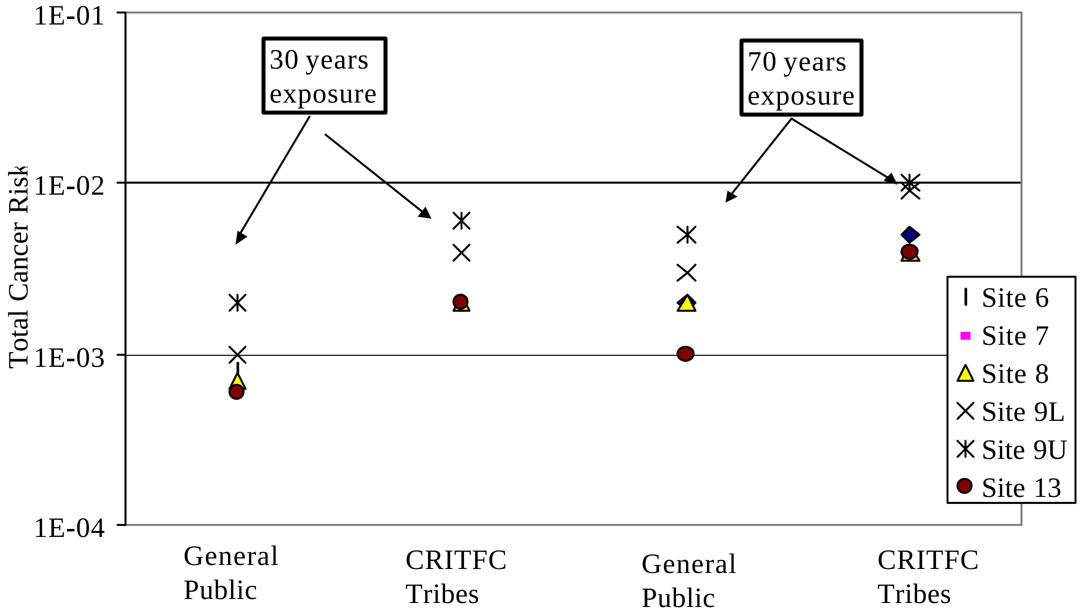


Figure 6-18. Comparison of estimated total cancer risks for consumption of white sturgeon across study sites for adults in the general public and CRITFC's member tribes at high consumption rates. Note that cancer risks for consumption of white sturgeon are the same for study sites 7 and 13.

Figure 6-19 shows the linear relationship between fish ingestion rate and estimated upper bound basin-wide cancer risk for adults for basin-wide average concentration of chemicals in white sturgeon fillet samples from the Columbia River Basin assuming both 30 and 70 years exposure duration. It also shows that cancer risks for a 70 year exposure were about 2 fold (i.e., 70 years/30 years = 2.3) higher than those for a 30 year exposure (see Appendix N for similar figures by study site and species).

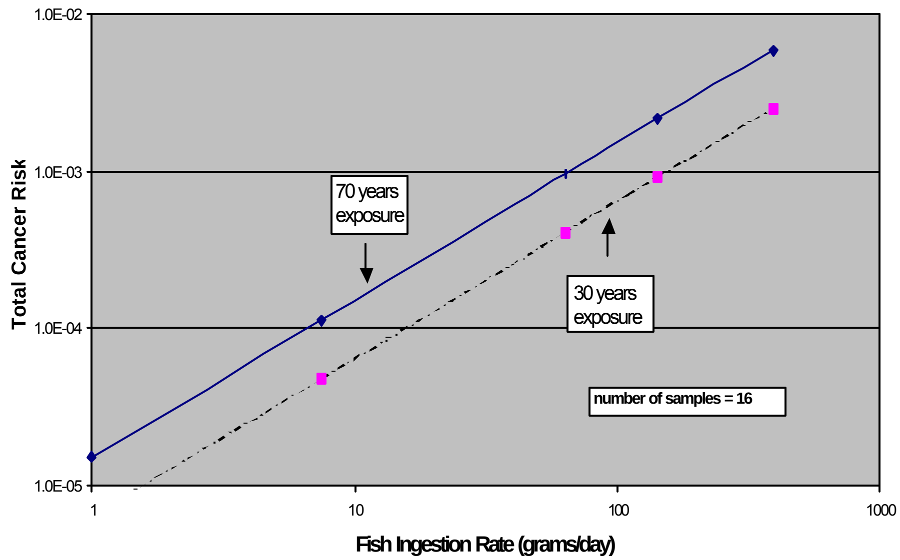


Figure 6-19. Total cancer risks versus fish consumption rate for adults. White sturgeon, basin-wide data (fillet with skin).

In the previous discussion on non-cancer results, it was shown that a small number of chemicals were responsible for most of the non-cancer health hazards from consuming fish. Tables 6-12 (fillet without skin) and Table 6-13 (whole body) show the chemicals with cancer risks at or greater than 1 X 10^{-5} for sturgeon for CRITFC's member tribal adults, average fish consumption and 70 years exposure duration. For cancer risks, a limited (but larger) number of chemicals were responsible for the majority of the cancer risk. These chemicals are:

- PCBs, including both Aroclors and dioxin-like PCB congeners,
- chlorinated dioxins and furans, with 2,3,7,8,-TCDF having the highest risk among the congeners,
- the pesticides aldrin, chlordane (total), DDD, DDE, and hexachlorobenzene, with DDE having the highest risk, and
- one metal, arsenic.

Not all chemicals were detected at every study site. For example, in the table with fillet without skin results (Table 6-12), Aroclors and PCB congeners 105, 118 and 156 were detected in all of the study site samples while other PCB congeners were detected at only one or two study sites.

Table 6-12. Chemicals with estimated cancer risks at or greater than 1 X 10^{-5} for white sturgeon, fillet without skin. CRITFC's member tribal adult, average fish consumption, 70 years exposure.

	Study Site*					
	CR - 6	**CR-7**	**CR -8**	**SR -13**	**CR - 9L**	**CR -9U**
PCBs						
Total Aroclors**	2 X 10^{-4}	1 X 10^{-4}	1 X 10^{-4}	1 X 10^{-4}	3 X 10^{-4}	7 X 10^{-4}
PCB 105	3 X 10^{-5}	2 X 10^{-5}	2 X 10^{-5}	3 X 10^{-5}	4 X 10^{-5}	1 X 10^{-4}
PCB 114	1 X10^{-5}	<	<	1 X 10^{-5}	2 X 10^{-5}	5 X 10^{-5}
PCB 118	3 X 10^{-5}	2 X 10^{-5}	2 X 10^{-5}	4 X 10^{-5}	5 X 10^{-5}	2 X 10^{-4}
PCB 126	<	2 X 10^{-5}	<	<	<	<
PCB 156	4 X 10^{-5}	3 X 10^{-5}	3 X 10^{-5}	5 X 10^{-5}	9 X 10^{-5}	2 X 10^{-4}
PCB 157	<	<	<	<	2 X 10^{-5}	5 X 10^{-5}
Dioxin/furans						
1,2,3,7,8-PeCDD	1 X 10^{-5}	2 X 10^{-5}	2 X 10^{-5}	1 X 10^{-5}	<	<
2,3,4,7,8-PeCDF	<	1 X 10^{-5}	2 X 10^{-5}	<	2 X 10^{-5}	2 X 10^{-5}
2,3,7,8-TCDD	4 X 10^{-5}	5 X10^{-5}	6 X 10^{-5}	5 X 10^{-5}	1 X 10^{-4}	3 X 10^{-5}
2,3,7,8-TCDF	2 X 10^{-4}	2 X10^{-4}	2 X 10^{-4}	6 X 10^{-5}	5 X 10^{-4}	3 X 10^{-4}
Pesticides						
Aldrin	<	<	<	<	2 X 10^{-5}	1 X 10^{-5}
Chlordane (total)	<	<	<	<	1 X 10^{-5}	2 X 10^{-5}
DDD	1 X 10^{-5}	1 X 10^{-5}	1 X 10^{-5}	1 X 10^{-5}	4 X 10^{-5}	8 X 10^{-5}
DDE	1 X 10^{-4}	1 X 10^{-4}	1 X 10^{-4}	1 X 10^{-4}	2 X 10^{-4}	4 X 10^{-4}
Hexachlorobenzene	<	<	<	<	2 X 10^{5}	<
Metals						
Arsenic	4 X 10^{-5}	5 X 10^{-5}	5 X 10^{-5}	3 X 10^{-5}	5 X 10^{-5}	4 X 10^{-5}
Total Cancer Risk for All Chemicals	8 X 10^{-4}	6 X 10^{-4}	7 X 10^{-4}	6 X 10^{-4}	1 X 10^{-3}	2 X 10^{-3}

"<" means that estimated cancer risk was less than 1 X 10^{-5} *Study site descriptions are in Table 1.1. CR = Columbia River; SR = Snake River
* * Based on "adjusted" Aroclor concentration (see Section 5.3.2)

Table 6-13. Chemicals with estimated cancer risks at or greater than 1 X 10^{-5} for white sturgeon, whole body. CRITFC's member tribal adult, average fish consumption, 70 years exposure.

		Study Site*		
		CR- 8	**CR -9L**	**CR- 9U**
PCBs				
	Total Aroclors**	3 X 10^{-4}	2 X 10^{-4}	3 X 10^{-4}
	PCB 105	6 X 10^{-5}	4 X 10^{-5}	5 X 10^{-5}
	PCB 114	2 X 10^{-5}	2 X 10^{-5}	2 X 10^{-5}
	PCB 118	7 X 10^{-5}	5 X 10^{-5}	5 X 10^{-5}
	PCB 156	1 X 10^{-4}	9 X 10^{-5}	9 X 10^{-5}
	PCB 157	2 X 10^{-5}	2 X 10^{-5}	2 X 10^{-5}
Dioxin/furans				
	2,3,4,7,8-PeCDF	2 X 10^{-5}	3 X 10^{-5}	2 X 10^{-5}
	2,3,7,8-TCDD	9 X 10^{-5}	1 X 10^{-4}	9 X 10^{-5}
	2,3,7,8-TCDF	3 X 10^{-4}	3 X 10^{-4}	4 X 10^{-4}
Pesticides				
	Aldrin	<	2 X 10^{-5}	2 X 10^{-5}
	Chlordane (total)	<	1 X 10^{-5}	<
	DDD	2 X 10^{-5}	3 X 10^{-5}	5 X 10^{-5}
	DDE	2 X 10^{-4}	2 X 10^{-4}	2 X 10^{-4}
	Hexachlorobenzene	<	2 X 10^{-5}	1 X 10^{-5}
Metals				
	Arsenic	7 X 10^{-5}	4 X 10^{-5}	4 X 10^{-5}
Total Cancer Risk for All Chemicals		1 X 10^{-3}	1 X 10^{-3}	1 X 10^{-3}

"<" means that estimated cancer risk was less than 1 X 10^{-5}. CR = Columbia River
*Study site descriptions are in Table 1-1. **Based on "adjusted Aroclor concentration (see Section 5.3.2)

The total cancer risk estimates and the summary of chemicals with risks at or greater than 1 X 10^{-5} for other resident fish species are provided in Appendix O by species: Tables 1.3 and 1.4 (bridgelip sucker), 2.3 and 2.4 (largescale sucker), 3.3 and 3.4 (mountain whitefish), 4.3 and 4.4 (white sturgeon), 5.3 and 5.4 (walleye), and 6.3 and 6.4 (rainbow trout). Table 6-14 shows a summary of the total cancer risk estimates for the resident fish species for one adult population - CRITFC's member tribal adults with an average fish consumption and 70 years exposure. Results of the fillet with skin samples are shown, except for sturgeon (only fillet without skin sampled) and bridgelip sucker (only whole body sampled).

Table 6-14. Summary of estimated total cancer risks by study site and basin-wide, resident fish species. CRITFC's tribal member adult, average fish consumption, 70 years exposure

Species	N	Sample type	Study site name	Study Site	Study site cancer risk	Range in study site cancer risks	Basin cancer risk
Bridgelip sucker	*3*	WB	Yakima	48	5 X 10^{-4}	5 X 10^{-4}	5 X 10^{-4}*
Largescale sucker	*19*	FS	Columbia	9U	6 X 10^{-4}	1 to 6 X 10^{-4}	4 X 10^{-4}
			Deschutes	98	1 X 10^{-4}		
			Umatilla	30	2 X 10^{-4}		
			Snake	13	2 X 10^{-4}		
			Yakima	48	4 X 10^{-4}		
			Yakima	49	3 X 10^{-4}		
Mountain whitefish	*12*	FS	Columbia	9U	4 X 10^{-3}	1 X 10^{-4} to 4 X 10^{-3}	1 X 10^{-3}
			Deschutes	98	3 X 10^{-4}		
			Umatilla	101	1 X 10^{-4}		
			Yakima	48	1 X 10^{-3}		
White sturgeon	*16*	FW	Columbia	6	8 X 10^{-4}	6 X 10^{-4} to 2 X 10^{-3}	1 X 10^{-3}
			Columbia	7	6 X 10^{-4}		
			Columbia	8	7 X 10^{-4}		
			Columbia	9L	1 X 10^{-3}		
			Columbia	9U	2 X 10^{-3}		
			Snake	13	6 X 10^{-4}		
Walleye	*3*	FS	Umatilla	30	2 X 10^{-4}	2 X 10^{-4}	2 X 10^{-4}*
Rainbow trout	*7*	FS	Deschutes	98	2 X 10^{-4}	2 X 10^{-4}	2 X 10^{-4}
			Yakima	49	2 X 10^{-4}		

N= number of samples; WB = whole body; FS = fillet with skin; FW = fillet without skin
* Basin-wide cancer risk based on one study site

White sturgeon and mountain whitefish had the highest estimated basin-wide cancer risks at 1 X 10^{-3} (Table 6-14). All of the white sturgeon study site cancer risks were at or greater than 6 X 10^{-4} with a high of 2 X 10^{-3}. The highest cancer risks for sturgeon were from consuming fish from the Columbia River at study sites 9L (1 X 10^{-3}) and 9U (2 X 10^{-3}). The four mountain whitefish study sites span more than an order of magnitude in cancer risk - 1 X 10^{-4} for the Umatilla (study site 101), 3 X 10^{-4} for the Deschutes (study site 98), 1 X 10^{-3} for the Yakima (study site 48), and 4 X 10^{-3} for the Columbia River (study site 9U). Cancer risks were highest for the Yakima (study site 48) and Columbia River (study site 9U) for whitefish and for the Columbia River at study sites 9U and 9L for sturgeon.

Bridgelip sucker (one study site at 5 X 10^{-4}) and largescale sucker (six study sites ranging from 1 to 6 X 10^{-4}) had the next highest basin-wide cancer risks, 5 X 10^{-4} and 4 X 10^{-4}, respectively. Walleye (one study site at 2 X 10^{-4}) and rainbow trout (two study sites at 2 X 10^{-4}) had the lowest basin-wide cancer risks.

Figure 6-20 summarizes the total basin-wide cancer risks for resident fish species for adults using high and average fish consumption rates for the general public and for CRITFC's member tribal populations assuming 70 years exposure duration. Note that the Y axis is on a logarithmic scale and that each bar begins at 0 on the Y axis. For example, the cancer risk for mountain whitefish for the general public adult, high fish consumption for 70 years, is 3 X 10^{-3}; for CRITFC member tribal adults, high fish consumption for 70 years, the cancer risk estimates is 8 X 10^{-3}. As with Table 6-14, this figure shows that consumption of mountain whitefish and white sturgeon result in the highest cancer risks, followed by sucker, rainbow trout, and walleye. It also shows that for all species, the total cancer risks were highest for CRITFC's member tribal adults at the high fish ingestion rates (389 g/day) followed by the general public adult, high ingestion rate (142.4 g/day); CRITFC's member tribal adult, average ingestion rate (63.2 g/day); and general public adult, average ingestion rate (7.5 g/day).

For a more detailed comparison of cancer risks across resident fish species for each study site, see Appendix N. In this appendix, cancer risks are shown over a range of ingestion rates for all species caught at a study site.

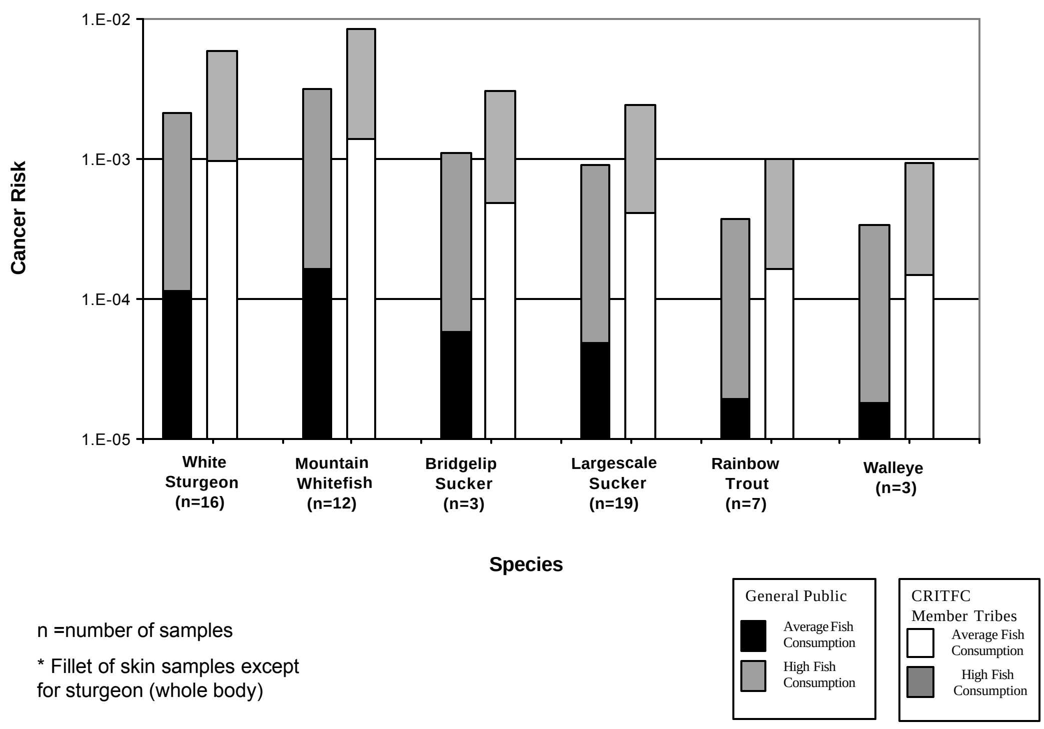


Figure 6-20. Adult cancer risks for resident fish species*. Columbia River Basin data (70 years exposure).

The chemicals with cancer risks equal to or greater than 1 X 10^{-5} for resident fish species are shown in Appendix O for CRITFC's member tribal adults for the average fish consumption rate and 70 years exposure (Tables 1.4 (bridgelip sucker), 2.4.1 and 2.4.2 (largescale sucker), 3.4.1 and 3.4.2 (mountain whitefish), 4.4.1 and 4.4.2 (white sturgeon), 5.4.1 and 5.4.2 (walleye), and 6.4.1 and 6.4.2 (rainbow trout).

In general, four chemical classes (PCBs, chlorinated dioxins and furans, pesticides and metals) were responsible for the cancer risks at or greater than 1 X 10^{-5} for all of the resident fish species. The exception to this was two study site samples for largescale sucker: the Snake River (study site 13, fillet with skin) had 2 semivolatiles at or greater than a 1 X 10^{-5} cancer risk, dibenz(a,h)anthracene and benzo(a)pyrene, and the Yakima River (study site 49, whole body) had one, 1,2-diphenylhydrazine.

For the metals, only one of the contaminants detected, inorganic arsenic, had an oral cancer slope factor. Thus, inorganic arsenic was the only detected metal for which cancer risks were estimated.

For the three other classes of chemicals contributing the most to the cancer risk (PCBs, dioxins/furans, and pesticides), the chemicals within each class that were at or greater than 1 X 10^{-5} vary among species and sometimes among different sample types of the same species. For example, the pesticide, hexachlorobenzene, was found at a level greater than 1 X 10^{-5} risk in only three white sturgeon samples: at Columbia River study site 9L for fillet without skin and at Columbia River study sites 9L and 9U for whole body samples. Aldrin was found at a cancer risk greater than 1 X 10^{-5} in only 2 species: at the Columbia River, study sites 9L and 9U, for both types of sturgeon samples (fillet without skin and whole body); and at Columbia River study site 9U for whitefish samples (whole body and fillet with skin).

All study sites and species had total Aroclors at or greater than a risk of 1 X 10^{-5} except for the Snake River (study site 13) for largescale sucker (fillet with skin). Up to seven different PCB congeners (105, 114, 118, 126, 156, 157 and 169) were found at or greater than a risk of 1 X 10^{-5} with the number per study site varying from zero to seven at different study sites. Up to four dioxins/furans (2,3,7,8-TCDF, 2,3,4,7,8-PCDF, 2,3,7,8-TCDD and 1,2,3,7,8-PCDD) were at or greater than a cancer risk of 1 X 10^{-5} with the number varying from two to four per study site.

Table 6-15 and Figures 6-21 through 6-26 show the percent contribution to total cancer risk from each chemical and class of chemical using the basin-wide cancer risk data for resident fish (fillet with skin for all species except sturgeon (fillet without skin) and bridgelip sucker (whole body).

Table 6-15. Percent contribution of contaminant groups to estimated cancer risks for resident fish species. Based on Columbia River Basin-wide averages.

	White Sturgeon	Largescale Sucker	Mountain Whitefish	Walleye	Rainbow Trout	Bridgelip Sucker
Tissue Type	*FW*	*FS*	*FS*	*FS*	*FS*	*WB*
Number of Samples	*16*	*19*	*12*	*3*	*7*	*3*
Total Metals	**4**	**2**	**1**	**33**	**ND**	**8**
Arsenic	4	2	1	33	ND	8
Total PCBs/Aroclors	**39**	**46**	**83**	**31**	**68**	**46**
PCB 105	3	2	6	3	4	2
PCB 114	1	1	2	1	2	1
PCB 118	4	6	15	6	9	3
PCB 126	2	9	18	ND	29	14
PCB 156	6	6	12	6	8	4
PCB 157	1	1	2	ND	2	ND
PCB 169	ND	2	<1	ND	ND	1
Other PCBs	<1	<1	1	<1	<1	<1
Total Aroclors*	21	19	26	15	15	22
Total Semi-Vocatives	**ND**	**28**	**ND**	**ND**	**ND**	**1**
1,2-Diphenylhydrazine	ND	ND	ND	ND	ND	1
Benzo(a)pyrene	ND	8	ND	ND	ND	ND
Dibenz[a,h]anthracene	ND	17	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	2	ND	ND	ND	ND
Other Semi-Vocatives	ND	2	ND	ND	ND	ND
Total Pesticides	**23**	**21**	**10**	**11**	**5**	**32**
Aldrin	2	ND	2	ND	ND	ND
DDD	2	1	1	1	<1	3
DDE	15	16	8	10	4	25
DDT	<1	2	<1	<1	1	3
Heptachlor Epoxide	1	ND	ND	ND	ND	ND
Hexachlorobenzene	1	ND	<1	ND	ND	ND
Other Pesticides	2	2	<1	ND	<1	<1
Total Dioxins/Furans	**36**	**5**	**8**	**26**	**29**	**13**
2,3,4,6,7,8-HxCDF	<1	<1	<1	1	2	<1
2,3,4,7,8-PeCDF	1	<1	1	1	2	2
2,3,7,8-TCDD	7	1	1	7	6	2
2,3,7,8-TCDF	26	1	5	6	2	3
OCDD	<1	<1	<1	<1	<1	<1
OCDF	<1	<1	<1	ND	<1	<1
1,2,3,7,8-PeCDD	1	2	2	7	13	5
1,2,3,4,7,8-HxCDD	<1	<1	<1	1	1	<1
other dioxins	1	1	<1	2	4	1

ND=Not detected; *Based on adjusted Aroclor concentration (See Section 5.3.2)

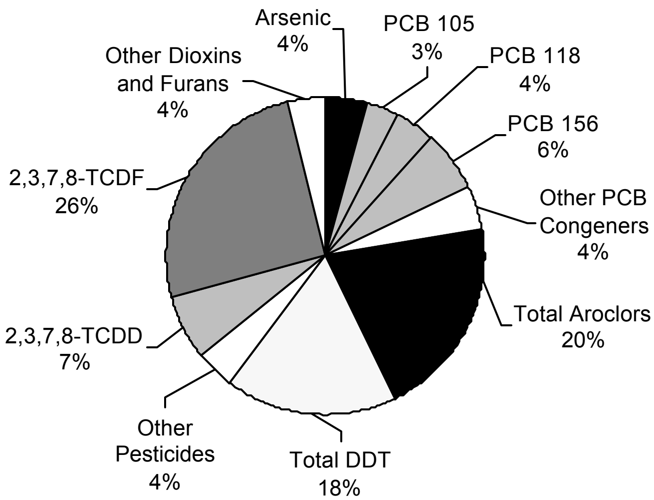


Figure 6-21. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of white sturgeon fillet without skin. Number of samples = 16.

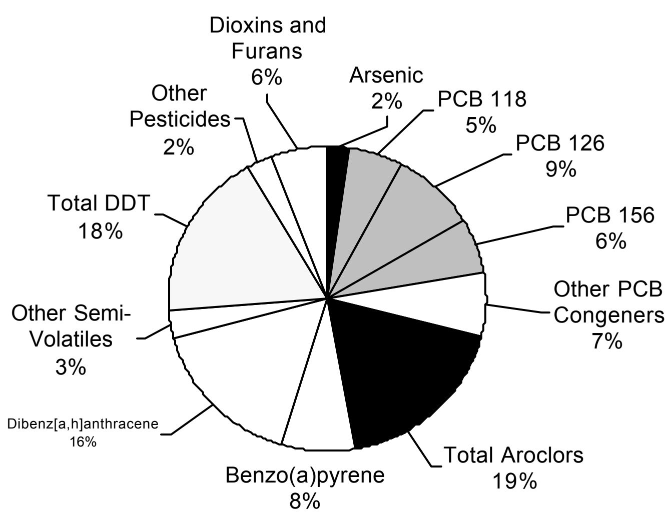


Figure 6-22. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of largescale sucker fillet with skin. Number of samples = 19.

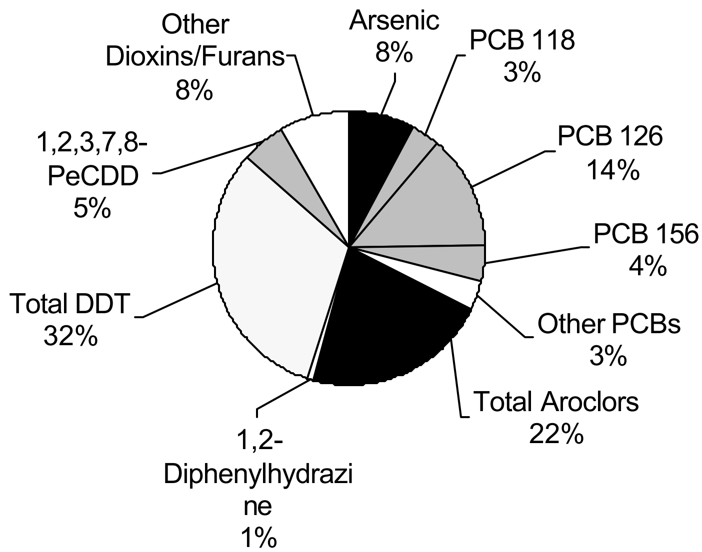


Figure 6-23. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of whole body bridgelip sucker. Number of samples = 3.

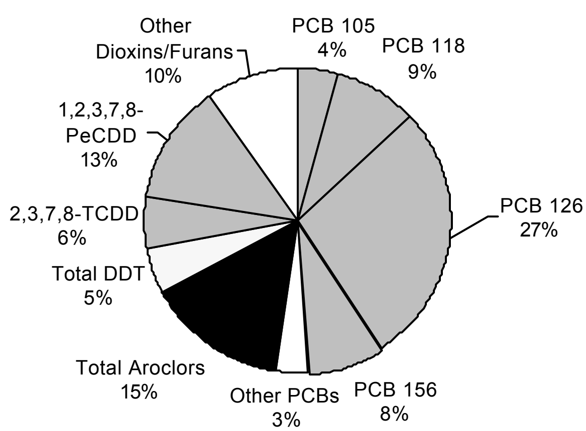


Figure 6-24. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of rainbow trout fillet with skin. Number of samples = 7.

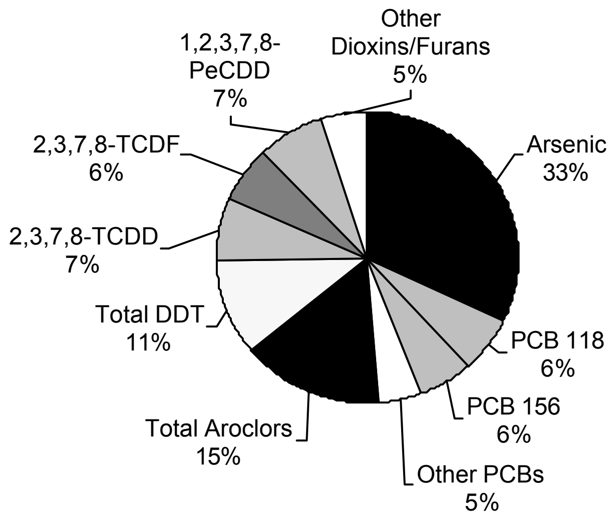


Figure 6-25. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of walleye fillet with skin. Number of samples =3.

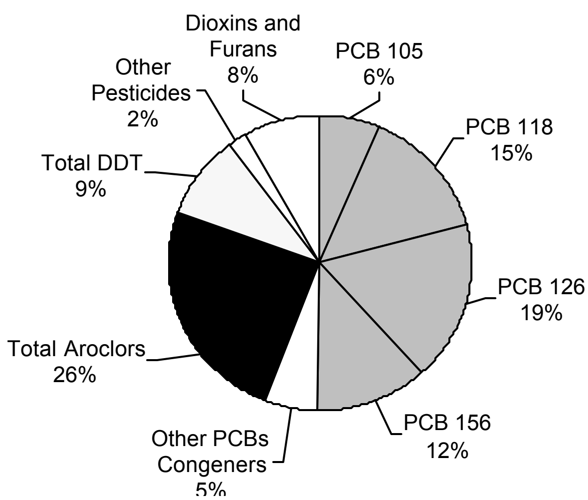


Figure 6-26. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of mountain whitefish fillet with skin. Number of samples = 12.

For all of the resident fish species except walleye, the majority of the cancer risk was from dioxins and furans, a small number of pesticides and PCBs. (Table 6-15 and Figures 6-21 through 6-26). Inorganic arsenic contributes to about 33% of the cancer risk for walleye.

- Chlorinated dioxins and furans contribute from 5% of the total cancer risk for largescale sucker to 36% for sturgeon. For sturgeon, 2,3,7,8-TCDF was by far the largest contributor of the dioxins/furans. For some of the other species, other congeners (e.g., 2,3,7,8-TCDD and 1,2,3,7,8-PeCDD) were contributors to the dioxin/furan cancer risk.

- Pesticides contribute from about 5% to 32% of the total cancer risk, with DDE contributing more than any other pesticide.

- PCBs (both total Aroclors and dioxin-like congeners) contribute from 31% to 83% of the total cancer risk. The contribution from Aroclors (primarily 1254 and 1260) to the cancer risk for this class of chemicals was approximately 15% for rainbow trout, 26% for mountain whitefish, 19% for largescale sucker, 22% for bridgelip sucker, 15% for walleye, and 21% for sturgeon. The contribution to PCB cancer risk from the dioxin-like PCB congeners ranges from a low of 17% for walleye to a high of 56% for mountain whitefish.

- The contribution from inorganic arsenic to total cancer risk was from 0% (not detected in rainbow trout fillets) to 33% for the resident fish species. For most species, the value was less than 8%. The exception was walleye at 33%.

6.2.2.2 Cancer Risk Evaluation for Anadromous Fish

The total cancer risk estimates for the anadromous fish species are provided in Appendix P by species: Tables 1.3 (coho salmon), 2.3 (fall chinook salmon), 3.3 (spring chinook salmon), 4.3 (steelhead), 5.3 (eulachon), and 6.3 (Pacific lamprey).

Table 6-16 summarizes the estimates of the total cancer risks for anadromous fish species by study site and by basin for CRITFC's member tribal adults, average consumption rate (63.2 g/day), and 70 years exposure. Fillet with skin data are shown except for eulachon, which had only whole body samples collected. Figure 6-27 shows the relative differences in cancer risks for anadromous fish species using average and high fish consumption rates for the general public and CRITFC's member tribal adult assuming 70 years exposure. Note that the Y axis is on a logarithmic scale and that all of the bars begin at 0 on the Y axis. For example, the cancer risk for Pacific lamprey for the general public adult, high fish consumption for 70 years, is slightly greater than 1×10^{-3}; for CRITFC member tribal adults, high fish consumption for 70 years, the cancer risk estimates is 4×10^{-3}. Columbia River Basin data are shown for all species (for coho salmon, eulachon and Pacific lamprey, only one study site was sampled).

Table 6-16. Summary of estimated total cancer risks by study site and basin-wide, anadromous fish species CRITFC's tribal member adult, average fish consumption, 70 years exposure

Species	N	Sample type	Study site name	Study site #	Study site cancer risk	Range in study site cancer risks	Basin cancer risk
Coho salmon	*3*	FS	Umatilla	30	2 X 10^{-4}	2 X 10^{-4}	2 X 10^{-4*}
Fall chinook salmon	*15*	FS	Columbia	8	2 X 10^{-4}	1 to 2 X 10^{-4}	2 X 10^{-4}
			Columbia	14	2 X 10^{-4}		
			Klickitat	56	2 X 10^{-4}		
			Umatilla	30	1 X 10^{-4}		
			Yakima	48	2 X 10^{-4}		
Spring chinook salmon	*24*	FS	Willamette	21	2 X 10^{-4}	2 to 3 X 10^{-4}	2 X 10^{-4}
			Wind River	63	2 X 10^{-4}		
			Little White Salmon	62	2 X 10^{-4}		
			Klickitat	56	2 X 10^{-4}		
			Looking Glass Creek	94	2 X 10^{-4}		
			Umatilla	30	3 X 10^{-4}		
			Yakima	48	2 X 10^{-4}		
			Icicle Creek	51	2 X 10^{-4}		
Steelhead	*21*	FS	Columbia	8	1 X 10^{-4}	1 to 3 X 10^{-4}	2 X 10^{-4}
			Hood River	25	3 X 10^{-4}		
			Klickitat	56	2 X 10^{-4}		
			Snake River	93	2 X 10^{-4}		
			Clearwater	96	3 X 10^{-4}		
			Yakima	48	2 X 10^{-4}		
Eulachon	*3*	WB	Columbia	3	2 X 10^{-4}	2 X 10^{-4}	2 X 10^{-4*}
Pacific lamprey	*3*	FS	Willamette	21	6 X 10^{-4}	6 X 10^{-4}	6 X 10^{-4*}

N= Number of Samples WB = whole body; FS = fillet with skin
* Basin-wide cancer risks based on one study site

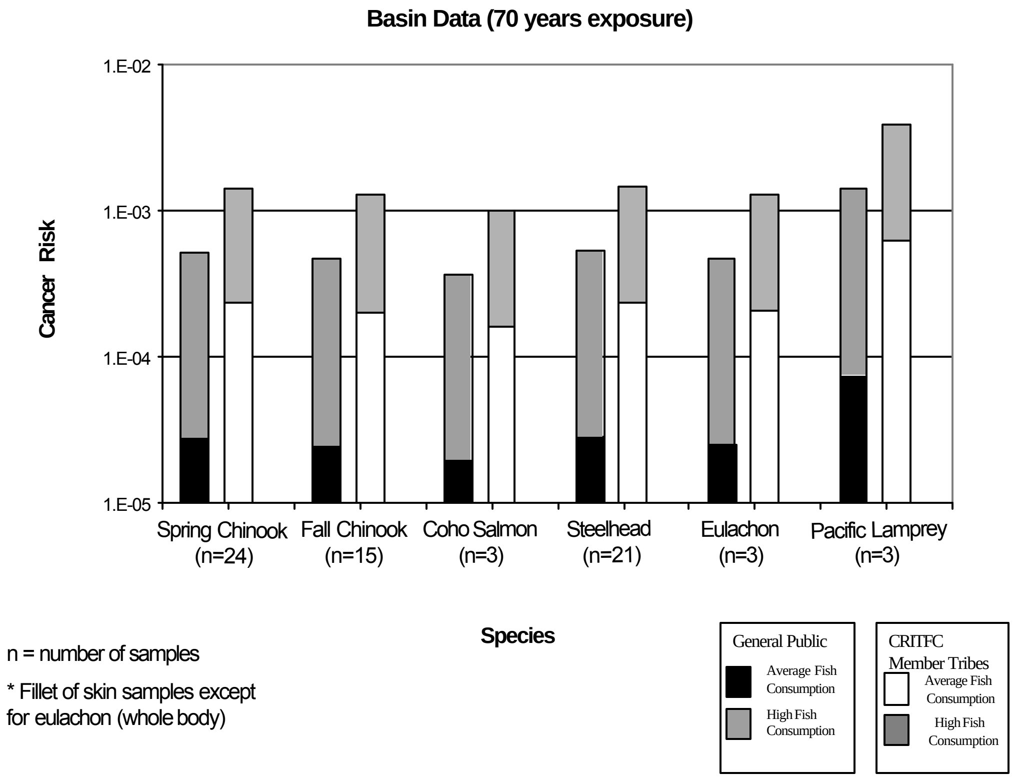


Figure 6-27. Adult cancer risks for anadromous fish species*. Columbia River Basin-wide average data (70 years exposure).

For coho salmon, fall chinook salmon, spring chinook salmon, steelhead and eulachon, the study site cancer risks were all within a range of $1 X 10^{-4}$ to $3 X 10^{-4}$ and the basin-wide risks were at approximately $2 X 10^{-4}$. The estimated cancer risk from consumption of Pacific lamprey was $6 X 10^{-4}$ (Table 6-16).

For all species, the total cancer risks were highest for CRITFC's member tribal adults at the high fish ingestion rates (389 g/day) followed by the general public, high ingestion rate (142.4 g/day); CRITFC's member tribal adult, average ingestion rate (63.2 g/day); and general public, average ingestion rate (7.5 g/day) (Figure 6-27).

For a more detailed comparison of cancer risks across anadromous fish species for each study site, see Appendix N. In this appendix, estimated cancer risks are shown for all species caught at a study site for a range of ingestion rates.

The chemicals with risks at or greater than 1 X 10^{-5} for each species for CRITFC's member tribal adults with average fish consumption and 70 years exposure are summarized in Appendix P by species. A review of this appendix shows that:

- For steelhead, spring chinook salmon, and fall chinook salmon, the same three chemical classes (PCBs, dioxins/furans, and one inorganic, arsenic) were responsible for the majority of the risks at or greater than 1 X 10^{-5}. Fillet with skin and whole body samples of coho had no risks greater than 10^{-5} for dioxins and furans while whole body samples had a 1 X 10^{-5} risk for DDE. For spring and fall chinook salmon and steelhead, which had dioxins and furans risks at or greater than1 X 10^{-5}, three congeners were greater than this risk level - 1,2,3,7,8-PCDD; 2,3,4,7,8-PCDF; and 2,3,7,8-TCDF. For steelhead and all three salmon, Aroclors and PCB congeners 126 and 118 were found at all study sites at or greater than 1 X 10^{-5}, as was inorganic arsenic.

- Eulachon was sampled at only one site (Columbia River, study site 3). Risks from consumption of the whole body composite sample were at or greater than 1 X 10^{-5} for two chemicals, arsenic and 1,2,3,7,8-PCDD.

- Pacific lamprey collected at two sites -Willamette Falls (21) and Fifteen Mile Creek (24) - had risks at or greater than 1 X 10^{-5} for four classes of chemicals: PCBs (Aroclors as well as PCBs 105,114,118,126, and 156); chlorinated dioxins/furans (1,2,3,7,8-PCDD and 2,3,7,8-TCDF); metals (inorganic arsenic); and pesticides (total chlordane, DDT, DDE and hexachlorobenzene).

Tables 6-17 and Figures 6-28 through 6-33 show the percent contribution to total cancer risk for each chemical and/or chemical class using basin-wide cancer risk data (based on fillet of skin data for all species except eulachon which was whole body).

A review of Table 6-17 and Figures 6-28 through 6-33 shows that:

- Arsenic contributes from 33 to 54% of the total cancer risk for salmon and steelhead; 58% for eulachon; and only about 7% for lamprey.

- PCBs (Aroclors and dioxin-like congeners) contribute from 32 to 50% of the total cancer risk for the salmon and steelhead, 77% for lamprey, and only 4% for eulachon. For the salmon, steelhead, and lamprey, Aroclors contribute from 12 to 28% of the total cancer risk. Aroclors were not detected in eulachon. Nine different PCB congeners were detected with PCB 126 contributing the most to total cancer risk (from 6 to 35%) for all species except eulachon. PCB 126 was not detected in eulachon.

- The percent contribution from all pesticides was from about 1 to 9% of the risk.

- The contribution to total cancer risk for chlorinated dioxins and furans was from 9 to 14% for all species except eulachon. For eulachon, the percent contribution to total cancer risk is about 36%.

- Salmon and steelhead look very similar in that arsenic and PCBs were the major contributors to cancer risk followed by dioxin/furans and then pesticides. For Pacific lamprey, PCBs were the major risk contributor at 77% with the rest of the risk split between arsenic, dioxin/furans and pesticides. Most of the risk for eulachon is from arsenic, then dioxins/furans with less than 4% from PCBs and pesticides combined.

Table 6-17. Percent contribution of contaminant groups to cancer risk for anadromous fish species. Based on Columbia River Basin-wide averages.

	Spring Chinook Salmon	Coho Salmon	Fall Chinook Salmon	Steelhead	Pacific Lamprey	Eulachon
Tissue Type	*FS*	*FS*	*F S*	*FS*	*FS*	*WB*
Number of samples	*24*	*15*	*3*	*21*	*3*	*3*
Total Metals	**50**	**45**	**54**	**33**	**7**	**58**
Arsenic	50	45	54	33	7	58
Total PCB/Aroclors	**32**	**43**	**32**	**50**	**77**	**4**
PCB 105	1	3	2	1	3	1
PCB 114	1	1	1	1	2	<1
PCB 118	3	ND	4	3	8	2
PCB 123	<1	<1	<1	<1	<1	<1
PCB 126	14	6	10	24	35	ND
PCB 156	1	5	1	2	3	1
PCB 157	<1	ND	<1	<1	1	<1
PCB 169	ND	ND	ND	<1	ND	ND
Other PCBs	<1	<1	<1	<1	<1	<1
Total Aroclors**	12	28	15	19	25	ND
Total Pesticides	**4**	**1**	**4**	**4**	**9**	**2**
Aldrin	ND	ND	ND	ND	ND	ND
Chlordane total	1	<1	1	1	2	ND
DDD	<1	<1	<1	<1	<1	ND
DDE	2	<1	2	2	3	2
DDT	1	<1	<1	<1	2	ND
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	1	ND	1	1	2	ND
Total Dioxins/Furans	**14**	**11**	**9**	**14**	**9**	**36**
2,3,4,6,7,8-HxCDF	<1	ND	ND	<1	<1	1
2,3,4,7,8-PeCDF	4	2	1	6	1	4
2,3,7,8-TCDD	1	1	1	1	1	5
2,3,7,8-TCDF	4	4	5	2	3	5
OCDD	<1	<1	<1	<1	<1	<1
OCDF	<1	<1	<1	<1	ND	<1
1,2,3,7,8-PeCDD	4	3	2	4	2	16
1,2,3,4,7,8-HxCDD	<1	ND	ND	<1	<1	1
Other dioxins	1	1	<1	1	1	5

* Number in parenthesis is number of samples in basin data ** Based on adjusted Aroclor concentration (see Section 5.3.2)
ND = not detected

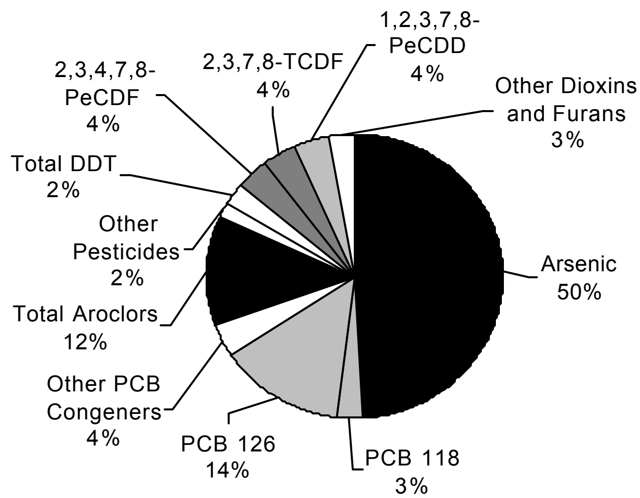


Figure 6-28. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of spring chinook fillet with skin. Number of samples = 8.

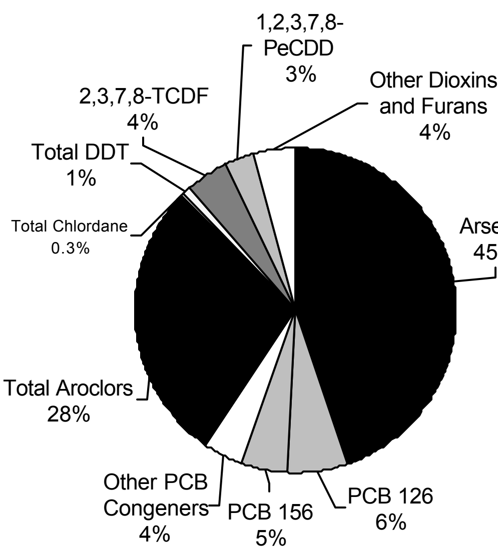


Figure 6-29. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of coho salmon fillet with skin. Number of samples =3.

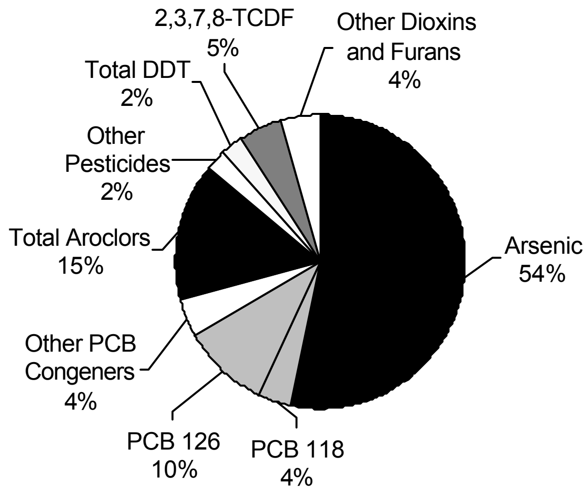


Figure 6-30. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of fall chinook salmon fillet with skin. Number of samples = 15.

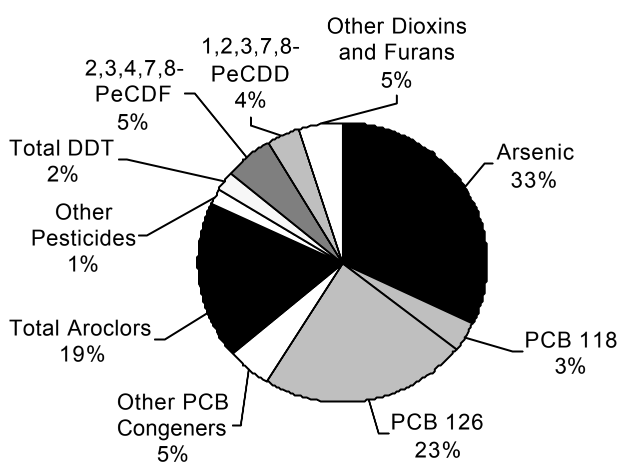


Figure 6-31. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of steelhead fillet with skin. Number of samples = 21.

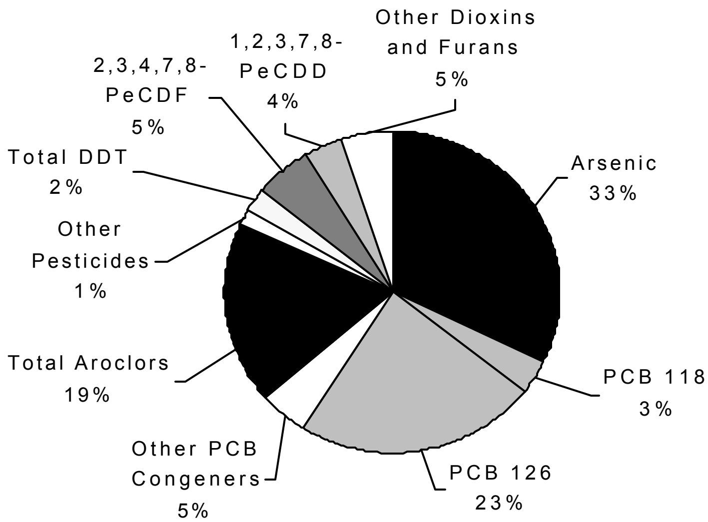


Figure 6-32. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of Pacific lamprey fillet with skin. Number of samples =3.

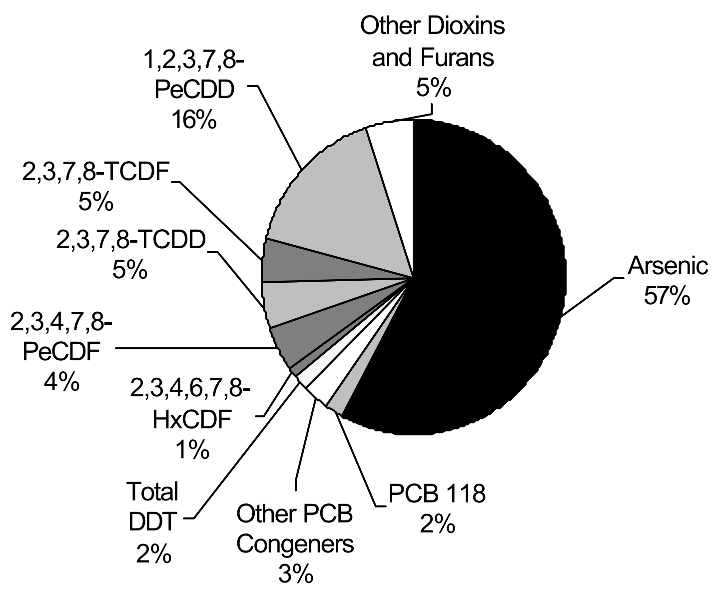


Figure 6-33. Percent contribution of basin-wide average chemical concentrations to cancer risk from consumption of whole body eulachon. Number of samples = 3.

6.2.2.3 Comparisons of Cancer Risks Between Anadromous Fish and Resident Fish Species

Table 6-18 shows a summary of the estimated total upper bound cancer risks for the basin and across study sites for all species at the high fish consumption rate for CRITFC's member tribal adults, 70 years exposure. It should be noted that the cancer risk estimates in Table 6-18 were calculated using high fish ingestion rates for CRITFC's member tribal adults, 70 years of exposure, while the results previously discussed for resident fish species in Table 6-14 and for anadromous fish species in Table 6-16 were calculated using average fish ingestion rates for CRITFC's member tribal adults, 70 years exposure. Conclusions from the comparisons in Table 6-18 are limited by the fact that different species were caught at different study sites and that sample numbers and types for each species varied.

Table 6-18 and the study site specific data in the tables in Appendices O and P show that for CRITFC's member tribal adults consuming fish at the high ingestion rate for 70 years:

- The basin-wide risks for *rainbow trout* and five of the anadromous fish (*coho, spring, and fall chinook salmon, steelhead, and eulachon*) were all estimated to be 1 X 10^{-3}. The range in the study site risks for the four species that had multiple study sites sampled was generally small: less than 2 fold for rainbow trout, fall chinook, and spring chinook. Steelhead had a slightly larger range (7 X 10^{-4} to 2 X 10^{-3}) due primarily to an estimated cancer risk of 7 X 10^{-4} at the Columbia River (study site 8); the estimated cancer risks for the other 5 study sites were at 1 or 2 X 10^{-3}.

- The basin-wide risk for *walleye* was 9 X 10^{-4}. The cancer risk for this one sample was within the range of study site risks for the species discussed in the previous bullet (rainbow trout, eulachon, the three salmon, and steelhead).

- The estimated basin-wide risks for high ingestion by adults in CRITFC's member tribes were greater than 1 X 10^{-3} among the remaining five species, with mountain whitefish and white sturgeon having the highest estimated basin-wide risks: *largescale sucker* (2 X 10^{-3}); *bridgelip sucker* (3 X 10^{-3}); *lamprey* (4 X 10^{-3}); *sturgeon* (6 X 10^{-3}), and; *whitefish* (8 X 10^{-3}). Three of these species had more than one study site used in the calculation of the basin-wide cancer risks, largescale sucker, sturgeon and whitefish. The range in cancer risks among the study sites sampled for sturgeon was about three-fold; for largescale sucker, about five-fold, and; for whitefish, about twenty-eight fold. The large difference in risk among study sites for whitefish was due to the low estimate of cancer risk of 7 X 10^{-4} for samples from the Umatilla (study site 101) and the high estimate of cancer risk of 2 X 10^{-2} at the Hanford Reach of the Columbia River (study site 9U). For sturgeon, no study site risk was less than 4 X 10^{-3}; the study site with the highest estimated cancer risk was the Columbia River at study site 9U.

Table 6-18. Summary of estimated total cancer risks by study site and basin-wide, all species. CRITFC's tribal member adult, high fish consumption, 70 years exposure				
Species	**N**	**Sample type**	**Range in study site cancer risks**	**Basin cancer risk**
Resident species				
bridgelip sucker	*3*	WB	$3 X 10^{-3}$	$3 X 10^{-3*}$
largescale sucker	*19*	FS	$8 X 10^{-4}$ to $4 X 10^{-3}$	$2 X 10^{-3}$
mountain whitefish	*12*	FS	$7 X 10^{-4}$ to $2 X 10^{-2}$	$8 X 10^{-3}$
white sturgeon	*16*	FW	$4 X 10^{-3}$ to $1 X 10^{-2}$	$6 X 10^{-3}$
walleye	*3*	FS	$9 X 10^{-4}$	$9 X 10^{-4*}$
rainbow trout	*7*	FS	$1 X 10^{-3}$, $1 X 10^{-3}$	$1 X 10^{-3}$
Anadromous species				
coho salmon	*3*	FS	$1 X 10^{-3}$	$1 X 10^{-3*}$
fall chinook salmon	*15*	FS	$9 X 10^{-4}$ to $1 X 10^{-3}$	$1 X 10^{-3}$
spring chinook salmon	*24*	FS	1 to $2 X 10^{-3}$	$1 X 10^{-3}$
steelhead	*21*	FS	$7 X 10^{-4}$ to $2 X 10^{-3}$	$1 X 10^{-3}$
eulachon	*3*	WB	$1 X 10^{-3}$	$1 X 10^{-3*}$
Pacific lamprey	*3*	FS	$4 X 10^{-3}$	$4 X 10^{-3*}$

WB = whole body; FS = fillet with skin; FW = fillet without skin; N = number of samples
* Basin-wide cancer risks based on one study site

Figure 6-34 is a summary of the cancer risks estimated to result from consumption of the resident fish and anadromous fish at all four ingestion rates for adults: general public adult, average and high fish consumption; CRITFC's member tribal adult, average and high fish consumption, assuming 70 years exposure. (Note that the Y axis is on a logarithmic scale). Basin-wide fillet with skin data were used for this figure, except for those species that had only whole body samples (bridgelip sucker and eulachon) or fillet without skin samples (sturgeon). The basin-wide cancer risks vary by species, with mountain whitefish having the highest estimated cancer risks and white sturgeon having the second highest among the species sampled. Lamprey, bridgelip sucker and largescale sucker were the next highest followed by the remaining seven species - the three salmon, steelhead, eulachon, rainbow trout, and walleye.

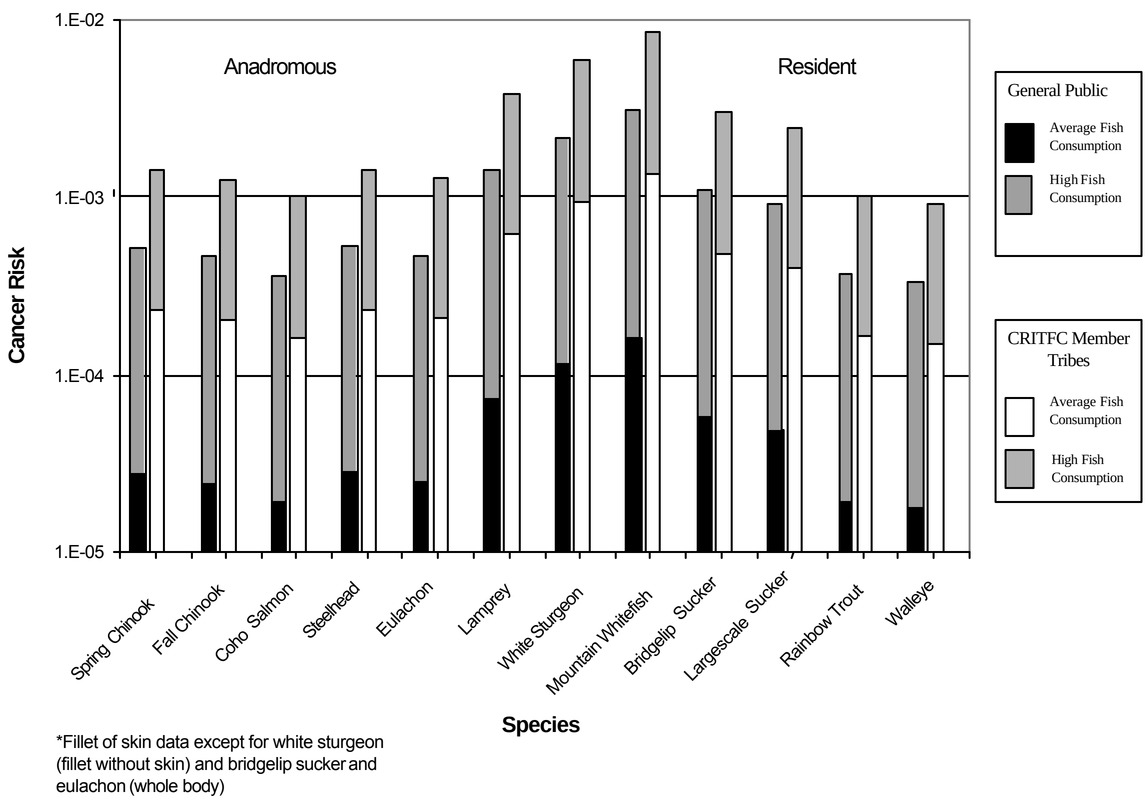


Figure 6-34. Adult estimated total cancer risks across all fish species sampled. Columbia River Basin-wide average data (70 years exposure).

For a more detailed comparison of cancer risks for anadromous fish and resident fish species for each study site, see Appendix N. In this appendix, estimated cancer risks are shown for all species caught at a sampling site using a range of fish ingestion rates.

The percent contribution of the chemicals and chemical classes to total cancer risk were shown in Tables 6-15 (resident fish species) and 6-17 (anadromous fish species) and in Figures 6-21 to 6-26 (resident fish species) and Figures 6-28 thru 6-33 (anadromous fish species). Fillet with skin data were used for these tables and figures except for sturgeon, for which fillet without skin data were used, and eulachon and bridgelip sucker, for which whole body data were used. A comparison of these tables and figures show that:

- Arsenic - For anadromous fish species, arsenic was a major contributor to cancer risk for all of the salmon and steelhead (33 to 54% for steelhead, fall and spring chinook, and coho salmon), and eulachon (58%), but contributes only 7% to the total cancer risk for lamprey. For resident fish, such a large contribution from arsenic was seen only for walleye (33%) and less so for bridgelip sucker (8%). As discussed in Section 4, it was assumed that 10% of the total arsenic measured in fish was inorganic. The impact of this assumption on the characterization of risk is discussed more in Section 6.2.6.

- PCBs - dioxin-like PCB congeners and Aroclors contribute from 32% to 82% of the total cancer risk for the resident fish; and from 32% to 77% for five of the anadromous fish, the exception being eulachon. For eulachon, dioxin-like PCB congeners/Aroclors contribute only 4% to the total cancer risk. For those 11 fish where dioxin-like PCB congeners/Aroclors were major contributors to risk, Aroclors 1254/1260 and, in general, dioxin-like PCBs 118, 126, and 156, contribute the most to the total dioxin-like PCB congener/Aroclor risk.

- Semi-volatiles - Semi-volatiles, including, PAHs, contribute little to the total risk. The exception was largescale sucker, where the contribution to the basin-wide average was 17% for dibenz(a,h,)anthracene and 8% for benzo(a)pyrene. This was misleading, however, because these two contaminants were found only at one of the six study sites where largescale sucker fillet were sampled, the Snake River at study site 13.

- Pesticides - For resident fish species, pesticides contribute from about 5% (for rainbow trout) to 32% (for bridgelip sucker) of the total cancer risk. For anadromous fish species, the percent contribution from pesticides was lower, from 1% (for coho salmon) to 9% (for lamprey). DDE was by far the major component of the pesticide cancer risk for resident fish species.

- Chlorinated Dioxins/Furans - Chlorinated dioxins/furans contribute from 5% (for largescale sucker) to 36% (for sturgeon) of the total cancer risk for resident fish species. Dioxins/furans contribute 36% to the eulachon cancer risk, but only 9% for lamprey and chinook salmon, 11% for coho, and 14% for steelhead and spring chinook. For resident fish species, 2,3,7,8-TCDF, 1,2,3,7,8-PCDD, and 2,3,7,8-TCDD were the major contributors to the dioxin/furan cancer risk. For the anadromous fish species, 2,3,7,8-TCDF, 1,2,3,7,8-PCDD, and 2,3,4,7,8-PCDF were the major contributors.

6.2.3 Summary of Non-Cancer Hazards and Cancer Risks for All Species

Tables 6-19 through 6-22 are a summary of the range in endpoint specific hazard indices and cancer risks across study sites for each species at the four fish ingestion rates used for adults. Hazard indices are shown only for those endpoints that most frequently exceeded a hazard index of 1. These endpoints are for reproduction/development and the central nervous system, immunotoxicity, and liver resulting primarily from exposures greater than the reference dose for methyl mercury, Aroclors, and DDT, DDE and DDD. Cancer risks are those estimated assuming a 70 year exposure duration.

- Hazard indices and cancer risks were lowest for the general public adult at the average ingestion rate and highest for CRITFC's member tribal adults at the high ingestion rate. For the general public with an average fish ingestion (7.5 g/day or about a meal per month), hazard indices were less than 1 and cancer risks are less than 1 X 10^{-4} except for a few of the more highly contaminated samples of mountain whitefish and white sturgeon (Table 6-19).

- For CRITFC's member tribal adults at the highest fish ingestion rates (389 g/day or about 48 meals per month), hazard indices were greater than 1 for several species at some study sites. Hazard indices (less than or equal to 8 at most study sites) and cancer risks (ranging from 7 X 10^{-4} to 2 X 10^{-3}) were lowest for salmon, steelhead, eulachon and rainbow trout and highest (hazard indices greater than 100 and cancer risks up to 2 X 10^{-2} at some study sites) for mountain whitefish and white sturgeon (Table 6-22).

- As discussed previously in Section 6.2.1, for the general public, the hazard indices for children at the average fish ingestion rate were about 0.9 those for adults at the average ingestion rate; the hazard indices for children at the high ingestion rate were about 1.3 times those for adults at the high ingestion rate. For CRITFC's member tribes, the hazard indices for children at the average and high ingestion rates were both about 1.9 times those for CRITFC's member tribal adults at the average and high ingestion rates, respectively.

Table 6-19. Summary of Hazard Indices and Cancer Risks Across Study sites. General Public Adult, average fish consumption (7.5 grams/day or 1 meal per month).

Species*	N*	Non-cancer endpoints which most frequently exceed a hazard index of one for all species			Cancer Risks (70 years exposure)
		Reproductive/ Developmental And Central Nervous System	Immunotoxicty	Liver	
Resident species					
bridgelip sucker	*3*	<1	<1	<1	6 X 10^{-5}
largescale sucker	*19*	<1	<1	<1	2 to 7 X 10^{-5}
mountain whitefish	*12*	<1	<1 to 3	<1	1 X 10^{-5} to 5 X 10^{-4}
white sturgeon	*16*	<1	<1 to 2	<1	7 X 10^{-5} to 3 X 10^{-4}
walleye	*3*	<1	<1	<1	2 X 10^{-5}
rainbow trout	*7*	<1	<1	<1	2 X 10^{-5}, 2 X 10^{-5}
Anadromous species					
coho salmon	*3*	<1	<1	<1	2 X 10^{-5}
fall chinook	*15*	<1	<1	<1	2 - 3 X 10^{-5}
spring chinook	*24*	<1	<1	<1	2 - 3 X 10^{-5}
steelhead	*21*	<1	<1	<1	1 to 3 X 10^{-5}
eulachon	*3*	<1	<1	<1	2 X 10^{-5}
Pacific lamprey	*3*	<1	<1	<1	7 X 10^{-5}

* N = number of samples. All samples are fillet with skin except sturgeon (fillet without skin) and bridgelip sucker and eulachon (whole body)

Table 6-20. Summary of Hazard Indices and Cancer Risks Across Study sites. General Public Adult, high fish consumption (142.4 g/day or 19 meals per month).

Species*	N*	Non-cancer endpoints which most frequently exceed a hazard index of one for all species			Cancer Risks (70 years exposure)
		Reproductive/ Developmental and Central Nervous system	Immunotoxicty	Liver	
Resident species					
bridgelip sucker	*3*	<1	6	2	1 X 10^{-3}
largescale sucker	*19*	2 to 7	1 to 8	<1 to 3	3 X 10^{-4} to 1 X 10^{-3}
mountain whitefish	*12*	<1 to 3	1 to 50	<1 to 4	2 X 10^{-4} to 9 X 10^{-3}
white sturgeon	*16*	1 to 7	6 to 40	2 to 8	1 to 5 X 10^{-3}
walleye	*3*	4	1	1	3 X 10^{-4}
rainbow trout	*7*	1 to 2	1 to 2	<1	4 X 10^{-4}, 4 X 10^{-4}
Anadromous species					
coho salmon	*3*	2	3	<1	4 X 10^{-4}
fall chinook	*15*	1 to 2	<1 to 3	<1	3 to 5 X 10^{-4}
spring chinook	*24*	<1 to 6	1 to 2	<1	4 to 6 X 10^{-4}
steelhead	*21*	1 to 3	1 to 2	<1	3 to 6 X 10^{-4}
eulachon	*3*	<1	<1	<1	5 X 10-^{4}
Pacific lamprey	*3*	<1	9	<1	1 X 10^{-3}

* N = number of samples; All samples are fillet with skin except sturgeon (fillet without skin) and bridgelip sucker and eulachon (whole body)

Table 6-21. Summary of Hazard Indices and Cancer Risks Across Study sites. CRITFC's Member Adult, average fish consumption (63.2 grams/day or 8 meals per month).

Species	N	Non-cancer endpoints which most frequently exceed a hazard index of one for all species			Cancer Risks (70 years exposure)
		Reproductive/ Developmental and Central Nervous System	Immunotoxicty	Liver	
Resident species					
bridgelip sucker	*3*	<1	3	1	5 X 10^{-4}
largescale sucker	*19*	<1 to 3	<1 to 3	<1 to 1	1 to 6 X 10^{-4}
mountain whitefish	*12*	<1 to 1	<1 to 22	<1 to 2	1 X 10^{-4} to 4 X 10^{-3}
white sturgeon	*16*	<1 to 3	3 to 18	<1 to 3	6 X 10^{-4} to 2 X 10^{-3}
walleye	*3*	2	<1	<1	2 X 10^{-4}
rainbow trout	*7*	<1	<1	<1	2 X 10^{-4}, 2 X 10^{-4}
Anadromous species					
coho salmon	*3*	1	1	<1	2 X 10^{-4}
fall chinook	*15*	<1 to1	1	<1	1 to 2 X 10^{-4}
spring chinook	*24*	<1 to 3	<1	<1	2 to 3 X 10^{-4}
steelhead	*21*	<1 to 1	<1 to 1	<1	1 to 3 X 10^{-4}
eulachon	*3*	<1	<1	<1	2 X 10^{-4}
Pacific lamprey	*3*	<1	4	<1	6 X 10^{-4}

N = number of samples. All samples are fillet with skin except sturgeon (fillet without skin).
Bridgelip sucker and eulachon are whole body fish tissue samples.

Table 6-22. Summary of Hazard Indices and Cancer Risks Across Study sites. CRITFC's Member Adult, high fish consumption (389 grams/day or 48 meal per month)					
Species*	**N***	**Non-cancer endpoints which most frequently exceed a hazard index of one for all species**			**Cancer Risks (70 years exposure)**
		Reproductive/ Developmental and Central Nervous System	**Immunotoxicty**	**Liver**	
Resident species					
bridgelip sucker	*3*	2	17	6	$3 X 10^{-3}$
largescale sucker	*19*	5 to 20	<1 to 21	<1 to 7	$8 X 10^{-4}$ to $4 X 10^{-3}$
mountain whitefish	*12*	<1 to 7	4 to 140	<1 to 11	$7 X 10^{-4}$ to $2 X 10^{-2}$
white sturgeon	*16*	3 to 20	16 to 108	6 to 21	$4 X 10^{-3}$ to $1 X 10^{-2}$
walleye	*3*	10	4	4	$9 X 10^{-4}$
rainbow trout	*7*	4 to 5	3 to 4	<1	$1 X 10^{-3}$, $1 X 10^{-3}$
Anadromous species					
coho salmon	*3*	7	7	<1	$1 X 10^{-3}$
fall chinook	*15*	3 to 6	<1 to 8	<1	$9 X 10^{-4}$ to $1 X 10^{-3}$
spring chinook	*24*	<1 to 17	3 to 6	<1	1 to $2 X 10^{-3}$
steelhead	*21*	4 to 8	3 to 6	<1	$7 X 10^{-4}$ to $2 X 10^{-3}$
eulachon	*3*	<1	<1	<1	$1 X 10^{-3}$
Pacific lamprey	*3*	<1	24	2	$4 X 10^{-3}$

N = number of samples. All samples are fillet with skin except sturgeon (fillet without skin).
Bridgelip sucker and eulachon are whole body fish tissue samples.

6.2.4 Impacts of Sample Type on Risk Characterization

For this study, both whole fish and fillet with skin samples were analyzed for all species except sturgeon, bridgelip sucker, and eulachon. Sturgeon were analyzed as whole fish and fillet without skin (since it is unlikely that sturgeon skin is eaten). For bridgelip sucker and eulachon only whole body samples were collected.

The risk characterization results for all species and sample types are included in the appendices. However, some of the risk characterization results previously discussed in Sections 6.2.1 and 6.2.2 focused on fillet with skin samples (except for those species for which fillet with skin were not collected). To determine the impact that tissue type might have on the risk characterization, the ratio of the estimated hazard indices and cancer risks for whole body to fillet samples were calculated (Table 6-23). These results were calculated for those species that had both fillet and whole body samples analyzed at a given site. For non-cancer effects, whole body to fillet ratios were calculated for the total hazard index as well as for the endpoints of immunotoxicity and reproduction. Table 6-23 also shows the number of whole body to fillet ratios that were greater than 1 compared to the total number of whole body to fillet ratios calculated for that species.

As can be seen from Table 6-23, there does not appear to be a consistent pattern in whole body to fillet ratios for the total hazard indices, the immunotoxicity hazard indices, or cancer risks at a given site for a species. The whole body to fillet ratios ranged from a low of 0.4 to a high of 6.6. Most of the ratios were less than 3. These results are consistent with the results in Section 2 of this report. In Section 2, it was shown that while whole body fish tissue samples tend to be somewhat higher in lipids and lipid soluble contaminants than fillet with skin samples for some species, these differences between whole body and fillet fish samples were not consistent across species. For reproductive effects, the ratios of the hazard indices for reproductive effects in whole body to fillet samples appear to be less than 1 more frequently than those for the other hazard indices or cancer risks. This may be because the hazard index for reproductive effects is based largely upon the contaminant mercury which is not lipophilic and binds strongly to protein (e.g., muscle tissue). However, any conclusions on the results of whole body to fillet samples are limited by the small sample sizes (usually 3) at each site and by the fact that whole body samples were always from a composite of fish different than those used for the whole body analysis (i.e., fillet and whole body samples are not from the same fish).

Table 6-23. Comparison of site specific non-cancer hazard indices (for CRITFC's member tribal children) and cancer risks (for CRITFC's member tribal adults) from consuming whole body versus fillet for different fish species.

	Hazard Indices (1)							
	Immunotoxicity		Reproductive Effects		Total Hazard Index		Cancer Risk (2)	
Species	Range in ratios of hazard indices for whole body/fillet across sites	F	Range in ratios of hazard indices for whole body/fillet across sites	F	Range of ratios of total hazard indices for whole body/fillet across sites	F	Range of ratios of cancer risks for whole body/fillet	F
coho	1.1	(1/1)	0.8	(0/1)	1.1	(1/1)	1	(0/1)
fall chinook	0.9 - 6.6	(3/5)	0.7-1.1	(1/5)	1.0 - 1.6	(3/5)	1 - 2	(2/5)
spring chinook	0.9 - 1.6	(4/8)	0.3 - 1.1	(1/3)	0.6 - 1.6	(4/8)	1 - 2	(3/8)
steelhead	1.1 - 1.4	(6/6)	0.6 - 1.6	(1/6)	0.9 - 1.5	(4/6)	0.5 - 2.0	(2/6)
eulachon	na	na	na	na	na	na	na	na
Pacific lamprey	1	(0/1)	na	na	1.2	(1/1)	1	(0/1)
bridgelip sucker	na	na	na	na	na	na	na	na
largescale sucker	0.6 - 3.3	(3/5)	0.2 - 1.3	(1/6)	0.5 - 2.2	(3/6)	0.7 - 2.5	(3/6)
mountain whitefish	0.4 - 2.1	(2/4)	0.7 - 0.9	(0/3)	0.8 - 1.6	(2/4)	0.5 - 1.4	(1/4)
white sturgeon	0.4- 2.9	(1/3)	0.3 - 3.3	(2/3)	0.4 - 2.7	(1/3)	0.8 - 2.3	(1/3)
walleye	1.8	(1/1)	1	(0/1)	1	(0/1)	1	(1/1)
rainbow trout	1.2 - 1.2	(2/2)	0.7- 1.7	(½)	1.1 - 1.5	(2/2)	1.0 - 1.0	(0/2)

F=Frequency of number of whole body to fillet ratios greater than 1 divided by the total number of whole body to fillet ratios for that species.
na = Not applicable; ratios could not be calculated because chemicals (Aroclors, mercury) were less than detection limits or because fillet data were not available (I.e., for bridgelip sucker and eulachon)
(1) Hazard indices used are those calculated for CRITFC's tribal member children, high fish consumption rate
(2) Cancer risk are those calculated for CRITFC's tribal member adults, 70 years exposure, high fish consumption

6.2.5 Risk Characterization Using a Multiple-species Diet

As discussed in Section 4.10, a hypothetical diet consisting of multiple fish species was developed based on information obtained during the 1991-1992 survey of fish consumption by members of the Nez Perce, Umatilla, Yakama, and Warm Springs Tribes (CRITFC, 1994). The percentage of the hypothetical diet assumed for each fish species and the resulting species specific ingestion rates (assuming a total fish ingestion rate of 63.2 g/day, the average for CRITFC's tribal members adults) were shown previously in Table 4-4.

Table 6-24 shows the resulting cancer risks and total non-cancer hazard indices calculated using this hypothetical diet and the average fish consumption rate (63.2 grams/day) for CRITFC's member tribal adult fish consumers. Cancer risk estimates for individual species were highest for lamprey fillets ($1.0 X 10^{-4}$) and lowest for walleye fillets ($4.2 X 10^{-6}$). The total excess cancer risk for consuming the fish used in this example was $4.0 X 10^{-4}$. Total hazard indices for individual species were highest for lamprey and mountain whitefish fillets (0.7) and lowest for eulachon and largescale sucker fillets (0.1). The total hazard index for consuming the fish used in this example was 3.2.

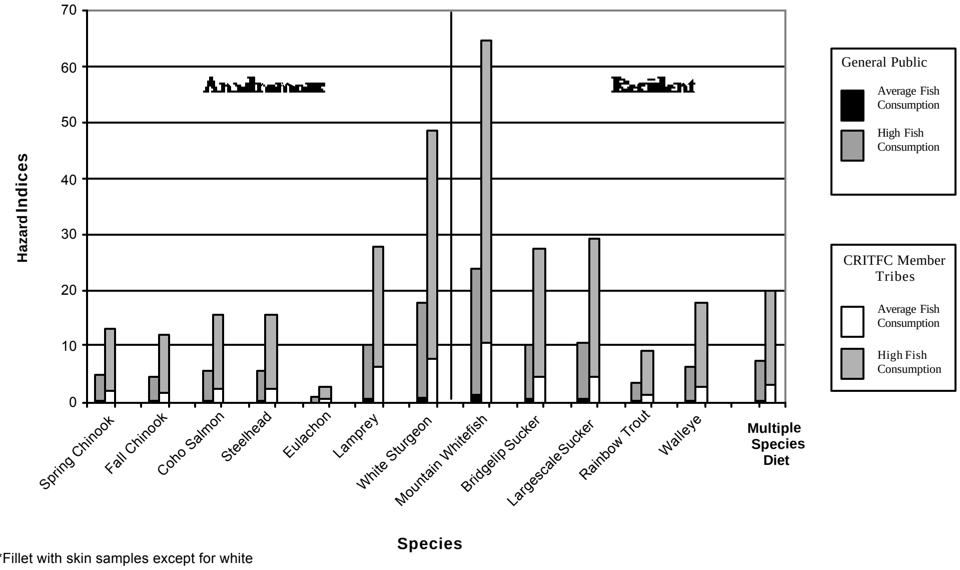
Table 6-24. Estimate cancer risks and non-cancer health effects for a hypothetical multiple-species diet based upon CRITFC's member average adult fish consumption (CRITFC, 1994)

Species	Percentage of Hypothetical	Consumption Rate (g/day)	Cancer Risk[a]	Non-cancer Effects[a]
Salmon[b,c,d]	27.7	17.5	$5.8 X 10^{-5}$	0.6
Rainbow Trout[d]	21.0	13.3	$3.5 X 10^{-5}$	0.3
Mountain Whitefish[d]	6.8	4.3	$9.3 X 10^{-5}$	0.7
Eulachon[e]	15.6	9.9	$3.3 X 10^{-5}$	0.1
Pacific lamprey[d]	16.3	10.3	$1.0 X 10^{-4}$	0.7
Walleye[d]	2.8	1.8	$4.2 X 10^{-6}$	0.1
White Sturgeon[f]	7.4	4.7	$7.1 X 10^{-5}$	0.6
Largescale Sucker[d]	2.3	1.5	$9.3 X 10^{-6}$	0.1
Totals	100.0	63.2	$4.0 X 10^{-4}$	3.2

[a]Risk estimates assume fish consumption by a 70 kg CRITFC's tribal member adult at the specified rate 365 days per year for 70 years
[b]Cancer risk estimates for salmon are the average of estimates for spring chinook ($6.4 X 10^{-5}$), fall chinook ($5.7 X 10^{-5}$), coho ($4.5 X 10^{-5}$), and steelhead ($6.4 X 10^{-5}$).
[c]Noncancer hazard indices for salmon are the average of estimates for spring chinook (0.6), fall chinook (0.5), coho (0.7), and steelhead (0.7).
[d]Risk estimates are based on analysis of uncooked composite samples of fillets with skin.
[e]Risk estimates are based on analysis of uncooked composite samples of whole body fish.
[f]Risk estimates are based on analysis of uncooked composite samples of fillets without skin.

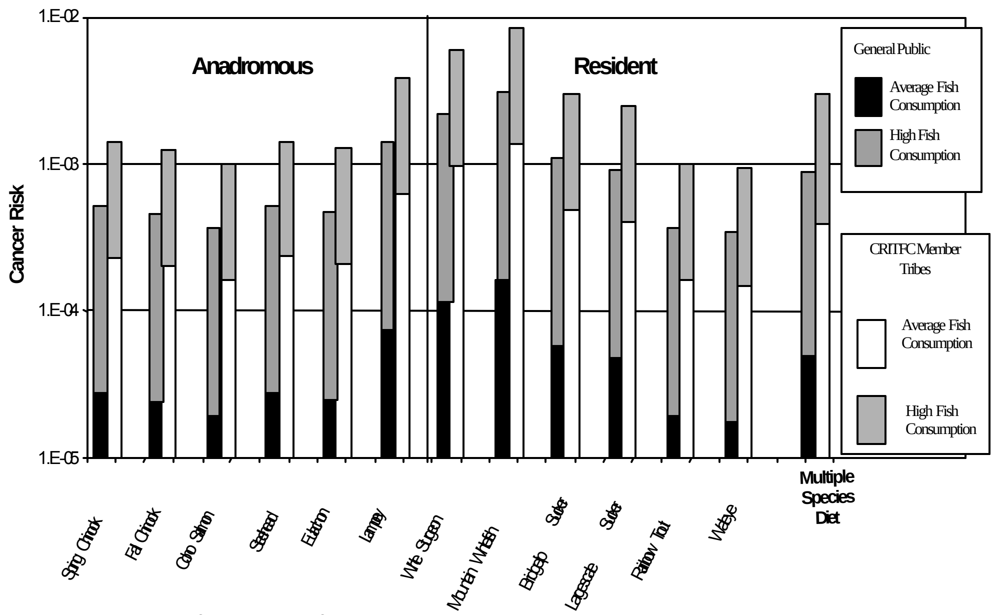
Figure 6-35 shows the total non-cancer hazard indices and Figure 6-36 shows the total cancer risks (70 years exposure) across all species with the results for the multiple-species diet shown for comparison. The results for both general public adult (average and high fish consumption) and CRITFC's member tribal adults (average and high fish consumption) using basin-wide data are included. For all four populations, the hypothetical diet of multiple species based on CRITFC's fish consumption survey was used. The non-cancer hazards and cancer risks for the multiple-species diet were lower than those for the most contaminated species (e.g., sturgeon and whitefish) and higher than those estimated for some of the least contaminated species (e.g., salmon, steelhead, rainbow trout, and eulachon).

These results demonstrate that the non-cancer hazards and cancer risks previously discussed in Sections 6.2.1 and 6.2.2 for individual species may not adequately reflect the cancer risks and non-cancer hazards for CRITFC's member tribes or other individuals from the general public whose diets are composed of a mixture of fish types from the Columbia River Basin.



*Fillet with skin samples except for white sturgeon (fillet without skin) and bridgelip sucker and eulachon (whole body)

Figure 6-35. Adult total hazard indices for all fish species, with multiple-species diet results. Basin-wide average data.



*Fillet with skin samples except for white sturgeon (fillet without skin) and bridgelip sucker and eulachon (whole body)

Figure 6-36. Adult cancer risks for all species, with multiple-species diet results. Columbia River Basin-wide average chemical concentration data. 70 years exposure.

6.2.6 Risk Characterization Using Different Assumptions for Percent of Inorganic Arsenic

As discussed in Section 5.3.3, total arsenic was measured in fish tissue samples in this study. Because a reference dose and cancer slope factor are available for only inorganic arsenic, an assumption about the percent of inorganic arsenic in fish had to be made to estimate the non-cancer hazards and cancer risks from consuming fish. The non-cancer hazards and cancer risks discussed in Section 6.2.1 and 6.2.2, respectively, assumed that for all fish species (resident fish and anadromous fish) caught in this study, 10% of the total arsenic was inorganic arsenic. The studies used to derive this value of 10% and the rationale for its selection were discussed in Section 5.3.3. The data in Section 5.3.3 also suggests that an alternative assumption for anadromous fish species could be considered - the assumption that 1% of the total arsenic was inorganic. Therefore, the non-cancer hazards and cancer risk were recalculated for anadromous fish species using basin-wide data assuming that 1% of the total arsenic was inorganic. The assumption of 1% inorganic arsenic for anadromous fish species in effect results in a contaminant level for arsenic that one tenth of that assuming that 10% was inorganic arsenic.

Table 6-25 shows the impact of the two different assumption (10% and 1% inorganic) on the estimated total hazard indices for anadromous fish species using basin-wide data. These results are shown for general public and CRITFC's member tribal adults at both the average and high fish consumption rates. As can be seen from this table and from Figure 6-37, assuming that 1% of total arsenic was inorganic rather than 10%, the total hazard indices were reduced by 2% for lamprey, 6% for coho and steelhead, and 11% for spring and fall chinook. However, for eulachon, the assumption of 1% inorganic arsenic reduces the total basin-wide hazard index for this fish species by 56%. The effect of this assumption on risks due to ingestion of eulachon was consistent with the data in Table 6-7 which showed the percent contribution of different contaminants on the basin-wide total hazard indices for anadromous fish species. Arsenic contributed from about 2% to 13% to the total hazard index for salmon, steelhead, and lamprey but about 60% to that for eulachon. Thus, assuming that inorganic arsenic represents 1% rather than 10% of total arsenic had the largest impact on the total non-cancer hazards for eulachon (a 56% reduction in the total hazard index) and less of an impact on the other anadromous fish species.

Table 6-25. Total hazard indices (HIs) for adults assuming that total arsenic is 1% versus 10% inorganic arsenic. Exposure concentrations used to estimate risks are Columbia River Basin-wide averages of fish tissue samples

Species	N	Tissue Type	Percent Inorganic Arsenic as Total Arsenic	Percent Decrease In Total HI Assuming 1% Inorganic Arsenic	Average Fish Consumer – Total HI – general public	Average Fish Consumer – Total HI – CRITFC member tribe	High Fish Consumer – Total HI – general public	High Fish Consumer – Total HI – CRITFC member tribe
coho salmon	*3*	FS	10		0.3	2.5	5.7	15.7
			1	6	0.3	2.4	5.4	14.8
spring chinook	*24*	FS	10		0.3	2.1	4.8	13.0
			1	11	0.2	1.9	4.2	11.6
fall chinook	*15*	FS	10		0.2	2.0	4.4	12.0
			1	11	0.2	1.7	3.9	10.7
steelhead	*21*	FS	10		0.3	2.6	5.7	15.7
			1	6	0.3	2.4	5.4	14.8
eulachon	*3*	WB	10		0.1	0.4	1.0	2.7
			1	56	0.0	0.2	0.4	1.2
Pacific lamprey	*3*	FS	10		0.5	4.5	10.1	27.7
			1	2	0.5	4.4	9.9	27.1

N= Number of samples; FS = fillet with skin; WB = whole body

Total HI is determined by summing all hazard quotients regardless of health endpoint.

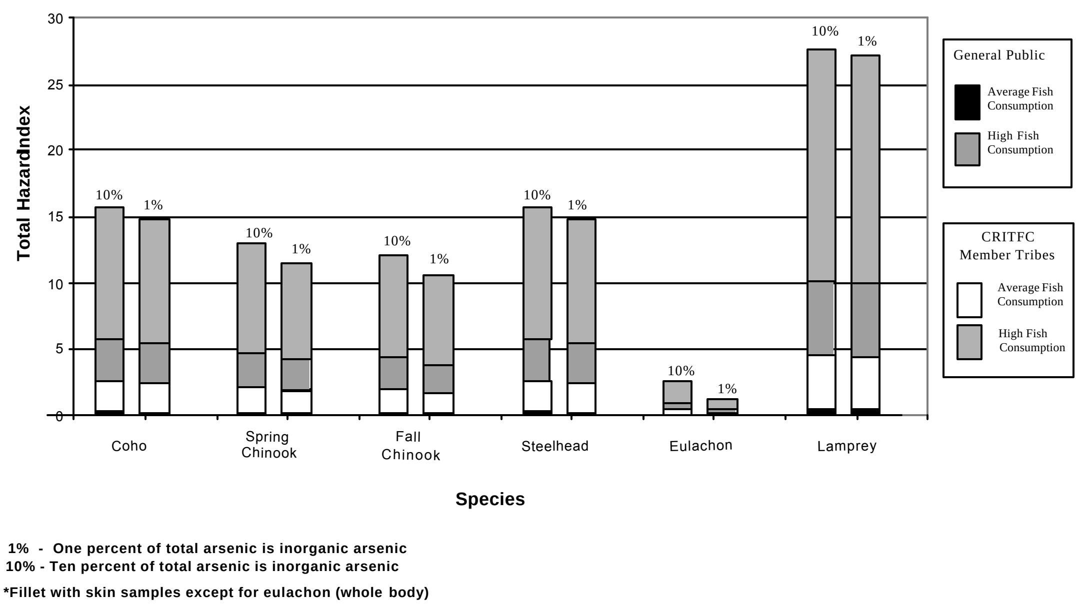


Figure 6-37. Impact of percent inorganic arsenic on total hazard index. Basin-wide data for anadromous fish species*.

Tables 6-26 and Figure 6-38 show the impact of the two different assumptions (10% and 1% inorganic arsenic as total arsenic) on the estimated total cancer risks for anadromous fish species using basin-wide data. These results are shown for general public and CRITFC's member tribal adults at both the average and high fish consumption rates and 70 years of exposure. Assuming that 1% of total arsenic was inorganic versus 10%, the cancer risks were reduced about 6% for lamprey, 29% for steelhead, and between 40% to 52% for coho, spring chinook, fall chinook and eulachon. These results are consistent with those previously discussed for Table 6-17 (percent contribution of different contaminants on the basin-wide total cancer risk for anadromous fish species) which showed that arsenic was a major contributor to the total cancer risks for all anadromous fish species except Pacific lamprey.

Table 6-26. Estimated total cancer risks for adults assuming that total arsenic was 1% versus 10% inorganic arsenic 70 years exposure. Exposure concentrations used to estimate risks are Columbia River Basin-wide averages of fish tissue samples.

					Average Fish Consumer		High Fish Consumer	
					Total Cancer Risk			
Species	N	Tissue Type	Percent Inorganic Arsenic as Total Arsenic	Percent Decrease In Total Cancer Risk Assuming 1% Inorganic Arsenic	general public	CRITFC member tribe	general public	CRITFC member tribe
coho salmon	*3*	FS	10		1.9E-05	1.6E-04	3.7E-04	1.0E-03
			1	40.4	1.1E-05	9.7E-05	2.2E-04	6.0E-04
spring chinook	*24*	FS	10		2.8E-05	2.3E-04	5.2E-04	1.4E-03
			1	44.6	1.5E-05	1.3E-04	2.9E-04	7.9E-04
fall chinook	*15*	FS	10		2.4E-05	2.0E-04	4.6E-04	1.3E-03
			1	48.4	1.2E-05	1.1E-04	2.4E-04	6.5E-04
steelhead	*21*	FS	10		2.8E-05	2.3E-04	5.3E-04	1.4E-03
			1	29.3	2.0E-05	1.7E-04	3.7E-04	1.0E-03
eulachon	*3*	WB	10		2.5E-05	2.1E-04	4.7E-04	1.3E-03
			1	52.0	1.2E-05	1.0E-04	2.3E-04	6.2E-04
Pacific lamprey	*3*	FS	10		7.4E-05	6.2E-04	1.4E-03	3.8E-03
			1	6.1	6.9E-05	5.8E-04	1.3E-03	3.6E-03

N = Number of samples; FS = fillet with skin; WB = whole body

This comparison of the results from using the two different assumptions (1% versus 10%) for inorganic arsenic in fish shows that the reduction on the total non-cancer hazards was less than 12% for all anadromous fish species, except eulachon which had about a 50% reduction. However, the impact was greater on the estimates of cancer risk. With the exception of lamprey for which cancer risks were reduced by only 6%, the reductions in cancer risks for steelhead was about 29% and for the other anadromous fish species ranged from about 40 to 50%.

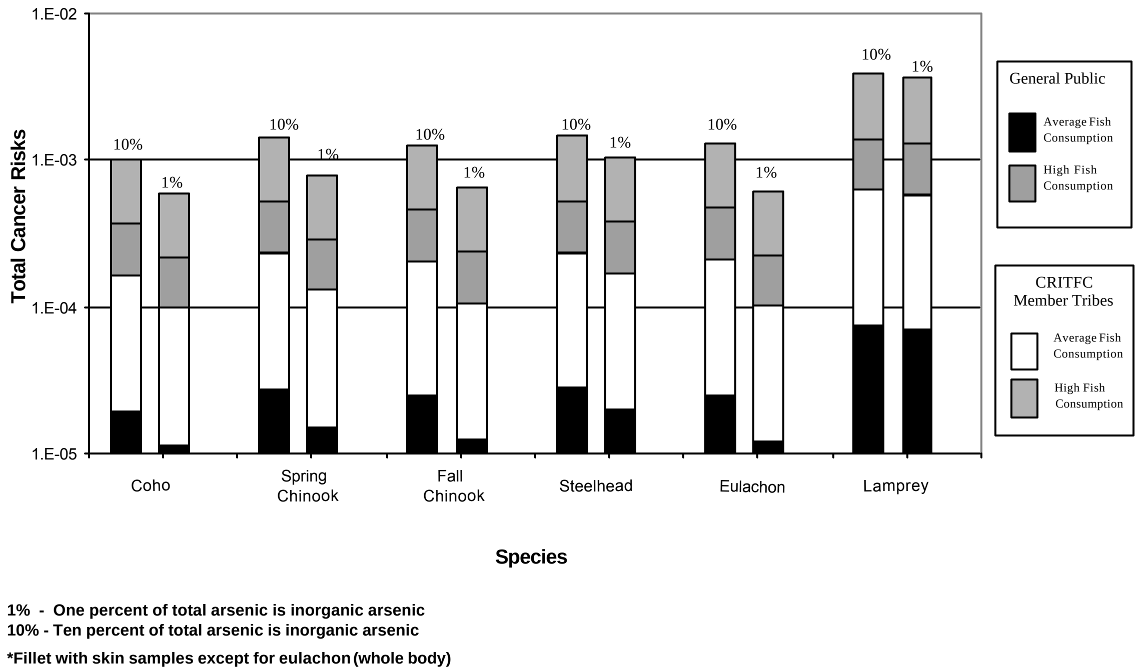


Figure 6-38. Impact of percent inorganic arsenic on cancer risks. Basin-wide data for anadromous fish species.

7.0 Lead Risk Assessment

Lead health risks are presented separately because lead health risk methods are unique owing to the ubiquitous nature of lead exposures and the reliance on blood lead concentrations to describe lead exposure and toxicity. Lead risks are characterized by predicting blood lead levels with models and guidance developed by EPA available from the following web site: http://www.epa.gov/superfund/programs/lead/prods.htm - software. In this assessment, lead exposure from fish consumption is added to all other likely sources of lead exposure to predict a blood lead level. Both the Integrated Exposure Uptake Biokinetic Model (IEUBK) for children and the EPA Adult Lead Model for the fetus predict blood lead levels from a given set of input parameters. There is no other model for lead exposures except the Adult Lead Model, so it is used for children and fetuses.

In contrast to risk assessments for cancer or non-cancer risks, lead risk assessments typically use central tendency exposure values to predict a central tendency (geometric mean) blood lead level. The predicted geometric mean blood lead level is then used in conjunction with a modeled log-normal distribution to estimate the probability of exceeding a target blood lead level of 10 µg/dl. Blood lead levels are a measure of internal dose that has been related to many adverse health effects (NRC, 1993). The emphasis on blood lead integrates exposure, toxicity and risk, which are more distinct in other types of risk assessment. For other chemicals, risk is described in terms of an external dose (e.g. mg/kg-day).

The IEUBK Model was used to predict blood lead levels in children up to 72 months of age (USEPA, 1994a,b). The EPA Adult Lead Model was used to predict blood lead levels in fetuses (USEPA, 1996b). This section on lead risk assessment is organized into separate discussions of the two lead models. Each of the two lead models was run using both central tendency and high end rates of fish ingestion. Central tendency rates of fish ingestion were used to predict both geometric mean blood lead levels and the probability of exceeding a blood lead level of 10 µg/dl in both children and fetuses. For the high end fish ingestion rates, only the most likely blood level could be predicted; it is not appropriate to predict the probability of exceeding 10 µg/dl associated with high end fish consumption.

7.1 Lead Concentrations in Fish

Study sites, collection methods, analytical methods, and quality assurance plans are discussed in Section 1; concentrations of lead in fish are discussed in Section 2. Whole fish had substantially higher lead levels because lead tends to concentrate in the bones and gills (Ay et al., 1999). Note that the maximum in the concentration scale for whole fish is 500 µg/kg and 100 µg/kg for fillets (Table 2-14). The highest individual sample was 1200 µg/kg in a fall chinook salmon taken from Station 14 on the Columbia River. For fish tissue samples with undetected lead concentrations, a value of half the detection limit was used (5 µg/kg) in all risk estimates.

7.2 Overview of Lead Risk Assessment Approach

Risk assessment methods for lead differ from other types of risk assessment because they integrate all potential sources of exposure to predict a blood lead level. Lead in the blood reflects all sources of lead exposure, regardless of its origin. Lead risk assessments reflect the widespread distribution of lead in the environment. Common sources of lead in the environment include residual contamination from past uses of lead in gasoline, paint, agricultural chemicals, and industrial sources including lead mining and smelting (NRC, 1993). People are exposed to lead through ingestion of soil and dust, inhalation of lead from the air, and consuming food with background concentrations of lead. Lead can enter drinking water through contamination of surface and groundwater as well as leaching from lead pipes and solder in plumbing systems. All of these sources and exposure pathways are included in the models used to assess lead risks. The IEUBK model is used to simulate lead exposures from air, water, diet, soil, and house dust. The Adult Lead Model accounts for the same sources of lead exposure by using a baseline blood lead level derived from the National Health and Nutrition Examination Survey (USEPA, 1996b).

Risk assessment methodologies for substances other than lead utilize a combination of central tendency and high end exposure values to estimate an aggregate reasonable maximum exposure scenario. A point value for risk derived using a reasonable maximum exposure scenario is accepted as being protective of public health. Public health protection using lead risk assessment methodology derives from a limit on the acceptable predicted blood lead values. An acceptable risk for lead exposure typically equates to a predicted probability of no more than 5% greater than the 10 µg/dl level (USEPA, 1998b)

Risk, expressed as predicted blood lead levels, was calculated in two ways for children and fetuses. The first, and more typical, method used median fish ingestion rates to predict: 1) a geometric mean blood lead level and 2) the corresponding risk of exceeding a blood lead level of 10 µg/dl. The probability of exceeding 10 µg/dl was calculated with a log-normal risk model based on the model's output (the geometric mean blood lead level) and an assumed geometric standard deviation. In the second method, high-end fish ingestion rates were used to predict blood lead levels for children or mothers who consume large amounts of fish. Because the resultant high-end fish ingestion prediction does not represent a geometric mean blood lead level, the geometric standard deviation could not be applied to predict the probability of exceeding 10 µg/dl. Predicted blood lead levels resulting from high-end fish consumption scenarios represent the most likely blood lead levels associated with high-end consumption rates.

The adverse health effects of lead have been related to blood lead concentrations in units of micrograms of lead per deciliter of whole blood (µg/dl). As a result, blood lead levels have evolved as measures of exposure, risk, and toxicity. Since 1991, the national level of concern for young children and fetuses has been 10 µg/dl (CDC, 1991). An analogous level has not been defined for other groups, but children and the developing fetus are accepted as being especially vulnerable to lead because lead interferes with the development of the central nervous system (NRC, 1993). Lead risks were evaluated by comparing predicted blood lead levels to the 10 µg/dl standard and by determining the expected percentage to exceed the 10 µg/dl criterion.

Adverse health effects observed at a blood lead level of 10 µg/dl are sub-clinical, meaning that, these effects cannot be diagnosed in an individual. The adverse health effects include cognitive deficits in IQ and learning, based on numerous scientific studies involving comparisons of large groups of children to control for confounding factors and account for the natural variability in cognitive function (NRC, 1993; USDHHS, 1999; CDC, 1991). The studies have incorporated both cross-sectional and longitudinal designs. The importance of primary prevention of lead exposure has been highlighted by recent studies suggesting adverse health effects at blood lead levels less than 10 µg/dl and the failure of chelation treatment to prevent cognitive impairments in treated children (Lanphear et al., 2000; Rogan et al., 2001; Rosen and Mushak, 2001).

Children are the population of greatest concern for lead exposure. Blood lead levels tend to peak in children as they become more mobile and begin to explore their surroundings. Blood lead levels normally peak at approximately 30 months of age when children are especially vulnerable to neuro-behavioral deficits (Rodier, 1995;Goldstein, 1990). The adverse effects of low-level lead poisoning can result from relatively short-term exposures on the order of months, as opposed to periods of years or longer for other chemicals. The fetus is vulnerable to the same developmental and neuro-behavioral effects as children. Although lead is harmful to fetuses, children are a greater concern because they generally have higher exposures than fetuses. Fetal exposures are lower because exposures to mothers are typically lower than exposures to children. These and other health effects are described in further detail in Appendix C (Toxicity Profiles).

7.3 Method for Predicting Risks to Children

In contrast to risk assessment methodologies for predicting cancer or non-cancer risks, the lead models rely on central tendency exposure values to predict a central tendency (geometric mean) blood lead level. The predicted geometric mean blood lead level is then used in conjunction with an assumed geometric standard deviation to estimate the probability of exceeding a target blood lead level of 10 µg/dl established by the Centers for Disease Control (CDC, 1991). In this way, central tendency exposure estimates are used to estimate upper percentile blood lead levels. An example graph of an IEUBK Model run depicting the geometric mean and percent greater than 10 µg/dl is shown in Figure 7-1. In the IEUBK model, a geometric mean blood lead level of 4.6 µg/dl corresponds to a 5% chance of exceeding 10 µg/dl using the default geometric standard deviation of 1.6 (USEPA, 1994b). Although lead risk assessment methods differ from that employed for other chemicals, the goal of protecting highly exposed individuals remains the same.

The geometric standard deviation accounts for the variation in blood lead observed in children exposed to similar environmental concentrations of lead. The variation in observed blood lead levels is attributed to differences in the children (behavior and metabolism); not the environment. Because the geometric standard deviation accounts for behaviors that determine exposure levels to lead, applying the geometric standard deviation to high contact rate behaviors, including fish ingestion, would over-estimate the variability and over-predict the probability of exceeding 10 µg/dl.

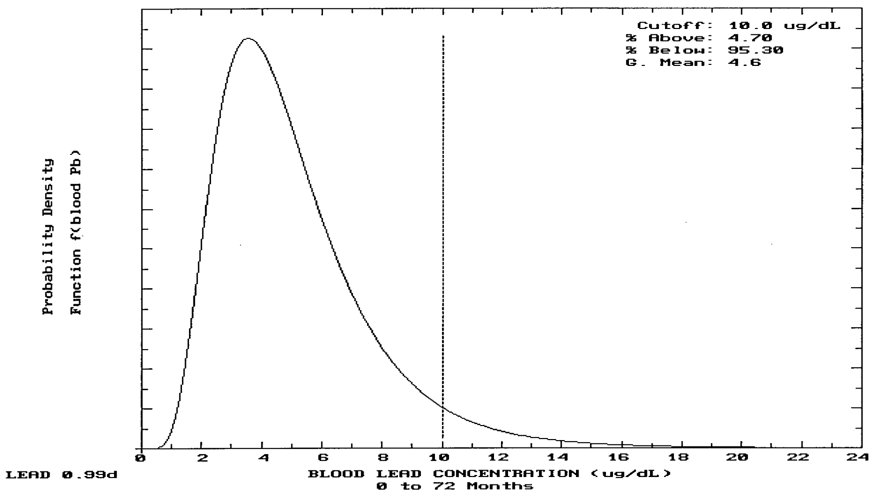


Figure 7-1. Sample IEUBK Model for Lead Output Graph.

Running the IEUBK Model with high-end fish consumption rates predicts the most likely blood lead levels for people eating large amounts of fish, although, the result does not correspond to the geometric mean of a population consuming different amounts of fish. Blood lead predictions for highly exposed individuals facilitate comparison of lead risks to risks from other chemicals, but results from high-end exposure inputs preclude application of the geometric standard deviation to calculate risks of exceeding a 10 µg/dl blood lead level. Risks to highly exposed individuals are typically characterized by the 95th percentile of the blood lead distribution centered around the predicted geometric mean blood lead rather than using the high-end fish ingestion values.

The IEUBK Model was run with all exposure parameters set to default levels with the addition of dietary lead intake attributable to lead in fish tissue for the full range of lead concentrations observed. Default exposure parameters are based on national average levels of lead in air, water food, soil, and dirt (Table 7-1) and described in detail in EPA guidance (USEPA, 1994b).

Table 7-1. Default Input Parameters Used for the IEUBK Model Adapted from (USEPA,1994b)

Input Parameter		Value
Soil lead concentration		200,000 µg/kg
House dust lead concentration (proportion of soil in dust = 0.7)		140,000 µg/kg
Combined soil and dust ingestion rate by age:		
	0-11 months	85 mg/day
	12-23 months	135 mg/day
	24-35 months	135 mg/day
	36-47 months	135 mg/day
	48-59 months	100 mg/day
	60-71 months	90 mg/day
Lead concentration in Air		0.10 :g/cubic meter
Lead concentration in drinking water		4 :g/liter

The default concentrations of lead in soil and house dust are representative of average, national conditions. The default concentrations for lead in soil and house dust are 200,000 µg/kg and 140,000 µg/kg respectively (USEPA, 1994b). These values are appropriate for urban areas and are likely to exceed the expected concentrations in rural areas surrounding the Columbia River because lead levels increase with urbanization. A recent survey of 50 homes from small, rural towns in Northern Idaho found soil lead concentrations less than 100,000 µg/kg (Spalinger et al., 2000). These concentrations would not account for severe lead paint contamination. Lack of data on specific soil and house dust concentrations remains a large source of uncertainty in this evaluation because soil and dust in the home account for a large proportion of lead exposure in young children (Manton et al., 2000) (Lanphear et al., 1998).

The IEUBK model has the capability to simulate exposures to locally grown vegetables, game, and fish. The IEUBK default values for soil, house dust, air, diet, and water were used in conjunction with an age-specific median fish ingestion rate of 16.2 g/day based on the fish consumption survey of CRITFC's member tribes (CRITFC, 1994). Fish ingestion was specified as the percentage of meat (Table 7-2) consisting of locally caught fish and the lead concentrations in the fish. There are other ways to simulate fish ingestion in the IEUBK Model (e.g. by specifying dietary lead intakes as µg/day), but it was preferred to specify fish ingestion as a percentage of meat to preserve the caloric and protein intake assumptions of the model. This approach substitutes fish for other protein sources rather than adding fish to the default diet. This approach conforms with IEUBK body weight and biokinetic assumptions and is described in EPA guidance (USEPA, 1994b).

Table 7-2. Input Parameters Used in the IEUBK Model Meat Consumption Rate by Age in the IEUBK model Adapted from (USEPA, 1994b)

Age Range (months)	Meat Consumption grams/day
12-24	87
25-36	96
37-48	102
49-60	107
61-72	112
Average	101

The CRITFC study examined Columbia River fish consumption in young children as surveyed by their parents. This study was selected as the most relevant study to assess the Columbia River lead hazard for all children because it is specific to the place, CRITFC's member tribes, and the age range specified by the IEUBK (CRITFC, 1994). The tribal ingestion rates are likely to overestimate fish consumption for non-tribal members. Because the CRITFC study presents consumption rates for children up to 72 months of age, the IEUBK Model was run for the same age range.

To facilitate comparisons between risks from lead and other chemicals presented in Section 6, the ingestion rates used for other chemicals are summarized in Table 7-3. Fish ingestion rates used to estimate risks from chemicals other than lead are based on mean and 99th percentiles of both the CRITFC survey and national data for the general public described in Section 4 of this report.

The distribution of child fish consumption rates from the CRITFC study is statistically skewed because it included individuals with very high fish consumption rates relative to others. For skewed data, the arithmetic mean is not an appropriate measure of central tendency because it is highly influenced by the individuals with large fish consumption rates. The median (50th percentile) is a preferred central tendency measure of skewed data because it is less sensitive to extreme values. The fish consumption data for CRITFC's member tribes (CRITFC, 1994) were re-analyzed to omit children who did not consume fish from the data set (Kissinger and Beck, 2000). The re-analysis calculated a median consumption rate occurred between 13 and 16.2 g/day, the 39th and 65th percentiles, respectively (see Table 7-4). Rather than interpolate a median value of 14.4 g/day between the 39th and 65th percentiles, the higher value was selected as a protective central tendency consumption rate.

Table 7-3. Fish Ingestion Rates (grams/day) Used to Assess Risk for Lead and other Chemicals

	Target Population					
Assessment	**Lead**		**Non-lead**		**Non-lead**	
Population	Native American		Native American		General Public	
Exposure Level	Central	High End	Central	High End	Central	High
	Mother and Fetus		Adult		Adult	
Ingestion Rate	39.2	389	63.2	389	7.5	142.4
Basis	50th CRITFC	99th CRITFC	Mean CRITFC	99th CRITFC	Mean EPA	99th
Age Range	Children < 72 Months		Children < 72 Months		Children < 15 years	
Ingestion Rate	16	101	24.8	162	2.83	77.95
Basis	50th CRITFC	IEUBK MAX*	Mean CRITFC	99th CRITFC	Mean	99th

* A fish ingestion rate of 101 g/day assumes that locally caught fish comprise 100% of all dietary protein sources and represents an upper constraint of the IEUBK Lead Model for Children

Table 7-4. Percentages of Child Fish Consumption Rates for Consumers of Fish From (Kissinger and Beck, 2000) analysis of (CRITFC, 1994)

Grams/day	Cumulative Percent	Grams/day	Cumulative Percent	Grams/day	Cumulative Percent
0.4	1%	8.1	33%	32.4	84%
0.8	1%	9.7	35%	48.6	89%
1.6	5%	12.2	38%	64.8	93%
2.4	5%	13.0	39%	72.9	95%
3.2	9%	16.2	65%	81.0	97%
4.1	14%	19.4	66%	97.2	98%
4.9	16%	20.3	67%	162.0	100%
6.5	18%	24.3	70%		

7.4 Risk Characterization for Children

Predicted blood lead levels spanning the full range of observed fish tissue concentrations are shown in Figure 7-2. Predicted geometric mean blood lead levels are plotted on the left axis with a solid line. The corresponding probabilities of exceeding 10 µg/dl are shown as percentages on the right axis with a dashed line. Each of the 11 pairs of points represents a separate IEUBK Model run at successively increasing concentrations of lead in fish. These results indicate that for fish containing lead up to 500 µg/kg, the probability of achieving a blood lead level greater than 10 µg/dl is no more than 5% and the predicted geometric mean blood lead level is 4.6 µg/dl. For comparison, only the average concentration of whole body eulachon had a lead concentration of 500 µg/kg. The next highest whole fish species is fall chinook, with an average lead concentration of 220 µg/kg. Average lead concentrations in all other whole fish and fillet samples occur well below 500 µg/kg and concentrations in fillets averaged 200 µg/kg (Table 2-14).

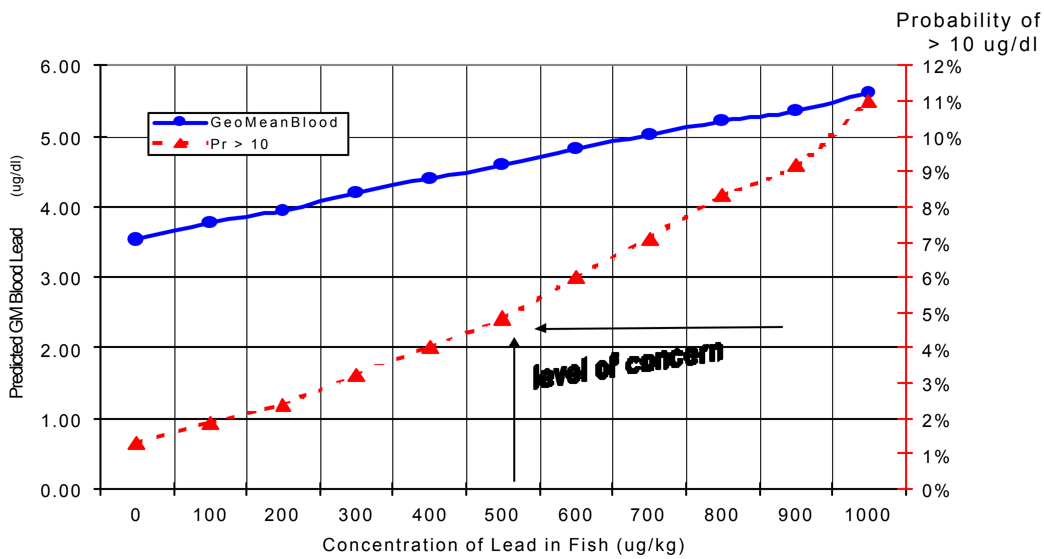


Figure 7-2. Predicted blood lead levels for children who consume of fish collected from the Columbia River Basin assuming fish is 16% of dietary meat.

To explore the effect of an extremely high fish consumption rate in children, the IEUBK Model was run assuming that fish replaced 100% meat in the diet (101 g/day) (Figure 7-3). The IEUBK Model was run repeatedly to determine the fish tissue concentration associated with a predicted blood lead level of 10 µg/dl. A lead concentration of 500 µg/kg in fish tissue corresponded to a predicted blood lead concentration of 10 µg/dl. This is the same concentration associated with a 5% risk of exceeding 10 µg/dl under the 16.2 g/day fish consumption scenario described in the previous paragraph.

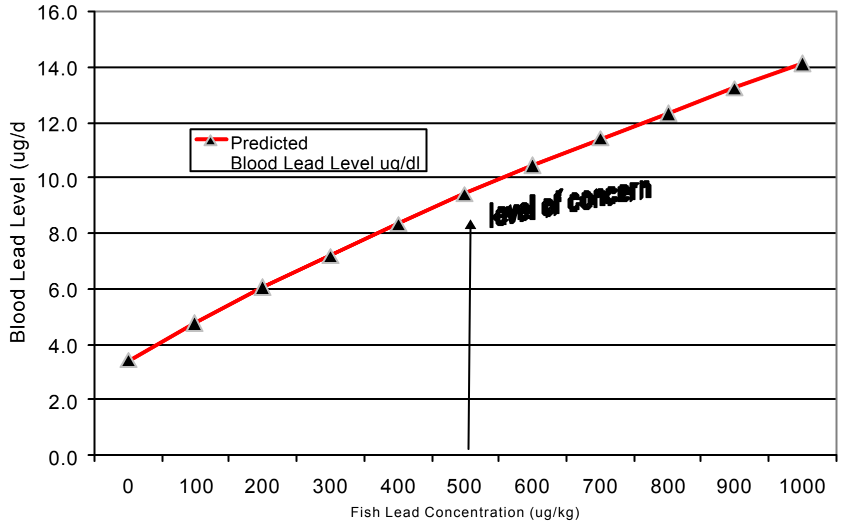


Figure 7-3. Predicted blood lead levels for children (0-72 months) who consume 101 g/day of fish collected from the Columbia River Basin, 1996-1998.

7.5 Uncertainties in risk estimates for Children

Lead risk assessment methods are unique because they use cumulative exposures to predict blood lead levels in contrast to methods used for other chemicals which generally limit evaluation of exposures to discreet sources. Because lead risks are cumulative, uncertainties are compounded by the many sources of exposure in addition to uncertainties arising from fish consumption. In children, lead exposure occurs primarily from lead in soil and house dust rather than from typical dietary sources (Manton et al., 2000). Sources of lead exposure common to children and fetuses include industrial or agricultural sources, occupational exposures, and environmental lead originating from gasoline or leaded paint. Occupational exposures can track contaminants from the workplace into the home, potentially spreading exposure among children and adults in a household (Fenske et al., 2000). A major source of uncertainty in this risk assessment may be attributable to sources of lead other than Columbia River fish. The magnitude of lead exposure from fish consumption varies with selection of fish parts eaten (e.g. whole versus fillet), species of fish, and the study site of the fish relative to sources of lead contamination.

The IEUBK model is normally used to simulate blood lead levels for children up to 84 months of age. However, because the fish consumption data from the CRITFC study were reported for children up to 72 months of age, IEUBK evaluation was limited to 72 months. A 72-month model run predicts higher blood lead concentrations than an 84-month model run because blood lead levels peak during the first 36 months. In the absence of data to estimate specific, concurrent residential exposures, the default concentrations of lead in soil and house dust represent a large source of uncertainty in the IEUBK evaluation because these sources are expected to account for most of the lead exposure to young children. However, the default soil and dust concentrations are unlikely to underestimate average levels of lead in the homes.

7.6 Method for Predicting Risks to Fetuses

The Adult Lead Model begins with a baseline blood lead level for adult women and then predicts an incremental increase in blood lead levels associated with an increase in exposure that is not included in the baseline blood lead levels (USEPA, 1996b and USEPA, 1999a). In the Adult Lead Model, fetal blood lead levels are set equal to 90% of the mother's blood lead level. If the baseline blood lead reflects the modeled incremental exposure, then the exposure is counted twice and the modeled blood lead level would be too high. In this study, the Adult Lead Model was used to evaluate fish ingestion as the source of incremental exposure greater than the baseline blood lead level.

The assumptions used in this approach include:

1) Lead exposures from all sources except consuming fish from the Columbia River are captured in the baseline blood lead level, based on high end estimates from national blood lead surveys, and
2) incremental ingestion of fish is not included in the baseline blood lead level.

Selection of a high baseline blood lead level minimized the possibility of underestimating risk. The lead ingested from fish is converted to a blood lead level by using a constant ratio of an increase in blood lead concentration associated with a mass of absorbed lead. This ratio is the Biokinetic Slope Factor (BKSF). The baseline blood lead level, the blood level in the absence of lead exposure via Columbia River fish ingestion, is critical to this calculation. A complete listing of all the Adult Lead Model input values is included in Table 7.5.

The equations used in the Adult Lead Model are (USEPA 1999b):

Equation 7-1
Adult Blood Lead Level = Baseline Blood Lead Level + Increase in Blood Lead

Equation 7-2
Increase in Blood Lead =
*[(BKSF) * Fish Ingestion Rate * Fish Concentration *Absorbed Fraction for Fish]*

Equation 7-3
*Fetal Blood Lead = Adult Blood * 0.9*
Equation 7-4

Probability that Fetal Blood Lead is greater or equal to 10 µg/dl using the z-value where:

z = ln (10)-ln (Fetal Blood Lead)/ln (Geometric Standard Deviation)

Analysis of the lead hazard associated with adult consumption of Columbia River fish was conducted using the formula:

Equation 7-5 $PbB_{adult,\ central} = PbB_{adult,0} + BKSF * (PBF * IR_F * AF_F * EF_F) / AT$

Table 7-5. Input Parameters Used for the EPA Adult Lead Model

Variable	Description	Value Used
$PbB_{adult,0}$	Adult blood lead concentration in the absence of other lead exposure.	Central 1.7 µg/dl High End 2.2 µg/dl
BKSF	Biokinetic slope factor relating the (quasi-steady state) increase in blood lead concent	
PbF	Fish lead concentration	full range of values: 0-1000 µg/kg
IR_F	Intake rate of fish in g/day median of CRITFC Adult Consumers	39.2 g/day
AF_F	Absolute gastrointestinal absorption factor for ingested lead in fish (dimensionless)	0.10
EF_F	Exposure frequency for ingestion of fish (days of exposure during the averaging period); may be taken as days per year in continuing long term exposures.	365 days per year
AT	Averaging time, the total period during which exposure may occur	365 days per year

Because study site-specific baseline blood lead levels and geometric standard deviations are not available for consumers of Columbia River fish, the Adult Lead Model was run using both central tendency and high-end estimates of the baseline blood lead level and the geometric standard deviation described in (USEPA, 1996b). The larger baseline blood lead level increased the predicted blood lead levels. An increase in the Geometric Standard Deviation increased the probability of exceeding 10 µg/dl. All input parameters are listed in Table 7.6.

Table 7-6. Adult Lead Model Baseline Blood Lead and Geometric Standard Deviations

Input Parameter	Baseline Blood Lead Level	Geometric Standard Deviation
Central Values	1.7 µg/dl	1.8
High End Values	2.2 µg/dl	2.1

Fish ingestion rates for adult consumers of Columbia River fish are based on the median ingestion rate of 39.2 g/day interpolated from Table 10 of the 1994 CRITFC consumption survey (CRITFC, 1994). Consumption rates were reported as 38.9 g/day and 40.5 g/day for the 49^{th} and 53^{rd} percentiles respectively (CRITFC, 1994). For comparison, EPA provides a mean estimate of national per capita fish consumption of 7.5 g/day (USEPA, 2000b). The Model was also run using the 99^{th} percentile ingestion rate from the CRITFC survey (389 g/day) to facilitate comparison with the risks from chemicals other than lead (Table 7.1).

7.7 Risk Characterization for Fetuses

The Adult Lead Model was used to evaluate potential lead risks to the fetus following maternal consumption of Columbia River fish. Predicted fetal geometric mean blood lead levels and associated probabilities of exceeding the 10 µg/dl for a range of lead levels in fish are summarized in Figures 7-4 and 7-5. Figure 7-4 shows results using the maximum recommended exposure parameters for the baseline blood lead level of 2.2 µg/dl and geometric standard deviation of 2.1 (USEPA, 1996b). Figure 7-5 is identical to Figure 7-4, but uses central tendency estimates of baseline blood lead level of 1.7 µg/dl and geometric standard deviation of 1.8. Although, the predicted risks of exceeding 10 µg/dl are substantially higher in Figure 7-4, the fish concentration associated with a 5% risk of exceeding 10 µg/dl is 700 µg/kg. Average fish concentrations in whole fish and fillets were 0.12 and 0.02 respectively. The highest lead concentrations were found in whole-body samples of eulachon with an average fish tissue concentration of 500 µg/kg lead. For the fetus of an adult consuming 39.2 grams of whole fish per day (129 µg/kg), the Adult Lead Model predicts that fetal blood lead levels will exceed 10 µg/dl less than 2% of the time using the high end values for baseline blood lead level and geometric standard deviation. Using high end values for baseline blood lead level and geometric standard deviation with the 389 g/day ingestion rate results in a predicted fetal blood lead level at a fish concentration of 600 µg/kg.

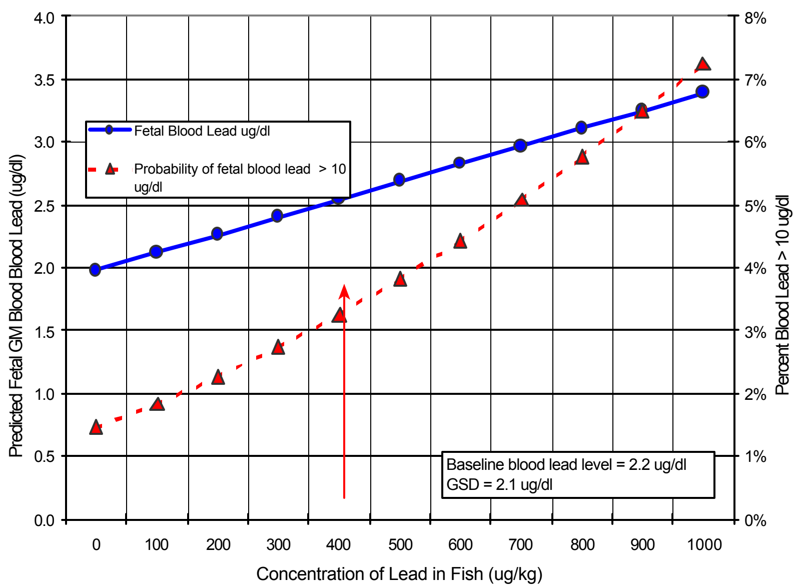


Figure 7-4. Predicted fetal blood lead levels with maternal fish ingestion rate of 39.2 g/day with baseline blood lead level at 2.2 µg/dl and GSD = 2.1 µg/dl.

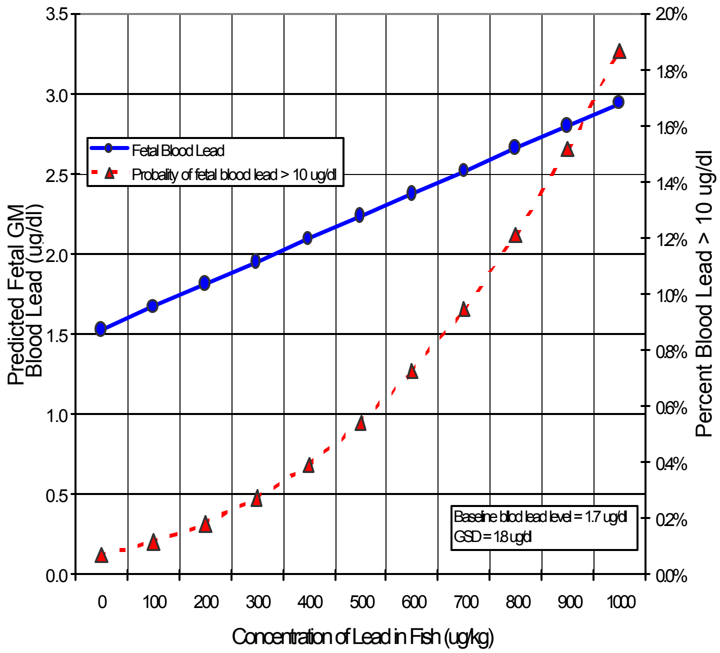


Figure 7-5. Predicted fetal blood lead level with maternal fish ingestion rate of 39.2 g/day with baseline blood lead level at 1.7 µg/dl and GSD = 1.8 µg/dl.

7.8 Uncertainty Analysis for Risk to Fetuses

Fetal risk estimates share common sources of uncertainties with the estimates for child risks including the assumed fish lead concentrations and fish consumption rates. Uncertainties unique to the Adult Lead Model include the assumed baseline blood lead level and geometric standard deviation parameters from the National Health and Nutrition Examination Survey (USEPA, 1996b). The results are based on the highest recommend values for the baseline blood lead levels and the geometric standard deviation. They are unlikely to underestimate risk.

7.9 Conclusions

Despite uncertainties in this assessment, lead levels in fish analyzed from the Columbia River occur at levels unlikely to cause a blood level greater than 10 µg/dl. Risks to children from fish consumption are unlikely to exceed 5% at lead concentrations less than 500 µg/kg (Figure 7-2, 7-3). Similarly, fetal risks are unlikely to exceed 5% at concentrations less than 700 µg/kg (Figure 7-4, 7-5). These levels of concern occur at lead concentrations near the maximum values of the samples. This conclusion is supported by several analyses using health protective exposure assumptions that are unlikely to underestimate risks from fish consumption. The exposure assumptions are based on default and high end exposure parameters recommended by EPA lead risk assessment guidance used in conjunction with fish ingestion rates from the CRITFC fish consumption survey (CRITFC, 1994) .

8.0 Radionuclide Assessment

8.1 Radionuclide Data Reporting and Use

A unique characteristic of some radionuclide analytical data is the occurrence of numerically negative results. Radionuclide analyses usually require the subtraction of an instrument background measurement from a gross sample measurement. Both results are positive, and when sample activity is low (close to background), random variations in measurements can cause the resulting net activity to be less than zero. Although negative activities have no physical significance, they do have statistical significance, as for example in the evaluation of trends or the comparison of groups of samples. Good practice for laboratory reporting of radionuclide analysis results therefore dictates reporting results as generated: whether positive, negative, or zero, together with associated uncertainties.

This is consistent with EPA guidance (USEPA, 1980a), which states: "When making measurements near background levels, one can expect to frequently obtain values that are less than the estimated lower limit of detection or minimum detectable concentration. If these values are not recorded and used in making average estimates, then these estimates are always going to be greater than the "true" representation in the environment. Therefore it is recommended that every measurement result should be recorded and reported directly as found."

The general principles for evaluation of radionuclide data for this project were:

a. It is generally best to use reported values plus the associated uncertainties.

b. Reported values are better estimates of actual concentrations than are minimum detectable concentrations.

c. J-qualified (estimated) data should not be used for quantitative purposes where unqualified data is available to substitute.

d. All reported data (including U-qualified (nondetect) data, should be used in averages.

e. Quantitative analyses should only be performed for those radionuclides which have at least one positive unqualified result reported.

f. For gamma data, the EPA's National Air and Radiation Exposure Laboratory (NAREL) reported minimum detectable concentration values for certain radionuclides of interest even in cases where the radionuclide was not detected and no value was reported. If these minimum detectable concentrations are used for quantitative analyses, the results should clearly note the use of minimum detectable concentration-based input. If minimum detectable concentrations are to be used for quantitative purposes, the minimum detectable concentrations may need additional decay corrections where holding times exceeded 10 half lives. This should not be an issue since no radionuclide with a half-life less than 10% of holding time was detected in any of the gamma analyses and therefore these short-lived radionuclides would not be used for analytical purposes.

8.2 General Information on Radiation Risk

Radiation is a known human carcinogen. As such, the models used to estimate risk from radiation exposure assume that at low levels of exposure, the probability of incurring cancer increases linearly with dose, and without a threshold.

All of the epidemiological studies used in the development of radiation risk models involve high radiation doses delivered over relatively short periods of time. Evidence indicates that the response per unit dose at low doses and dose rates from low-linear energy transfer radiation (primarily gamma rays) may be overestimated if extrapolations are made from high doses acutely delivered. The degree of overestimation is often expressed in terms of a dose and dose rate effectiveness factor that is used to adjust risks observed from high doses and dose rates for the purpose of estimating risks from exposures at environmental levels. EPA models for radiation risk include a dose and dose rate effectiveness factor of 2 applicable to most low-linear energy transfer radiation exposure. For high-linear energy transfer radiation (e.g. alpha particles), the differences in relative biological effect are accounted for in weighting factors applied in the calculation of dose and risk.

In addition to cancer risk, radiation can also represent a risk for hereditary effects. Radiation-induced genetic effects have not been observed in human populations, however, and cancers generally occur more frequently than genetic effects. The radiation-related risk of severe hereditary effects in offspring is estimated to be smaller than that for cancer. The risk of severe mental retardation from radiation exposure to the fetus is estimated to be greater per unit dose than the risk of cancer in the general population, but the period of susceptibility is very much shorter. Based on these considerations, EPA generally considers the risk of cancer to be limiting and uses it as the sole basis for assessing radiation-related human health risks.

The risk coefficients used in this risk assessment are derived using age-specific models and are age-averaged. This means that the risk coefficients are appropriate for use in estimating exposure over a lifetime, since they are derived by taking into account the different sensitivities to radiation as a function of age. The risk coefficients in this assessment may be used to assess the risk due to chronic lifetime exposure of an average individual to a constant environmental concentration. The risk estimates in this report are intended to be prospective assessments of estimated cancer risks from long-term exposure to radionuclides in the environment. The use of the risk coefficients listed for retrospective analyses of radiation exposures to populations should be limited to estimation of total or average risks in large populations. The risk coefficients are not intended for application to specific individuals or to specific subgroups.

Estimates of lifetime risk of cancer to exposed individuals resulting from radiological and chemical risk assessments may be summed to determine the overall potential human health hazard. It is standard practice, however, to tabulate the two sets of risk estimates separately. This is due to important differences in the two kinds of risk estimates. For many chemical carcinogens, laboratory experiments and animal data are the basis for estimates of risk. In the case of radionuclides, however, the data come primarily from epidemiological studies of exposure to humans. Another important difference is that the risk coefficients used for chemical carcinogens generally represent an upper bound or 95th percent upper confidence level of risk, while radionuclide risk coefficients are based on best estimate values.

8.3 Risk Calculations

Data qualifiers assigned during the data verification and validation process were used in making decisions about numerical values for input into risk calculations. Reported values were used with the following exceptions: zero was used where negative values were reported and one half of the reported minimum detectable concentration was used where the result was reported as minimum detectable concentration.

The naturally-occurring radionuclide potassium-40 (K-40) is a special case in the risk calculations. Potassium is an essential nutrient which contains the naturally radioactive isotope potassium-40, which has a half-life of more than one billion years. K-40 constitutes 0.01% of natural potassium which as a result has a specific activity of approximately 800 pCi/g of potassium. Variations in diet have little effect on the radiation dose received, since the amount of potassium in the body is under close hemostatic control. Although K-40 is the predominant source of radiation exposure from food, calculation of dose or risk for specific food pathways is not meaningful since the biological control of potassium content in the body (and hence the radiation dose due to potassium) means that the dose is independent of intake. Therefore, K-40 concentrations were not included in the calculations of cumulative risk from radionuclides in samples. K-40 concentrations and risks are discussed separately for comparison.

Quantitative analyses were performed only for those radionuclides which had at least one positive unqualified result reported. Those radionuclides and their associated risk coefficients are:

Radionuclide		Risk Coefficient (risk/Bq)
Uranium -234	(U-234)	2.58×10^{-9}
Uranium-235+D	(U-235+D)	2.63×10^{-9}
Uranium-238+D	(U-238+D	3.36×10^{-9}
Strontium-90+D	(Sr-90+D)	2.58×10^{-9}
Plutonium-239	(Pu-239)	4.70×10^{-9}
Bismuth-212	(Bi-212)	included in Th-228+D coefficient
Bismuth-214	(Bi-212)	included in Ra-226+D coefficient
Cesium-137+D	(CS-127+D)	1.01×10^{-9}
Potassium-40	(K-40)	9.26×10^{-10}
Lead-212(Pb-212)		included in Th-228+D coefficient
Lead-214(Pb-214)		included in Ra-226+D coefficient
Raon-224(Ra-224)		included in Th-228+D coefficient
Thorium-228+D	(Th-228+D)	1.14×10^{-8}
Radon-226+D	(Ra-226+D)	1.39×10^{-8}
Telllurim-208	(Tl-208)	included in Th-228+D coefficient

Risks

for individual radionuclides were calculated using morbidity coefficients for dietary intake from EPA guidance (USEPA 1999c). Many of the radionuclides detected are members of important naturally-occurring decay chains (e.g. Ra-226 series, Th-228 series). For these radionuclides, risks were calculated based on risk from the entire decay series in secular equilibrium. Risk coefficients representing the entire decay series (identified with "+D" designation) were derived by summing the risk coefficients for all decay chain members. For some decay series members (e.g. Po-218) no data is available in EPA guidance and these radionuclides were not included in the calculation of risk coefficients (USEPA, 1999d). Based on data for these radionuclides reported in HEAST the risks from radionuclides which are not included in EPA guidance are insignificant in comparison to the risks from the other members of the decay series for which EPA guidance provides data (USEPA, 1994c; USEPA, 1999d).

The general approach used in selecting data for input into decay series calculations was to:

1) use measured data wherever possible,
2) prioritize measured data in accordance with assigned data qualifiers, and
3) to use minimum detectable concentration values (minimum detectable concentrations) for input only when other sources of data were not available.

In selecting the value to use for the concentration of the radionuclide at the head of the chain, decay products were used as surrogates. This is consistent with the physical principles of radioactive decay and secular equilibrium. Where more than one decay product was available to act as surrogate, positive values were selected over nondetect. The largest positive value was used where two or more otherwise equally suitable results were available.

In cases where Tl-208 was used as a surrogate for the Th-228 decay series, the branching ratio of the Bi-212 decay (36% decaying to Tl-208) was taken into account. If no decay chain member data is available, one-half of the minimum detectable concentration value for Ra-226 was used for input into the calculation for the Ra-226+D subchain. Similarly, one-half the minimum detectable concentration for Ra-228 was used as input into the Th-228+D subchain calculation where necessary. In the case of Cs-137, if no gamma peak was reported, one-half of the Cs-137 minimum detectable concentration was used as input for this radionuclide.

If there was a choice between uranium data from uranium alpha analyses and from gamma analyses (e,g, U-235), the uranium alpha analysis data was used. Alpha analysis for uranium is a more sensitive technique than gamma analysis. In particular, U-235 analysis by gamma spectroscopy involves additional analytical uncertainty resulting from Ra-226 interference with the spectral line used to quantify U-235. If only the gamma data was available, it was used with appropriate consideration of data qualifiers.

Analytical results used for risk calculations included three samples which had a total of six "J" qualified (estimated) results among them. Five of these estimated values represented uranium isotopes which are expected to be present, and for which the estimated values represent the best available data for input into the risk calculation. In one case the estimated value used represented a result for Pu-239. These estimated values were included in the calculations for completeness, and their inclusion did not significantly alter the magnitude of the risks calculated.

8.4 Composite Study site Results

Plutonium, strontium and uranium analyses were not performed on all samples sent for radionuclide analysis. For some of the composite groups of samples (composites 53 (study site Columbia River 9U), 24 (study site Columbia River 7), and 25 (study site Columbia River 8), only gamma analyses were performed. Risks were calculated based on the gamma component of these samples only. Risks were calculated based on a nominal consumption rate of 1 gram per day and also for consumption rates of 7.5 g/day (average public consumption), 142.4 g/day (99th percentile public consumption), 63.2 g/day (average CRITFC's member tribe consumption) and 389 g/day (99th percentile CRITFC's member tribe consumption). These consumption rates are the same as used for the nonradionuclide risk analysis. Risks were calculated for a 70 year lifetime. Composites of particular interest include Composite 54 (study site -K-Basin ponds) and 30 (study site Snake River 13). Table 8-1 presents a summary of the calculated risks for each consumption rate.

8.4.1 Potassium-40 Results

As expected, the results for K-40 analyses are very consistent throughout the samples and represent one of the most prominent sources of radioactivity in all samples analyzed. The concentrations in samples ranged between 1.7 pCi/g and 3.7 pCi/g with an average value of 2.8 pCi/g. If this value were used to calculate risk in the same manner as the other radionuclides detected, the resulting calculated average risk would be 1×10^{-3}. As noted previously, however, although K-40 is the predominant source of radiation exposure from food, calculation of dose or risk for specific food pathways is not meaningful since the biological control of potassium content in the body (and hence the radiation dose due to potassium) means that the dose is independent of intake. Therefore, K-40 concentrations were not included in the calculations of cumulative risk from radionuclides in samples. K-40 concentrations and risks are presented separately for the purposes of comparison.

8.5 Background

As anticipated, many of the radionuclides present in naturally-occurring background were also present in the samples analyzed. The sampling and analysis for radionuclides was not designed to provide the statistical power necessary to quantitatively define background. The mobile nature of the species sampled together with normal regional and local variations in concentrations of naturally-occurring radionuclides in the environment make such an effort impractical in the context of this project. However, an effort was made to obtain data that would provide a qualitative perspective on background concentrations in fish. To this end, samples were taken from the Snake River (composite group number 30; study site Snake River 13) to represent fish that would not be affected by the operations of nuclear facilities in the Tri-Cities area. Examination of the analytical results for the Snake River samples shows that in none of the samples was there any Pu-239 or Sr-90 detected. Cs-137 was detected, as could be expected from the worldwide distribution of this radionuclide as a result of the atmospheric testing of nuclear weapons during the 1950's and early 1960's. In addition, naturally occurring radionuclides in the uranium and thorium decay series were also detected.

Table 8-1. Composite risks for consumption of fish contaminated with radionuclides from the Columbia River Basin for the general public and CRITFC's member Tribes .

		Fish Consumption Rates				
Composite number (study sites)	**Species**	**Unit (1 g/d)**	**Average Public (7.5 g/d)**	**High Public (142.4 g/d)**	**Average CRITFC's member tribe (63.2 g/d)**	**High CRITFC's member tribe (389 g/d)**
52 (9E,9F)	Largescale sucker	6×10^{-7}	5×10^{-6}	9×10^{-5}	4×10^{-5}	2×10^{-4}
53 (9F,9H)	Largescale sucker	9×10^{-7}*	7×10^{-6} *	1×10^{-4}*	6×10^{-5}*	4×10^{-4}*
54 (9K)	White sturgeon	6×10^{-7}	5×10^{-6}	9×10^{-5}	4×10^{-5}	2×10^{-4}
24 (7A)	White sturgeon	1×10^{-6}*	8×10^{-6}*	1×10^{-4}*	6×10^{-5}*	4×10^{-4}*
25 (8F)	White sturgeon	8×10^{-7}*	6×10^{-6}*	1×10^{-4}*	5×10^{-5}*	3×10^{-4}*
29 (8E,8B)	White sturgeon	6×10^{-7}	5×10^{-6}	9×10^{-5}	4×10^{-5}	2×10^{-4}
84 (8F)	Channel catfish	8×10^{-7}	6×10^{-6}	1×10^{-4}	5×10^{-5}	3×10^{-4}
85 (8F,8I)	Largescale sucker	9×10^{-7}	7×10^{-6}	1×10^{-4}	6×10^{-5}	3×10^{-4}
86 (8C)	Channel catfish	6×10^{-7}	5×10^{-6}	9×10^{-5}	4×10^{-5}	3×10^{-4}
30 (13E,13F)	White sturgeon	8×10^{-7}	6×10^{-6}	1×10^{-4}	5×10^{-5}	3×10^{-4}
87 (9I)	White sturgeon	7×10^{-7}	5×10^{-6}	1×10^{-4}	4×10^{-5}	3×10^{-4}
88 (9I)	White sturgeon	7×10^{-7}	5×10^{-6}	1×10^{-4}	4×10^{-5}	3×10^{-4}
78 (9Q,9P)	Mountain whitefish	8×10^{-7}	6×10^{-6}	1×10^{-4}	5×10^{-5}	3×10^{-4}
79 (9O,9N)	Mountain whitefish	6×10^{-7}	5×10^{-6}	9×10^{-5}	4×10^{-5}	2×10^{-4}
82 (9D,9B,9A)	White sturgeon	8×10^{-7}	6×10^{-6}	1×10^{-4}	5×10^{-5}	3×10^{-4}
83 (9A)	White sturgeon	5×10^{-7}	4×10^{-6}	7×10^{-5}	3×10^{-5}	2×10^{-4}

*Composites 53, 24, and 25 did not have uranium, strontium or plutonium analyses performed, and the composite risks do not include contributions from those radionuclides.

8.6 Uncertainties

The uncertainty associated with cancer risk estimates for ingestion of fish contaminated with radionuclides includes contributions from the analytical uncertainties of the reported results, and risk coefficients. The analytical uncertainties associated with the laboratory results are reported at the two standard deviation level. For radionuclide analyses, uncertainties related to counting statistics depend on the number of counts obtained, which varies with the analytical technique used as well as the concentrations of radionuclide in the sample. As a percentage of the reported result, their magnitude typically varies from a few percent in the case of gamma results which are significantly greater than detection limits (e.g. K-40 results), to 20-40% for uranium results, to more than 100% in cases of reported results which are classified as non-detect.

Some analytical results are qualified as estimated values due to interferences from other radionuclides in the analysis. Additional uncertainty results from the use of some radionuclides as surrogates for other radionuclides in decay series, the assumption of secular equilibrium, and the use of minimum detectable concentration data in calculating risk. These uncertainties likely result in overestimates of risk.

The uncertainties associated with the risk coefficients are likely to be larger than those due to analytical uncertainties. EPA guidance does not provide specific quantitative uncertainty estimates of the cancer risk coefficients (USEPA 1999d). National Council on Radiation Protection and Measurements. (NCRP) Report 126 (NCRP, 1997), examined the question of uncertainties in risk coefficients for the relatively simple case of external radiation exposure to low linear energy transfer (primarily gamma) radiation. The conclusion was that the 90% confidence interval encompassed a range approximately a factor of 2.5 to 3 higher and lower than the value of the risk estimate. Since estimates of risk from ingestion of food necessarily involve the added complexity of modeling of physiological processes to determine dose and risk, the uncertainties in this context are likely to be even greater.

The National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR), in their report, addressed the issue of uncertainty in risk estimates for low doses from low linear energy transfer radiation (NAS, 1990). BEIR V considered the assumptions inherent in modeling such risks and concluded that at low doses and dose rates it must be acknowledged that the lower limit of the range of uncertainty in the risk estimates extends to zero.

8.7 Discussion

Considering the number of samples, the mobility of the fish, and the range of results obtained, it does not appear to be possible to attribute results to specific sources. Most of the radionuclides detected are known to be present naturally in the environment. Cs-137 is also widespread in the environment and was detected in many samples without apparent pattern. There were three samples in the vicinity of the Hanford Reach (Columbia River study site 9U) which showed positive detection results for Sr-90.

Sr-90, like Cs-137, is a widespread radionuclide resulting from atomic testing in the atmosphere. It is also associated with Hanford operations and is known from other environmental studies to be present in Columbia River sediments near Hanford.

The estimated risks are similar across all composite groups (Table 8-1). This is consistent with the observation that the majority of the estimated risk is generally due to radionuclides which are members of naturally occurring decay chains.

8.8 Conclusions

The risks calculated for fish consumption (Table 8-1) are small relative to the estimated risks associated with radiation from naturally-occurring background sources, to which everyone is exposed. In the US, the average annual effective dose equivalent is approximately 300 millirem including exposure to radon. The lifetime risk associated with this background dose can be estimated to be approximately 1×10^{-2}, or 1%.

9.0 Comparisons of Fish Tissue Chemical Concentrations

9.1 Comparison by Chemical Concentration

In this section the fish tissue residues from our study are compared to other food types and studies of contaminants in fish reported in literature. This section also includes a comparison of fish tissue concentration data for smallmouth bass and channel catfish in addition to the 13 fish species which were the main focus of this report.

9.1.1 Chlordane

Chlordane was used as a pesticide from the 1940's until the late 1980's. Until 1983 it was used on corn and citrus fruits, lawns and gardens. It was banned in 1988.

Like most of the other cylclodiene pesticides (heptachlor, heptachlor expoxide, aldrin, dieldrin, endrin, and endosulfans I and II) chlordane degrades very slowly. Various of its metabolites can stay in the soil for over 20 years and can bioaccumulate in tissues of higher organisms.

Exposure to chlordane occurs largely from eating contaminated foods, such as root crops, meats, fish, and shellfish, or from touching contaminated soil. In the early 1980's chlordane was detected in 4 of 324 food composites: 3 potato composites ranging from trace to 2 µg/kg, and 1 garden fruit composite at a trace level (Gartrell et al., 1986). In the 1980 U.S. Food and Drug Administration (USFDA) market basket survey of infant and toddler diet samples, chlordane was detected at 5 µg/kg in one of 143 toddler food composites (Gartrell et al., 1985).

Chlordane concentrations of 118 to 290 µg/kg were measured in various estuarine fish in coastal states surveyed (Butler and Schutzmann, 1978). In a more recent survey, Munn and Gruber (1997) reported fish concentrations of 140 - 610 µg/kg of the sum of chlordane in composite samples of whole body fish from the Central Columbia Plateau.

The average concentrations of total chlordane found in anadromous fish tissue from our study ranged from <4 µg/kg in eulachon and coho salmon to 43 µg/kg in Pacific lamprey (Table 2-3). Egg samples from spring chinook sample had the highest average concentration (66 µg/kg) in our study (Table 2-3). The average concentrations of total chlordane in the resident fish species in our study ranged from < 2.4 µg/kg in rainbow trout and bridgelip sucker to 29 µg/kg in white sturgeon (Table 2-3).

9.1.2 Total DDT

The legal use of DDT in agriculture has been banned in the United States since 1972. DDT and its derivatives are persistent, bioaccumulative compounds which are ubiquitous in the organisms, sediments, and soils.

Exposure to DDT and its structural analogs (DDE, DDD) occurs primarily from eating contaminated foods, such as root and leafy vegetables, meat, fish, and poultry. From 1967 to 1972 the concentrations of total DDT in meat, fish and poultry decreased from 3,200 µg/kg to 900 µg/kg (IARC, 1978). From 1970 to 1973, DDE residues decreased only 27%, compared to a decrease of 86% and 89% for DDT and DDD, respectively (USEPA, 1980).

Based on data from the US Fish and Wildlife Service National Pesticides Monitoring Program (Schmitt et al., 1981), the DDT concentrations in fish ranged from 100 to 11,000 µg/kg.

DDT was detected in meats (0.3 µg/kg) and raw berries (2.0 µg/kg) consumed by indigenous residents of the Canadian Arctic (Berti et al., 1998).

The maximum concentration of DDE in the fish from several USGS surveys was in a whole body composite sample of carp (3,300 µg/kg) from the Brownlee Reservoir on the Snake River, Idaho (Table 9-1). The maximum concentration of DDE in our study was in the whole body composite sample of white sturgeon (1400 µg/kg) from the Hanford Reach of the Columbia River (study site 9U). The maximum concentrations of DDE in bridgelip sucker, rainbow trout, and largescale sucker levels in our study were higher than levels found by Munn and Gruber (1997) in the Central Columbia Plateau (Table 9-1). The largescale sucker levels in our study were similar to the largescale sucker levels reported by Clark and Maret (1998) for the Snake River Basin.

Table 9-1. Comparison of range concentrations of sum of DDE (o,p' & p.p') in whole body composite fish samples Columbia River Basin.

Fish	µg/kg	Location	Reference
carp	3300	Brownlee Reservoir, Snake River, Idaho	Clark and Maret ,1998
bridgelip sucker	87	Palouse River, Central Columbia Plateau	Munn and Gruber, 1997
bridgelip sucker	120-340	Northern Desert, Central Columbia	Munn and Gruber ,1997
bridgelip sucker	***347 - 612***	***Columbia River Basin***	***Our study, 1996-1998***
rainbow trout	9.5-32	Northern Desert, Central Columbia	Munn and Gruber, 1997
rainbow trout	***5-89***	***Columbia River Basin***	***Our study, 1996-1998***
largescale sucker	33-1300	Snake River Basin	Clark and Maret ,1998
largescale sucker	120-400	Palouse River, Central Columbia Plateau	Munn and Gruber, 1997
largescale sucker	***29-1312***	***Columbia River Basin***	***Our study, 1996-1998***

9.1.3 PCBs

PCBs, are stable, man-made chemicals that only degrade at very high temperatures. They do not conduct electricity and most of the various types of PCBs and PCB mixtures take the form of liquids. For these reasons, PCBs have been used extensively in much of the world as electrical insulating fluids, especially in capacitors and transformers which deliver high voltage in critical devices and situations where fire prevention is of great concern. PCBs have also been used extensively as hydraulic fluids, as well as in the manufacture of carbonless copy paper, etc. Environmental contamination with PCBs has resulted from industrial and domestic discharges, landfills, and atmospheric transport of incompletely incinerated PCBs.

Under environmental conditions, PCBs are extremely stable and slow to chemically degrade

(Eisler, 1986b). PCBs enter the environment as mixtures containing a variety of individual components (congeners) and impurities that vary in toxicity. The chlorinated nature of the various PCB molecules also makes them more fat soluble, and thus capable of bioaccumulating in aquatic food webs. The lipid solubility of the PCBs increases with increased chlorine substitution. This lipophilicity also tends to increase resistence to biodegradation.

Because of the relatively great environmental persistence and lipophilicity of this group of pollutants, low-level PCB contamination is now a global phenomenon, with PCB residues occurring almost universally in human milk, other human tissues, food, etc. For the general population, likely routes of ongoing chronic exposure to PCBs are primarily from food (Table 9-2).

Table 9-2. PCB residues in raw agricultural commodities, 1970-76. (Source: Duggan et al, 1971)

Food Type	Number of samples	Percent Detected	Average (µg/kg)
fish	*2,901*	46	892
eggs	*2,302*	9.6	72
milk	*4,638*	4.1	67
cheese	*784*	0.9	11
red meat	*15,200*	0.4	8
poultry	*11,340*	0.6	6

The estimated PCB content of a typical teenage boy's diet was about 15 µg/day in 1971, decreasing by 1975, to about 8.1 µg/day (IARC, 1978). The levels of PCBs have declined in ready-to-eat foods from 1978 to 1982 (Table 9-3). However, the human body burden remains high. The body burden of PCBs in human fat ranged between 500 and 1,500 µg/kg in 1987 (USEPA, 1987).

Table 9-3. The declining trends in PCBs in ready-to-eat foods collected in markets of a number of US cities (Source: Duggan et al., 1971).

Year	Number of samples	Percent Detected	Average (µg/kg
1978	*360*	9	trace - 50
1979	*360*	4	<1 - 2
1980	*360*	2	2
1981- 82	*324*	2	1

In the 1980 -1981 USFWS survey of PCBs in fish from 107 locations the geometric was 530 µg/kg (Schmitt et al., 1985). This was lower than mean PCB levels from previous monitoring efforts, in which geometric means for PCBs were 880 µg/kg (1976-1977) and 850 µg/kg from (1978- 1979) (Schmitt et al., 1985).

In a 1976-1980 EPA survey of PCB residues in finfish from the Chesapeake Bay watershed, the concentrations ranged from non detects to 4,640 µg/kg (Tale 9-5). There was no trend over time as was observed in the USFWS Pesticide Monitoring Program.

Table 9-4. The 1976-80 ranges for PCB residues from 547 finfish from the Chesapeake Bay and its tributaries (Source: USEPA, 1987a).

Year	µg/kg
1976	ND - 980
1977	30 - 510
1978	60 - 4,640
1979	10 - 1,600
1980	3 - 1,450

In later studies concentrations of total PCBs in a variety of fish tissue types ranged from 10 µg/kg in white sucker fillets in Saginaw Bay, Lake Huron, Michigan to 14,500 µg/kg in fish from the Spokane River, Washington (Table 9-5). Measurements of Aroclor 1254 and 1260 in white croaker muscle in California ranged from 1 µg/kg to 713 µg/kg (Table 9-6).

Table 9-5. Total PCB concentrations in fish tissue from studies reported in the literature from 1978-1994.

Species & Tissue type	µg/kg	Location/date of study	Reference
fish livers	132 - 772	near the outfall for the Los Angeles County wastewater treatment plant 1980-81,	Gossett et al., 1983.
750 fish samples	70 - 14,500	11 major lakes and rivers in Alberta, Canada	Chovelon et al., 1984
25 white suckers fillets	10-180	Saginaw Bay, Lake Huron, 1979-1980	Kononen, 1989
freshwater fish (whole body)	mean = 36 maximum =930	Spokane River, WA, 1999	Johnson, 2001

Table 9-6. Concentrations Aroclor 1254 & 1260 in white croaker muscle tissue from California water bodies in the spring of 1994. (Source: Fairey et al., 1997)

ug/kg	Location
137 - 613	13 locations throughout San Francisco Bay
1	Southern California Dana Point,
757	Malibu

The concentration of Aroclor 1254 ranged from 480 µg/kg to 9,930 µg/kg in lake trout from lakes in Michigan (Table 9-7). The concentration of Aroclor 1254 in resident fresh water species from our study ranged from 10 µg/kg in rainbow trout to 930 µg/kg in mountain whitefish.

Table 9.7. Concentrations of Aroclor 1254 in lake trout from lakes in Michigan during 1978-82 (Devault et al., 1986).

ug/kg	Location
5630 - 9930	Lakes Michigan
2100 - 3660	Lake Huron
480-1890	Lake Superior

The concentration of Aroclors in chinook salmon eggs from Lake Michigan were much higher than the levels found in our study (Table 9-8).

Table 9-8. Aroclor concentrations in chinook salmon eggs reported for Lake Michigan, Michigan, compared to our study of Aroclors in the chinook salmon eggs.

µg/kg	N	salmon	Location/date of study
Aroclor 1254			
5,400		chinook	Lake Michigan, 1982 (Jaffet et al., 1985)
12	***1***	***fall chinook***	***Columbia River Basin, 1996-1998***
15 - 20	***6***	***spring chinook***	***Columbia River Basin, 1996-1998***
Aroclor 1260			
1,100		chinook	Lake Michigan, 1982 (Jaffet et al., 1985)
<19	***1***	***fall chinook***	***Columbia River Basin, 1996-1998***
<18		***spring chinook***	***Columbia River Basin, 1996-1998***

< = detection limit

Concentrations of PCBs measured in fish from our study were compared to other fish surveys in Lake Roosevelt on the upper Columbia River in Washington (Table 9-9). The maximum concentration of Aroclors 1254 and 1260 in walleye and rainbow trout were lower in our study of the Columbia River Basin than the EPA (USEPA, 1998c) and USGS (Munn, 2000) surveys of Lake Roosevelt, Washington. Concentrations of the Aroclors in white sturgeon were higher in our study than the EPA study of Lake Roosevelt, Washington (Table 9-9).

Table 9-9. Concentrations of Aroclors 1254 and 1260 in composite samples of fish fillets from Lake Roosevelt, Washington compared concentrations measured in our study of the Columbia River Basin.

Fish Species	µg/kg	N	Location	Reference
	Aroclor 1254			
small walleye	30 - 10	9	Lake Roosevelt, 1994	USEPA, 1998c
large walleye	35 - 89	2	Lake Roosevelt, 1994	USEPA, 1998c
walleye	***12 - 14***	***7***	***Columbia River Basin, 1996-1998***	***our study***
white sturgeon*	15 - 77	2	Lake Roosevelt, 1994	USEPA, 1998c
white sturgeon*	***10 - 190***	***16***	***Columbia River Basin, 1996-1998***	***our study***
rainbow trout	13 - 45	10	Lake Roosevelt, 1994	USEPA, 1998c
rainbow trout	3 - 49	16	Lake Roosevelt, 1998	Munn, 2000
rainbow trout	***10 - 20***	***7***	***Columbia River Basin, 1996-1998***	***our study***
smallmouth bass	ND - 8	9	Lake Roosevelt, 1994	USEPA, 1998c
smallmouth bass	***38 - 83***	***3***	***Columbia River Basin, 1996-1998***	***our study***
kokanee	28 - 40	4	Lake Roosevelt, 1994	USEPA, 1998c
lake whitefish	31 - 51	3	Lake Roosevelt, 1994	USEPA, 1998c
	Aroclor 1260			
small walleye	4 - 13	9	Lake Roosevelt, 1994	USEPA, 1998c
large walleye	23 - 32	2	Lake Roosevelt, 1994	USEPA, 1998c
walleye	***<19***	***7***	***Columbia River Basin, 1996-1998***	***our study***
white sturgeon*	13 - 102	2	Lake Roosevelt, 1994	USEPA, 1998c
white sturgeon*	***13 - 200***	***16***	***Columbia River Basin, 1996-1998***	***our study***
rainbow trout	5 - 72	10	Lake Roosevelt, 1994	USEPA, 1998c
rainbow trout	***<18***	***7***	***Columbia River Basin, 1996-1998***	***our study***
smallmouth bass	3 - 6	9	Lake Roosevelt, 1994	USEPA, 1998c
smallmouth bass	***68 - 220***	***3***	***Columbia River Basin, 1996-1998***	***our study***
kokanee	10 - 14	4	Lake Roosevelt, 1994	USEPA, 1998c
lake whitefish	16 - 29	3	Lake Roosevelt, 1994	USEPA, 1998c

N - number of samples < = detection limit *White sturgeon were individual fillets without skin

9.1.4 Chlorinated Dioxins and Furans

Because of their chlorination and specific chemical structures, most chlorinated dioxins and furans are highly fat soluble, and difficult for the body to quickly degrade and excrete. They are similar to some of the other persistent chlorinated residues like DDT and PCBs. Also like PCBs and DDTs, chlorinated dioxins and furans can bioaccumulate in fish. The amount of furans in fish can sometimes be tens of thousands times higher than the levels in the surrounding water.

The chlorinated dibenzodioxins and chlorinated dibenzofurans are not produced intentionally by industrial processes. Rather, most chlorinated dioxins and furans are generated in very small amounts as unwanted impurities during the manufacture of several chlorinated chemicals and consumer products, including certain wood treatment chemicals, some metals, and paper products. When the waste water, sludge, or solids from these processes are released into waterways or soil in dump sites, the sites may become contaminated with chlorinated dioxins and furans. These unwanted contaminants also enter the environment from burning municipal and industrial waste in incinerators, as well as from gasoline exhaust, and the burning of coal, wood, or oil for home heating and production of electricity. Other production chemicals which can generate unwanted trace amounts of 2,3,7,8-TCDD have included the forestry herbicide 2,4,5-trichlorophenoxy propionic acid (Silvex), and the industrial chemical 2,4,5-trichlorophenol. Unwanted trace amounts of some of the higher-chlorinated dioxins, especially the hexa and octa isomers, have also been associated with the production of the widely used wood preservative, pentachlorophenol.

Many of the various chemicals and processes which significantly produce chlorinated dioxins and furans in the environment are either being slowly phased out or are strictly controlled. It is currently believed that chlorinated dioxin and furan emissions associated with incineration and combustion activities are the predominant environmental source of these contaminants (USEPA, 2000e). Chlorinated dioxins and furans also arise from natural processes in the environment such as forest fires and volcanos.

TCDF is often found in fish tissue because of its affinity for lipids and because of its formation as a by-product in the industrial processes, especially pulp and paper mills (USEPA, 2000e). The concentration of 2,3,7,8-TCDF was measured in a variety of fish species from Lake Roosevelt, Washington by the USEPA in 1994 (Table 9-10). The concentrations of 2,3,7,8-TCDF in walleye ranged from 0.0001 to 0.0063 µg/kg (Table 9-10). The maximum concentration from our study was lower than the maximum reported for Lake Roosevelt, Washington. The white sturgeon 2,3,7,8-TCDF maximum concentration in our study was higher than the maximum from the 1994 Lake Roosevelt study (Table 9-10). The rainbow trout 2,3,7,8-TCDF concentrations were similar in both studies.

Table 9-10. Concentrations of 2,3,7,8-TCDF in composite samples of fish fillets collected from Lake Roosevelt, Washington in 1994 compared with our 1996-1998 survey of the Columbia River Basin.

Fish	µg/kg	N	Collection date	Reference
small walleye	0.0001 - 0.0016	*9*	Lake Roosevelt, 1994	USEPA, 1998c
large walleye	0.0007 - 0.0063	*2*	Lake Roosevelt, 1994	USEPAc 1998c
walleye	***0.0006 - 0.00085***	***3***	***Columbia River Basin, 1996-98***	***our study***
white sturgeon	0.016 - 0.025	*2*	Lake Roosevelt, 1994	USEPA, 1998c
white sturgeon	***0.0025 - 0.054***	***16***	***Columbia River Basin, 1996-98***	***our study***
small rainbow trout	0.000098 - 0.0015	*6*	Lake Roosevelt, 1994	USEPA, 1998c
large rainbow trout	0.0015 - 0.00188	*10*	Lake Roosevelt, 1994	USEPA, 1998c
rainbow trout	***0.0001 - 0.0003***	***7***	***Columbia River Basin, 1996-98***	***our study***
kokanee	0.0028 - 0.0031	*4*	Lake Roosevelt, 1994	USEPA, 1998c
smallmouth bass	0.00001 - 0.0041	*9*	Lake Roosevelt, 1994	USEPA, 1998c
lake whitefish	0.0038 - 0.01610	*3*	Lake Roosevelt, 1994	USEPA, 1998c

N= number of samples

In the USEPA National Dioxin Survey (USEPA, 2000d) background levels of toxicity equivalence concentrations for chlorinated dioxins, furans, and dioxin-like PCB congeners were 0.00116 ±0.00121 µg/kg in fish and 0.00046 ± 0.00099 µg/kg in beef. In our study the average toxicity equivalence concentrations ranged from a low of 0.0004 µg/kg in fall chinook salmon to the highest average concentration of 0.0063 µg/kg in mountain whitefish.

9.1.5 Metals

The metals measured in our study are naturally occurring substances. Some of these metals are essential at trace levels for survival of vertebrates. These chemicals may combine with other chemicals to form compounds,(e.g. methylmercury, dimethyarsenic, arsenocholine, arsenosugars) which alters their bioavailability and toxicity. Most can become toxic if sufficiently high levels are encountered in the environment. Many of the metals which are taken up by fish tend to increase in concentration as the organisms age and increase in body size (Wiener and Spry, 1996, reported in Clark and Maret, 1998).

Information about barium, beryllium, cobalt, and manganese and are not included in this section. Background information on these chemicals is included in the Toxicity Profiles (Appendix C)

9.1.6 Aluminum

Aluminum is the most common and widely distributed metal in the earth's crust. Concentrations as high as 150,000 - 600,000 mg/kg have been reported in soil. The average ingestion of aluminum by humans has been estimated at 30 - 50 mg/day (Bjorksten, 1982). This estimate may be low, in light of a 1997 United Kingdom (UK) total diet study involving 20 different food groups from 20 representative towns, for the general UK population, where the highest mean concentrations of aluminum were found in the bread (6,600 µg/kg) and fish (6,100 µg/kg) (Ysart et al., 2000). Aluminum is present in the natural diet, in amounts varying from very low in animal products to relatively high in plants.

In our study the basin-wide average aluminum concentrations ranged from non-detect in coho salmon (whole body and fillet) to 69,000 µg/kg in whole body largescale sucker. The maximum concentration was 190,000 µg/kg in the largescale sucker composite sample from the main-stem Columbia River (study site 8).

9.1.7 Arsenic

Arsenic is found widely in nature, and occurs most abundantly in sulfide ores. Arsenic levels in the earth's crust average about 5,000 µg/kg. Arsenic is found in trace amounts in aquatic environments. As was described in Section 5, arsenic exists in both organic and inorganic forms. The most common combined form of arsenic is the inorganic compound, arsenopyrite (FeAsS). The organic arsenic compounds are less toxic than the inorganic arsenic compounds.

Arsenic does not readily bioconcentrate in aquatic organisms. It is typically water soluble and does not combine with proteins. Since, aquatic invertebrates accumulate arsenic more readily than fish biomagnification is unlikely (Spehar et al., 1980). Planktivorous fish are more likely to concentrate arsenic than omnivorous or piscivorous fishes (Hunter et al., 1981). Eisler (1988a) found no evidence that biomagnification occurs in aquatic food chains. In 1995, Robinson et al., found no evidence of arsenic uptake or accumulation from water in both rainbow and brown trout. The rainbow trout in our study had the lowest arsenic concentrations (<25 µg/kg fillet; 120 µg/kg whole body) of the fish species sampled.

In a 1997 UK study, dietary exposures to arsenic were estimated to be about 65 µg /day (Ysart et al., 2000). The "fish" food group had the highest mean arsenic concentration (400 µg/kg; Ysart et al., 2000).

Arsenic levels recorded for fish tissues seem to be quite variable. Fish taken from the Great lakes contained 5.6 - 80 µg/kg arsenic; primarily in the lipid fraction of the fish tissue (Lunde, 1970). In a study of African tilapia fish, muscle tissue contained arsenic levels ranging from110 µg/kg(Ikdu and Marget Lakes) to one specimen with 10,500 µg/kg (Abu Quir Bay) (El Nabawi et al., 1987). Ashraf and Jaffar (1988) measured arsenic levels of 2,880 µg/kg and 2510 µg/kg in two tuna species from the Arabian Sea. The authors noted that increased arsenic content was proportional to increased weight in the tuna species.

The average arsenic levels in resident, fresh water fish species in our study ranged from not detect in rainbow trout fillet to 490 µg/kg in whole body walleye (Table 2-14). The average concentrations in anadromous species from our study ranged from 310 µg/kg in Pacific lamprey fillet to 890 µg/kg in whole body eulachon. There was no correlation between lipid and arsenic in fish in our study, as was observed in the Great Lakes study (Lunde, 1970) or body weight and arsenic as observed by Asraf and Jaffar (1988).

9.1.8 Cadmium

Cadmium naturally occurs in the aquatic environment, but is of no known biological use and is considered one of the most toxic metals. While cadmium is released through natural processes, anthropogenic cadmium emissions have greatly increased its presence in the environment. In aquatic systems, cadmium quickly partitions to sediment, but is readily remobilized through a variety of chemical and biological processes (Currie et al., 1997). Cadmium does not bioconcentrate significantly in fish species, but does tend to accumulate more readily in invertebrates. Omnivorous and insectivorous predators tend to accumulate cadmium in their tissues more than piscivorous predators (Scheuhammer, 1991). Saiki et al., (1995) found no evidence of biomagnification of cadmium in steelhead on the Upper Sacramento River. Eisler (1985a) also maintains that evidence for cadmium biomagnification suggests that only the lower trophic levels exhibit biomagnification. Cadmium tends to form stable complexes with metallothionein (a sulfhydryl-rich protein). The resulting cadmium complexes have long half-lives and a tendency to accumulate with age in exposed organisms. As such, long lived species tend to be at a higher risk from chronic low-level dietary cadmium exposure.

People who are smokers are exposed to significant levels of inhaled cadmium. The major exposure route for the non-smoking human population is via food. In a 1997 UK study, the mean population dietary exposures to cadmium was estimated to be about 12 µg/kg/day for the general UK population (Ysart et al., 2000). Cadmium concentrations were highest in the viscera and trimmings of animals (77 µg/kg), and nuts (59 µg/kg), while the bread and potato food groups made up the greatest contributions (both 25%) to dietary exposure of the general population.

Certain cruciferous vegetable crops are known to be able to sequester elevated cadmium levels if grown in sufficiently contaminated soils. Queiroloa et al. (2000) reported ranges of 0.2 to 40 µg/kg for cadmium, with highest levels being found in potato skin in a study of vegetables (broad beans, corn, potato, alfalfa and onion) from farming villages in Northern Chile.

The WHO (1992) indicates that marine organisms generally contain higher cadmium residues than their freshwater and land-dwelling counterparts. In our study the highest cadmium levels were in whole body samples of largescale sucker (250 µg/kg) followed by spring chinook salmon (170 µg/kg) and Pacific lamprey (150 µg/kg).

Average cadmium concentrations ranged from non detect in fillet samples of walleye, coho salmon, and fall chinook salmon to 120 µg/kg in whole body spring chinook salmon. The maximum concentration (250 µg/kg) was in the largescale sucker composite sample from the Hanford Reach of the Columbia River (study site 9U).

9.1.9 Chromium

Chromium is widely distributed in the earth's crust, with an average concentration of about 125,000 µg/kg. It is found in small amounts in all soils and plants. Most of the chromium present in food is in the trivalent form [Cr(III)], which is an essential nutrient. The hexavalent form is more toxic, but is not normally found in food. In freshwater environments, hydrolysis and precipitation are the most important processes in determining the environmental fate of chromium, while absorption and bioaccumulation are considered minor. Chromium (VI) is highly soluble in water and thus very mobile in aquatic systems (Ecological Analysts, 1981).

The mean daily dietary intake of chromium from air, water, and food, is estimated to be about 0.2 - 0.4 µg, 2.0 µg, and 60 µg, respectively (ATSDR, 2000). The predicted intakes from air chromium are probably exceeded considerably in the case of smokers, and those who are occupationally exposed.

In a 1997 UK study, meat products contained the highest mean chromium concentration (230 µg/kg), but beverages made the greatest dietary contribution (19%) to the population exposure to chromium (Ysart et al., 2000). The US Food and Nutrition Board has recommended a safe and adequate dietary intake of chromium of 0.05 - 0.20 µg/day (Seller and Sigel, 1988).

Chromium was found in fish sampled from 167 lakes in the northeast United States at levels ranging from 30-1,460 µg/kg with a mean of 190 ug/kg (Yeardley et al., 1998). Seaweeds have been shown to sequester total chromium by a bioaccumulation factor of about 100 times greater than ambient levels in seawater (Boothe and Knauer, 1972). Snails showed an accumulation factor of 1×10^{6} for total chromium (Levine, 1961).

In our study, basin-wide average chromium concentrations ranged from <100 µg/kg in eulachon to 360 µg/kg in the whole body white sturgeon (Table 2-14). The maximum concentration (1000 µg/kg) was measured in the whole body white sturgeon sample from the main-stem Columbia River (study site 8)

9.1.10 Copper

Because of its ubiquitous occurrence in the environment, and its essentiality for life, copper is found naturally at trace levels in aquatic and terrestrial organisms. Copper is not strongly bioconcentrated in vertebrates, but is more strongly bioconcentrated in invertebrates. In salmonids the accumulation of copper in muscle, kidney, and spleen tissues occurred at copper concentrations ranging from 0.52-3 µg/L in both seawater and freshwater (freshwater hardness=46-47 mg/L)(Camusso and Balestrini, 1995; Peterson et al., 1991; Saiki et al., 1995). The concentrations of copper in fish tissues reflect the amount of bioavailable copper in the environment. Baudo (1983, Wren et al. (1983), and Mance (1987) have all concluded that copper, along with zinc and cadmium do not biomagnify in the aquatic environment.

Intake of copper from food tends to be about one order of magnitude greater than intake from drinking water (USEPA, 1987). Exceptions to this are in relatively rare situations involving consumption of “soft” drinking water sources supplied by copper pipes; which can result in daily individual drinking water intakes of copper in excess of 2 mg/day. In a 1997 UK diet study, copper was highest in viscera and trimmings (50,000 µg/kg) and nuts (8,500 µg/kg), with mean concentrations in the other food groups ranging from 50 to 2,100 µg/kg (Ysart et al., 2000).

In our study, the copper concentrations ranged from 250 µg/kg in white sturgeon fillet sample to 4500 µg/kg in whole body Pacific lamprey. The maximum concentration (14,000 µg/kg) was in the whole body fall chinook salmon composite sample from the main-stem Columbia River (study site 14).

9.1.11 Lead

Lead is a naturally occurring, ubiquitous compound that can be found in rocks, soils, water, plants, animals, and air. Lead is the fifth most prevalent commercial metal in the US. Lead is found naturally in all plants, with normal concentrations in leaves and twigs of woody plants of about 2,500 µg/kg, pasture grass 1,000 µg/kg, and cereals from 100 -1,000 µg/kg (IARC, 1980).

Absorption of lead by aquatic animals is affected by the age, gender and diet of the organism, as well as the particle size, chemical species of lead, and presence of other compounds in the water (Eisler, 1988b; Hamir et al., 1982). Although inorganic lead is poorly accumulated in fish, it has been shown to bioconcentrate in aquatic species. Invertebrates tend to have higher lead bioconcentration factors than vertebrates. A bioconcentration factor of 42 was observed in brook trout embryos (Eisler, 1988b). Bioconcentration factors decrease as waterborne lead concentrations increase, thus suggesting accelerated depuration or saturation of uptake mechanisms (Hodson et al., 1984). Exposures of rainbow trout to 3.5-51 µg/L tetramethyl lead from 7 - 14 days resulted in rapid accumulation of lead. However, once the fish were removed to clean water, lead decreased rapidly from organs, followed by a slower release from other body components, until baseline levels were reached. An increase in dietary calcium of 0-8400 µg/kg reduced the uptake of waterborne lead in coho salmon, possibly due to interactions with gill membrane permeability (Hodson et al., 1984). In vertebrates, lead concentrations tend to increase with age and localize in hard tissues such as bone or teeth.

The primary exposure route for lead is food (Table 9-11). Foods which are likely to have elevated lead levels are dried foods, liver, canned food, and vegetables which have a high area-to-mass ratio. Historic use of soldered food cans greatly increased the lead content of prepared and processed foods. Sherlock (1987) reported that while ravioli from welded (no lead) cans contained 30 µg/kg lead, ravioli from a 98% lead soldered can was found to contain a mean content of 150 µg/kg lead.

Table 9-11. Lead concentrations in food purchased in five Canadian cities between 1986 - 1988 (Source: Dabeka and McKenzie, 1995.

category	% contribution to dietary intake	mean µg/kg	maximum µg/kg
fruits and fruit juice	13.9	44.4	372.7
miscellaneous	6.1	41.7	178.9
vegetables	16.8	24.4	331.7
meat and poultry	7.6	20.2	523.4
fish	*0.7*	*19.3*	*72.8*
sugar and candies	1.5	18.3	111.6
soups	4.5	15.5	48.7
bakery goods and cereals	20.6	13.7	66.4
beverages	20.9	9.9	88.8
fats and oils	0.3	9.6	19.7
milk and milk products	7.1	7.7	44.7
canned and raw cherries			203
canned citrus fruit			126
canned beans			158
canned luncheon meats			163

The basin-wide average lead concentrations in fish from our study of the Columbia River Basin ranged from non detect in fillets of Pacific lamprey, walleye, and rainbow trout to 500 µg/kg in whole body eulachon (Table 2-14). The maximum concentration (1200 µg/kg) in our study was in the whole body fall chinook salmon from the main-stem Columbia River (study site 14).

9.1.12 Mercury

While mercury does occur naturally in small amounts in aquatic environments, the cycling of mercury prolongs the influence of man-made mercury compounds (Hudson et al., 1995). Mercury is cycled through the environment through an atmospheric-oceanic exchange. This cycling is facilitated by the volatility of the metallic form of mercury. Natural bacterial transformation of mercury results in stable, lipid soluble, alkylated compounds such as methyl mercury (Beijer and Jernelov, 1979. In sediments, mercury is usually found in its inorganic forms, but aquatic environments are a major source of methyl mercury (USEPA, 1985). In background freshwater systems, mercury occurs naturally at concentrations of 0.02-0.1 µg/L (Moore and Ramamoorthy, 1984).

Mercury has been shown to bioconcentrate in a variety of aquatic organisms. Aquatic predators face the greatest danger of bioconcentrating mercury, and thus their tissue concentrations best reflect the amount of mercury available to aquatic organisms in the environment. Fish have been shown to concentrate mercury as methyl mercury even when they are exposed to inorganic mercury. Fish, such as rainbow trout, have been found to accumulate mercury in the form of methyl mercury at aquatic concentrations as low as 1.38 ng/L (Ponce and Bloom, 1991).

Some evidence supports the biomagnification of mercury in aquatic food chains. When comparing benthic feeding fish, fish that feed on plankton, invertebrates, and vertebrates, the greatest mercury concentrations were found in piscivorus fishes. Thus, the authors of this study concluded that mercury content in fish increased with higher trophic levels (Wren and MacCrimmon, 1986).

Freshwater ecosystems historically associated with heavy gold mining activity have often been impacted by elevated mercury levels in fish. This is in large part due to the use of liquid elemental mercury, or quicksilver, as a means of separating out gold during the mining process, especially during historic times.

Dietary sources greatly exceed other media like air and water as a source of human mercury exposure and uptake. In a 1997 UK diet study, fish contained the highest mean concentration (43 µg/kg), and made the greatest contribution (33%) to the population dietary exposure estimate (Ysart et al., 2000). The World Health Organization, EPA, and others indicate that risk to humans from mercury contamination via ocean fish is mainly through the consumption of predator species like swordfish, king mackerel, and shark (WHO, 1976).

In a monitoring study of fish in British Columbia, Canada, mercury concentrations in muscle tissue of various fish ranged from 40 µg/kg in rainbow trout to 2,860 µg/kg in lake trout (Table 9-12). In our study, rainbow trout the average mercury concentrations ranged from 73 µg/kg in whole body samples to 77 µg/kg in the fillet samples (Table 2-14).

Table 9-12. British Columbia monitoring study of mercury concentrations in fish fillet tissue. (Source: Bligh and Armstrong 1971)

Fish Species (study location)	µg/kg
Rainbow trout (Tezzeron Lake)	40
herring	70
dolly varden or char (Carpenter Lake)	410-1,940
dogfish or shark (English Bay)	1,080
lake trout (Pinchi Lake)	2,860

A 1984 EPA national survey of fish tissue found mercury ranging from 50 µg/kg in salmon to 610 µg/kg in pike (Table 9-13). In our study average mercury concentrations in fillet samples of salmon was 84 µg/kg in fall chinook, 100 µg/kg in spring chinook, and 120 µg/kg in coho. (Table 2-14).

Table 9-13. EPA 1984 survey of total mercury concentrations in edible fish tissue, shrimp, and prepared foods. (Source USEPA, 1984b)					
Fish Species	**µg/kg**	**Invertebrates**	**µg/kg**	**Prepared food**	**µg/kg**
salmon	50	shrimp	460	fish sticks	210
whiting	50			canned tuna	240
sardines	60				
flounder	100				
snapper	450				
bass	210				
catfish	150				
trout	420				
pike	610				

In a more recent EPA national survey of mercury in fish tissue, median mercury levels ranged from 1 µg/kg in largemouth bass, channel catfish, bluegill sunfish, and common carp to 8,940 µg/kg in largemouth bass (Table 9-14). The concentrations of mercury fillets of fish tissue in our study were 380 - 470 µg/kg in smallmouth bass, 160 - 200 µg/kg in walleye, and 240 - 280 µg/kg in channel catfish (Table 9-27). All of these fish species had lower concentrations in our study than in the EPA 1990-1995 survey (USEPA, 1999e).

Table 9-14. Mercury concentrations from an EPA 1990 - 1995 national survey of fish fillets (Source : USEPA, 1999e).

Species	µg/kg
largemouth bass	1 - 8,940
Smallmouth bass	8 - 3,340
walleye	8 - 3,000
northern pike	100 - 4,400
channel catfish	1 - 2,570
bluegill sunfish	1 - 1,680
common carp	1 - 1,800
white sucker	2 - 1,710
yellow perch	10 - 2,140

In 1999, May et al. (2000) collected 141 samples of fish from reservoir and stream areas in the Bear and South Yuba River watersheds in the Sierra Nevada of Northern California (Table 9-15). Fish concentrations in the California survey ranged from 20 µg/kg to 1,500 µg/kg (Table 9-15). Rainbow trout mercury concentrations in fillets ranged from 45 - 150 µg/kg (Table 9-27). Channel catfish mercury concentrations ranged from 240 - 280 µg/kg (Table 9-27).

Table 9-15. USGS survey of mercury concentrations in fish tissue from reservoirs and streams in Northern California. (Source: May et al, 2000). Fish were fillets without skin

Reservoir	µg/kg
largemouth bass	20 - 1,500
Reservoir sunfish	< 100 - 410
channel catfish	160 - 750
Streams	**µg/kg**
Brown trout	20 - 430
rainbow trout	60 - 380

Several recent surveys in Washington measured concentrations of mercury in resident fish species (Table 9-16). The walleye samples from our study were within the range of the samples from Munn and Short (1997) and Munn (2000). Smallmouth bass from our study were within the range of the studies by Munn et al. (1995) and Sedar et al. (2001) although the maximum concentrations in our smallmouth bass were lower than the levels found in Lake Roosevelt, Washington (Munn et al.,1995) and Lake Whatcom (Serdar et al., 2001). Serdar et al., (2001) reported a mean concentration of (70 µg/kg) in most fish species in Washington State. The authors found higher concentrations of mercury in 6 of 8 fillets with the skin off. In our study all the fillets, except white sturgeon, were analyzed with skin. There was also no consistent pattern between fillets with skin or whole body. Rainbow trout concentrations from our study were also within the range observed in rainbow trout from Lake Roosevelt, Washington, although the maximum was lower than the maximum observed in Lake Roosevelt (Munn et al, 1995).

Table 9-16. Mercury concentrations in fish fillets collected in Lake Whatcom and Lake Roosevelt, Washington compared to our study of the Columbia River Basin .

Fish species	Tissue Type	µg/kg	N	Location	
walleye	composite	110 - 440	*34*	Lake Roosevelt, 1994	Munn and Short 1997
walleye	individual	110 - 150	*8*	Lake Roosevelt, 1998	Munn 2000
walleye	***composite***	***160 - 200***	***3***	***Columbia River Basin, 1996-1998***	***our study***
smallmouth bass	composite	160 - 620	*5*	Lake Roosevelt, 1994	Munn et al., 1995
smallmouth bass	individual	100 - 1840	*96*	Lake Whatcom, 2000	Serdar et al., 2001
smallmouth bass	***composite***	***380 - 470***	***3***	***Columbia River Basin, 1996-1998***	***our study***
rainbow trout	individual	110 - 240	*6*	Lake Roosevelt, 1994	Munn et al., 1995
rainbow trout	***composite***	***45 - 150***	***7***	***Columbia River Basin, 1996-1998***	***our study***
perch	individual	120 - 290	*30*	Lake Whatcom, 2000	Serdar et al., 2001
kokanee	individual	100 - 130	*30*	Lake Whatcom, 2000	Serdar et al., 2001
pumpinkinseed	individual	70 -120	*30*	Lake Whatcom, 2000	Serdar et al., 2001
cutthroat trout	individual	60 - 80	*30*	Lake Whatcom, 2000	Serdar et al., 2001
brown bullhead	individual	70 - 440	*30*	Lake Whatcom, 2000	Serdar et al., 2001

N= Number of samples

9.1.13 Nickel

Nickel occurs naturally in rocks and soils and can leach into aquatic environments. However, weathering of nickel-containing substrates results in only small amounts of nickel entering into aquatic systems. Manmade sources of nickel include mining, combustion of coal, petroleum and tobacco, manufacture of cement and asbestos, food processing, textile and fur fabrication, laundries, and car washes (USEPA, 1983). The National Academy of Sciences reports that fish contain nickel at a maximum of 1,700 µg/kg (NAS, 1975).

Nickel concentrations the maximum nickel concentration was 17,000 µg/kg in a whole body steelhead sample from the Klickitat River (study site 56). This sample was an anomaly since the other samples from this site were 170 and 520 µg/kg. The average concentrations in fillet samples ranged from 15 µg/kg in Pacific lamprey to 260 µg/kg in walleye; whole body ranged from 50 µg/kg in eulachon to 1200 µg/kg in Coho salmon.

9.1.14 Selenium

While selenium is ubiquitous in the earth's crust, only trace levels normally occur in aquatic environments. Selenium enters aquatic habitats from a number of anthropogenic and natural sources. Elevated levels in aquatic systems are found in regions where soil is selenium-rich or where soils are extensively irrigated (Dobbs et al., 1996). As an essential micronutrient, selenium is used by animals for normal cell functions. However, the difference between useful amounts of selenium and toxic amounts is small. Selenium at low levels in the diet is an essential element for humans. At elevated dose levels, it exhibits toxicity (selenosis). Organic and reduced forms of selenium (e.g. seleno-methionine and selenite) are generally more toxic and will bioaccumulate (Besser et al., 1993; Kiffney and Knight, 1990). Bioconcentration of selenium may be modified by water temperature, age of receptor organism, organ and tissue specificity, and mode of administration (Eisler, 1985a). Fish bioconcentrate selenium in their tissues with particularly high concentrations observed in ovaries when compared to muscle tissues (Lemly, 1985; Hamilton et al., 1990) and milt (Hamilton and Waddall, 1994). Selenium that is bioconcentrated appears to occur in its most harmful concentrations in predator species such as chinook salmon (Hamilton et al., 1990). Bioconcentration factors (BCFs) in rainbow trout range from 2-20 after exposure to 220-410 µg/L selenium. The magnitude of the BCFs appeared to be inversely related to exposure concentrations (Adams and Johnson, 1977). Biomagnification of selenium has also been well documented. The magnitude of the biomagnification ranges from 2-6 times between producers and lower consumers (Lemly and Smith, 1987). Piscivorous fish accumulate the highest levels of selenium and are generally one of the first organisms affected by selenium exposure, followed by planktivores and omnivores (Lemly, 1985).

Selenium has been frequently detected in a great variety of commonly consumed foods. In a 1997 UK diet study the mean selenium concentrations in the viscera and trimmings was estimated to be 490 µg/kg and 250 µg/kg in nuts (Ysart et al., 2000). Meat products (15%), fish (13%), and bread (13%) groups make the greatest contributions to diet (Ysart et al., 2000).

In the US infant diet the average concentration of selenium was highest in grains and cereals followed by fish (Table 9-17).

Table 9-17. Selenium concentrations in US infant diet. (Source: Gartrell et al., 1985 and 1986).		
Food Group	**1979 µg/kg**	**1981-1982 µg/kg**
other dairy products	2	15
potatoes	2	2
beverages	2	
whole milk	4	9
vegetables	4	7
sugars and adjuncts	11	
oils and fats	12	5
meat, fish and poultry	107	112
grain and cereals	156	192

Selenium is well known to accumulate in living tissues. Selenium has been found in marine fish meal at levels of about 2,000 µg/kg, which is about 50,000 times greater than the selenium levels in seawater (Wilbur, 1980). Table 9-18 is a list of selenium concentrations in a variety of fish tissue types.

Table 9-18. Concentrations of selenium in fish reported in the literature.

Fish type	µg/kg	Location and date	Reference
	Mean		
Razorback sucker eggs	3,700 - 10,600	Utah (1992)	Hamilton and Waddell, 1994
largemouth bass and bluegills gonads	2,630 - 4,640	power plant cooling reservoirs (1994)	Baumann and Gillespie, 1986
rainbow trout, edible portion	270	Toronto Harbor, Canada 1980	Davies, 1990
northern pike, edible portion	250	Toronto Harbor, Canada 1980	Davies, 1990
	Geometric mean		
freshwater fish	560 460 470	112 selected US monitoring stations during from 1976-1979	Lowe et al., 1985
brown trout liver	6,290	South Platte River Basin in 1992 -93	Heiny and Tate, 1997
carp liver	8,130	South Platte River Basin in 1992 -93	Heiny and Tate, 1997
white sucker liver	17,900	South Platte River Basin in 1992 -93	Heiny and Tate, 1997
lake trout	500 to 860	Lake Huron from 1980 - 85	Great Lakes Water Quality Board, 1989
walleye and splake /backcross lake trout	650 to 790	Lake Huron 1980 - 85	Great Lakes Water Quality Board, 1989
walleye and splake /backcross lake trout	700 to 790	Lake Huron 1979 and 1985,	Great Lakes Water Quality Board, 1989
	Maximum		
carp	3,650	Colorado River 1978 -79,	Lowe et al., 1985

The average concentrations of selenium in our study ranged from 220 µg/kg in a rainbow trout fillet to 1,100 µg/kg in the white sturgeon fillet (Table 2-14). The maximum concentration (2700 µg/kg) was in a white sturgeon fillet sample from the Hanford Reach of the Columbia River (study site 9U).

9.1.15 Vanadium

Vanadium is found in vegetables from about 0.5 to 2 µg/kg, with an average of about 1 µg/kg (Beyerrum, 1991). Veal and pork have been found to contain about 0.1 µg/kg. According to ATSDR (1992), foods containing the highest levels of vanadium include ground parsley, 1,800 µg/kg; freeze-dried spinach, 533 - 840 µg/kg; wild mushrooms, 50 - 2,000 µg/kg; and oysters, 455 µg/kg. Intermediate levels are found in certain cereals, like maize (0.7 µg/kg), and Macedonian rice 30 µg/kg). Also vanadium has been found in beef at 7.3 µg/kg, and in chicken at about 38 µg/kg. Seller and Sigel (1988) indicate that beverages, fats, oils, and fresh fruits and vegetables contained the least vanadium, ranging from less than 1 to about 5 µg/kg. Grains, seafoods, meats, and dairy products were generally from about 5 to 30 µg/kg. Prepared food ranged from 11 to 93 µg/kg, and dill seed and black pepper contained 431 and 987 µg/kg vanadium, respectively. ATSDR (ATSDR, 1992) indicates that in general, seafoods have been found to contain somewhat higher levels of vanadium than do tissues from terrestrial animals.

Mackeral has been found to contain about 3.5 µg/kg of vanadium, with 28 µg/kg in freeze-dried tuna (ATSDR, 1992). Konasewich et al. (1978) found vanadium in whole-fish samples of burbot and bloater chub taken from Lake Huron at concentrations of 75 µg/kg and 260 µg/kg, respectively. The same authors also found vanadium in whole samples of lake trout from Lake Superior, at 85 µg/kg. Nakamoto and Hassler (1992) found vanadium in the carcasses of male and female bluegill taken from the Merced River and the Salt Slough, California, at mean concentrations of 2,200 and 1,700 µg/kg, respectively.

In our study the average vanadium concentrations ranged from 5 µg/kg in fillet samples of spring chinook salmon and walleye to 310 µg/kg in whole body largescale sucker. The maximum concentration (770 µg/kg) was in a whole body rainbow trout composite sample from the Umatilla River (study site 101).

9.1.16 Zinc

Zinc occurs naturally in the earth’s crust at an average concentrations of about 70,000 µg/kg. It is introduced into aquatic systems via leaching from igneous rocks. Zinc is found in all living organisms and is an essential element for growth, development and reproduction. However aquatic animals tend to accumulate excess zinc which can result in growth retardation, hyperchromic anemia, and defective bone mineralization. Because zinc combines with biomolecules in target species and most of these species accumulate more than they need for normal metabolism, data showing bioconcentration factors for target receptors may be misleading. Bioconcentration factors (BCF’s) reported by EPA ranged from 51 in Atlantic salmon (*Salmo salar*) to 1,130 for the mayfly (*Ephemerella grandis*) (USEPA, 1987c). Little to no evidence exists indicating the successive biomagnification of zinc in tissues of fish and avian receptors (USEPA, 1987c).

In the ATSDR survey of food groups the levels for zinc ranged from 29,200 µg/kg in fish/meal/poultry to 2,300 µg/kg in leafy vegetables (Table 9-19).

Food Group	µg/kg	Food Group	µg/kg
meat/fish/poultry	29,200	dairy products	4600
grain/cereals	8,700	legumes	8300
legumes	8,300	leafy vegetables	2300
legumes	8,300		

Table 9-19. Concentrations of zinc in food groups. (Source: ATSDR, 1993)

The average concentrations of zinc in whole body fish tissue from our study ranged from 3800 µg/kg in the white sturgeon fillet to 30,000 µg/kg in the whole body coho salmon (Table 2-14). The maximum concentration (40,000 µg/kg) was in the whole body mountain whitefish from the Deschutes River (study site 98).

9.2 Comparisons By Fish Species

This section includes general descriptions of each of the chemicals measured in this study followed by brief comparisons of these chemicals with data reported in databases or other studies. More information about each chemical is provided in Appendix C (Toxicity Profiles). In addition to chemical descriptions, this section includes a summary of the life history of the fish species. This brief discussion of the habitat preferences and feeding habits is intended to provide some understanding of how the fish may be exposed to pollutants. Appendix B (Fish Life Histories) contains detailed information on each fish species.

The chemical levels measured in fish tissue from our study in largescale and bridgelip sucker, mountain whitefish, rainbow trout, channel catfish, smallmouth bass, fall and spring chinook, and coho were compared with levels reported in 4 databases and two other similar studies in the Columbia River Basin. Only those concentrations which had more than a 10 fold difference are discussed.

Information on white sturgeon, walleye, steelhead, eulachon, and Pacific lamprey was not found in these databases or reports. However their life histories and a synopsis of the literature information described in Section 9.1 are added to this section to complete the summary for all species from this study.

The 4 databases were developed by:

1) the USGS, National Contaminant Biomonitoring Program (NCBP) database (Schmitt et al., 1999a),

2) the USGS, Biomonitoring of Environmental Status and Trends (BEST) database (Schmitt et al., 1999b)

3) the State of Washington, Puget Sound Ambient Monitoring Program (PSAMP) (West et al., 2001 and

4) EPA's 1994 survey of literature reports on chemical data from the Columbia River

Basin (USEPA 1994d)

The NCBP database includes data on persistent organochlorine insecticides, industrial chemicals, herbicides, and potentially toxic contaminants that may threaten fish and wildlife resources (Schmitt et al., 1999a). The NCBP database, from the early 1960's through 1986, contains measured values of average whole-body composite fish samples where each composite sample was comprised of five individual fish samples.

The BEST database includes data from the smallmouth bass sampled from the Mississippi River drainage during August-December 1995 (Schmitt et al., 1999b). Fish tissue data consisted of whole body composite samples, where, ideally, each composite sample consisted of 10 individual fish samples.

The PSAMP database consists of measured chemical concentrations in fillet (without skin) composites of adult chinook and coho salmon (West et al., 2001). Composite samples include 2-5 individual fish, with five individual fish per composite being the most common.

EPA's 1994 database includes a compilation of data from 1984 to 1994 on chemical concentrations in fish tissue and sediments from the Columbia River Basin. The information in the database includes individuals and agencies contacted, data sources, abstracts for contaminant studies, and an overview of future or ongoing studies (USEPA, 1994d).

The data from two surveys of chemicals in fish from the Columbia River Basin were also compared to fish tissue residues from our study:

1) The Lower Columbia River Bi-State Water Quality Program (Tetra Tech, 1996) and

2) Willamette River Human Health Technical Study (EVS, 2000)

The Lower Columbia River Bi-State Water Quality Program (Tetra Tech, 1996) characterized potential human health risks associated with consuming fish from the lower Columbia River, below the Bonneville Dam. The Bi-State study was conducted during two periods: 1991-1993 and 1995. Data from 1991-1993 consisted of data that measured chemical contaminant concentrations in fillet tissues of five different resident target fish species (largescale sucker, carp, peamouth, white sturgeon, and crayfish). Five individual fish were composited to form single composite samples. Data from 1995 included measured chemical concentrations in fillet fish tissue from largescale sucker, smallmouth bass, chinook salmon, and coho salmon. Fish tissue data for these species consists of range and mean data from three composite samples where each sample was made up of eight fish.

The Willamette River Human Health Technical Study (EVS, 2000) included data from four fish species of which smallmouth bass and largescale sucker were used for comparisons with our study. Data were compared for both fillet with skin and whole body tissue. All samples from the

Willamette study were composite samples formed by homogenizing tissue from five to eight individual fish.

9.2.1 Largescale Sucker (*Catostomus macrocheilus*) and Bridgelip Sucker (*C. columbianus)*

The largescale sucker is native to the Pacific Northwest in tributaries to the Pacific Ocean from the Skeena River in British Columbia to the Sixes River in Oregon (Scott and Crossman 1973). Largescale suckers are abundant throughout the Columbia River and are the most common resident fish species collected in the Hanford Reach (Gray and Dauble 1977).

Dauble (1986) found that algal periphyton was the major food item for fry, juvenile, and adult largescale suckers in the Columbia River. The stomachs of adults may also contain crustaceans, aquatic insect larvae, snails, fish eggs, sand, and bottom debris (Dauble 1986, Scott and Crossman 1973). Stream fish appear to feed upon more algae, diatoms, and aquatic insect larvae other than Chironomidae, whereas lake fish include Amphipoda and Mollusca (Carl 1936).

The bridgelip sucker is found in the Fraser and Columbia river basins from British Columbia to southeastern Oregon, including the Harney basin, below Shoshone Falls in the Snake River, and in northern Nevada (Scott and Crossman 1973, Lee et al. 1980). Throughout its range in coexists and hybridizes with the largescale sucker (*C. macrocheilus*) (Dauble and Buschbom 1981).

The life history and behavior of the bridgelip sucker are poorly understood. According to Scott and Crossman (1973), this fish usually inhabits small, swift, cold-water rivers with gravel to rocky substrates, whereas Wydoski and Whitney (1979) report it inhabits quiet backwater areas or the edges of the main current of rivers with sand or mud bottoms. In the Yakima River, Patten et al. (1970) found this fish in warm flowing waters. In the mid Columbia River during the day, Dauble (1980) found that subadult and adult bridgelip suckers were common in the tailouts of pools, at the end of riffles, and above boulders in the main current. At night, these fish were more abundant near shore in flowing water 0.6 to 1.5 m deep.

The diet of *C. columbianus* is almost entirely periphyton during all seasons. This fish has an expanded cartilaginous lower lip on its mouth that enables it to efficiently crop algae attached to the bottom. However, like almost all other suckers, this species also feeds to some extent on aquatic insect larvae and crustaceans (Dauble 1978, Wydoski and Whitney 1979). Mammals and some birds prey on this species (Scott and Crossman 1973).

Chemical concentrations in largescale sucker fish tissue were compared for arsenic, cadmium copper, mercury, lead, selenium, zinc, p,p'-DDE, p,p'-DDT, Aroclor 1254, and Aroclor 1260 were compared data in the NCBP databases and the Bi-State and Willamette River studies (Table 9-20a).

While the metal concentrations in largescale sucker from our study were within the range of the other studies and databases examined, the maximum concentrations of metals were higher or lower depending on the chemical (Table 9-20a). Cadmium concentrations were 25 times higher in our study than in the Willamette River study and National NCBP database. Lead in largescale sucker from our study was 9 times higher than in largescale sucker from the NCBP National database.

The organic chemical comparisons in largescale sucker were also quite variable (Table 9-20a). With exception of the Aroclors the organic chemical concentrations in our study were all within the range of the other databases and studies. However, the maximum concentrations were different. The maximum concentration of p,pDDE in largescale sucker was 9 times higher in our study than in the Bi-State study, and 14 times higher than in the NCBP Columbia River station 98.

The maximum Aroclor 1254 concentrations in largescale sucker were higher in the Columbia River NCBP stations (from 8x to 46x) than in our study. The detection limits were too high in the National NCBP database to discern a difference in Aroclor 1254 and our study.

With the exception of cadmium, the Willamette River study results for metals and organic chemicals were similar to our study.

The concentrations of chemicals in bridgelip sucker were within the range found in largescale sucker, except the largescale sucker had higher maximum concentrations (Table 9-20a,b).

Table 9-20a. Comparison of chemical concentrations in composites samples of whole body largescale sucker.

Station	USGS- NCBP- Columbia River Basin				USGS- NCBP				EPA	
	Columbia (46)	Columbia (47)	Columbia (98)	Snake (41,42,96)	National	Willamette	Bi-State		Our study	
		range	range	range	range	single composite	mean	max	ave	range
Chemical	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*
Arsenic	<50 - 870	130 - 290	111 - 333	<50 - 260	40 - 270	120	8	385	160	74- 320
Cadmium	<50 - 160	<50 - 600	50 - 410	<50 - 260	<5 - 9	10	37	66	55	13-250
Copper	850 - 1340	1070 - 1283	720 - 1150	490- 4318	600 - 1010	1780	912	1230	1400	800-5600
Lead	90 - 390	100 - 520	160 - 2570	10 - 290	20 - 120	37	171	860	170	27-1100
Mercury	50 - 320	<10 - 160	20 - 130	10 - 230	10 - 370	121	122	264	130	<58-250
Selenium	60 - 430	60 - 386	190 - 250	170 - 450	80 - 340	ND	132	260	310	<180-500
p,p'-DDE	20 - 2000	20 - 1100	10-90	50 - 560	10 - 970	835	59	150	370	28-1300
p,p'-DDT	10 - 270	10 - 430	10-70	10 - 440	10 - 190	190	10	56	33	<1-180
Aroclor 1254	100 - 2100	5 - 3000	100 - 600	<5 - 500	<100	53	176	270	30	<14-65
Aroclor 1260	100 - 700	<5 - 100	100 - 300	<5 - 300	<100 - 300	36	35	1300	38	<12-100

Min= minimum; Max = maximum, Ave = average < = detection limit

NCBP = USGS National Contaminant Biomonitoring Program 1969-1986. Range of average whole body composites. Station numbers are in parentheses.

Willamette = composites without replication, EVS, 2000.

Bi-State = whole body concentrations of fish collected during 1991-1993 from the lower Columbia River, below Bonneville Dam. Mean and maximum (max) TetraTech, 1996

EPA- Our study = range of composite fish samples from sites in the Columbia River Basin. See table 1-1 and 1-2 for description of sites.

Table 9-20b . Comparison of ranges of chemical concentration in composite samples of whole body bridgelip sucker.

Station	USGS - NCBP- Columbia River Basin			NCBP	EPA
	Salmon (43)	Snake (96)	Columbia (98)	National	Our Study
Chemical	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*
Arsenic	160 - 330	No Data	180 - 270	60	260 - 300
Cadmium	20 - 50	No Data	70 - 280	<50 - 60	22 - 32
Copper	680 - 1900	No Data	No Data	No Data	880 - 1800
Lead	100 - 220	No Data	530 - 1000	<100 - 110	37 - 78
Mercury	40 - 80	120	20 - 70	80 - 160	<40 - 53
Selenium	200 - 470	No Data	200 - 260	No Data	280
p,p''-DDE	10 - 30	340 - 440	<10 - 40	200 - 350	310 - 560
p,p''-DDT	<10 - 20	190 - 200	<10 - 40	180 - 380	37 - 52
PCB1254	<100	<100 - 500	<100	1000 - 2800	18 - 32
PCB1260	<100	<100	<100 - 4800	No Data	27 - 49

< = detection limit

NCBP = USGS National Contaminant Biomonitoring Program 1969-1986 Range of average whole body composites. Station numbers are in parentheses.

EPA- Our Study = range of composites from the Yakima River (study site 48).

9.2.2 Mountain Whitefish (*Prosopium williamsoni*)

The mountain whitefish is native to cold water rivers and lakes in western North America, both east and west of the Continental Divide (Scott and Crossman 1973). Seven-year old fish range in length and weight from 307 to 387 mm and from 475 to 890 g, respectively, while the ranges for 8-year old fish are 330 to 410 mm and 501 to 944 g (Scott 1960, Pettit and Wallace 1975, Thompson and Davies 1976). Mountain whitefish feed primarily on immature forms of bottom-dwelling aquatic insects such as Diptera (true flies and midges), Trichoptera (caddisflies), Ephemeroptera (mayflies), and Plecoptera (stoneflies) (Wydoski and Whitney 1979, Cirone et al. 2002).

The ranges of chemical concentrations in the whole body mountain whitefish, from the present study were compared with mountain whitefish data from the NCBP database (Table 9-21). There was no consistent pattern between the metal concentrations in our study of mountain whitefish and NCBP database (Table 9-21). The maximum arsenic and cadmium levels were similar in our study and the NCBP database. The maximum copper concentrations in mountain whitefish in our study were 6 to 9 times higher than the concentrations in the NCBP database. Lead concentrations were higher in the NCBP database. The maximum mercury levels measured in the Salmon River in NCBP database were higher than the levels measured in our study; the levels in the NCBP Snake River mountain whitefish were lower. The maximum selenium concentrations were lower in the NCBP database than in our study.

The maximum p,p' DDE concentrations in mountain whitefish in our study were 700 times higher than the concentrations in mountain whitefish from the NCBP Salmon River station. The Aroclor concentrations were not comparable because of the higher detection limits in the NCBP database.

Table 9-21. Comparison of ranges chemical concentrations in composite samples of whole body mountain whitefish.

	USGS -NCBP - Columbia River Basin			EPA
Station	Salmon (43)	Snake (96)	Columbia (97)	Our Study
Chemical	µg/kg	µg/kg	µg/kg	µg/kg
Arsenic	120	No data	No data	120 - 180
Cadmium	40	No data	No data	<4 - 54
Copper	840	590	No data	620 - 5000
Lead	100	103	No data	10 - 72
Mercury	290	65	190	<47 - 130
Selenium	680	472	No data	590 - 1800
p,p'-DDE	<10	590	1410	13 - 770
p,p'-DDT	20	30	350	<2 - 49
Aroclor 1254	<100	100	<100	<21 - 140
Aroclor 1260	<100	100	100	<18 - 130

< = detection limit

NCBP = USGS National Contaminant Biomonitoring Program 1969-1986. Range of average whole body composites. Station numbers are in parentheses.

EPA- Our Study = range of composite fish samples from sites in the Columbia River Basin. See table 1-1 and 1-2 for description of sites

9.2.3 White Sturgeon (*Acipenser transmontanus*)

White sturgeon is native to the Pacific Northwest where it has evolved life history characteristics that have allowed them to thrive for centuries in large, dynamic river systems containing diverse habitats. These characteristics include opportunistic food habits, delayed maturation, longevity, high fecundity, and mobility (Beamesderfer and Farr 1997). White sturgeon may attain lengths and weights of more than 6 m and 580 kg, respectively, during a life span of over 100 years (Scott and Crossman 1973). White sturgeon body weight ranged from 9 to 34 kg.

White sturgeon take advantage of scattered and seasonal food sources by moving between different riverine habitats. They feed on a wide range of food items including zooplankton, molluscs, amphipods, aquatic larvae, benthic invertebrates, and fish (McCabe et al. 1993). White sturgeon are more predaceous than any other North American sturgeon (Semakula and Larkin 1968) and can capture and consume large prey (Beamesderfer and Farr 1997). Seasonal migrations occur in the Lower Columbia River where sturgeon move to feed on eulachon (*Thaleichthys pacificus*), northern anchovy (*Engraulis mordax*), American shad (*Alosa sapidissima*), moribund salmonids, amphipods, and other invertebrates (DeVore et al. 1995).

Concentrations of the Aroclors and 2,3,7,8-TCDF and in white sturgeon from our study of the Columbia River Basin were higher than the EPA 1994 (USEPA, 1998c) studies of Lake Roosevelt, Washington (Tables 9-9 and 9-10).

9.2.4 Walleye (*Stizostedion vitreum)*

The original range of the walleye generally east of the Rocky Mountains was expanded when it was introduced to the Columbia River below Roosevelt Dam in the 1940's or 50's (Wydoski and Whitney 1979). This species shows a preference for large, semi-turbid waters, but is capable of inhabiting a large range of physical and chemical conditions (Colby et al. 1979).

Feeding usually occurs near or at the bottom, and walleye may move into shallow water to feed. Walleye fry feed on rotifers, copepods, and cladocerans. Juvenile and adult walleye are largely piscivorus, but invertebrates (e.g., mayfly nymphs and amphipods) may be a large part of their diet in the late spring and early summer. Cannibalism is common with this species (Colby et al. 1979, Eschmeyer 1950). Prey for this species in the Columbia River includes mainly cottids, cyprinids, catostomids, and percopsids; out migrating juvenile salmonids were a smaller part of their diet (Zimmerman 1999).

Adult walleye are not usually preyed upon by other fish. However, in its native range northern pike and muskellunge do prey on this fish (Colby et al. 1979). They are also probably preyed upon by fish eating birds and mammals (Sigler and Sigler 1987).

The maximum concentration of Aroclors 1254 and 1260 and 2,3,7,8-TCDF in walleye were lower in our study of the Columbia River Basin than levels found in surveys of Lake Roosevelt, Washington, (USEPA, 1998c; Munn, 2000) (Tables 9-9 and 9-10).

9.2.5 Channel catfish (*Ictalurus punctatus*)

The original range of the channel catfish, east of the Rock Mountains was expanded when it was introduced to Idaho waters in 1893, but the date of its introduction to Washington waters is unknown (Wydoski and Whitney 1979, Simpson and Wallace 1982).

Young channel catfish tend to feed primarily on aquatic insects and bottom arthropods, but after attaining about 100 mm in length they are usually omnivorous or piscivorus (Carlander 1969). Adult channel catfish consume a wide variety of plant and animal material including clams, snails, crayfish, pondweed, and small terrestrial vertebrates (Eddy and Underhill 1976, Moyle 1976).

Young channel catfish are prey to a variety of fishes and piscivorus birds but the adults, due to their size and bottom occurrence, are probably free of predation (Scott and Crossman 1973, Schramm et al. 1984).

The concentrations of chemicals measured in channel catfish our study were compared to levels reported in the NCBP database (Table 9-22). The concentrations of metals were higher in the National and Columbia Basin NCBP databases with two exceptions. The maximum concentrations of arsenic and selenium concentrations in channel catfish were 10 times higher in our study than the NCBP Willamette station. The concentrations of the following metals were higher in the NCBP national database: cadmium 29x , lead 60x, mercury 14x, and selenium 4 times higher.

The concentrations of organic chemicals were higher in the NCBP National database than in our study. The maximum concentrations of the following chemicals in channel catfish from the National NCBP database were higher than the levels in channel catfish in our study: p,p'DDE 47x, p,p'DDT 166x, Aroclor 1260 672x, and Aroclor 1260 42 times higher. The concentrations of p,p' DDT in the NCBP Columbia Basin stations were 5 - 23 times higher than in our study. The maximum concentrations of Aroclor 1254 in channel catfish was from the NCBP Columbia Basin Stations were 24 to 76 times higher than in our study.

Table 9-22. Comparison of ranges of chemical concentrations in whole body channel catfish tissue from our study with the USGS-NCBP database.

Station	USGS - NCBP Willamette (45)	USGS - NCBP Snake (96)	USGS - NCBP National	EPA Our Study ave	EPA Our Study
Chemical	*µg/kg*	*µg/kg*	*µg/kg*		*µg/kg*
Arsenic	<50	<50 - 610	10 - 630	230	110 - 430
Cadmium	<50	<50	3 - 760	17	13 - 26
copper	no data	no data	no data	510	410 - 590
Lead	100	<100 - 210	30 - 2000	21	12 - 33
Mercury	290	80 - 900	<10 - 4500	210	140 - 320
Selenium	60	70 - 180	<50 - 2500	500	410 - 630
p,p'-DDE	570	<10 - 1050	10 - 42300	570	280 - 900
p,p'-DDT	<10 - 1050	<10 - 220	<5 - 7500	21	0.8 - 45
Aroclor 1254	4400	<10 - 1400	<50 - 39000	38	25 - 58
Aroclor 1260	No Data	<100 - 500	<50 - 5900	77	32 - 140

*Samples are fillet with skin; Ave= average

NCBP = USGS National Contaminant Biomonitoring Program 1969-1986. Range of average whole body composites. Station numbers are in parentheses.

EPA-Our Study = whole body composite samples from the Columbia River (study site 8) and the Yakima River (study site 48)

9.2.6 Smallmouth Bass (*Micropterus dolomieu)*

The range of the smallmouth bass, originally restricted to freshwaters of eastern-central North American, was expanded by plantings in the Pacific Northwest in the late 1800s and early 1900s. In Washington, smallmouth bass are most numerous in the Columbia and Snake rivers (Wydoski and Whitney 1979, Simpson and Wallace 1982).

Smallmouth bass fry initially eat copepods and cladocerans and at lengths of 2 to 5 cm change to a diet of insects and small fish (Hubbs and Bailey, 1938). Tabor et al. (1993) found that salmonids made up from 4 to 59% (by weight) and from 19 to 30% (by volume) of the diet of samllmouth bass in the Columbia River Basin. The authors concluded that predation rates on salmonids were high during the spring and early summer when subyearling salmon were abundant and of suitable forage size and shared habitat with the smallmouth bass.

Smallmouth bass in the Columbia River grow at a rate equal to or better than that of bass from other locations in the United States. In a 1952 study, the weights and total lengths of the Columbia River fish at age four were 510 g and 32 cm; age six, 794 g and 38 cm; age eight, 1,304 g and 43 cm; and at age ten, 1,814 g and 47 cm, respectively (Henderson and Foster 1957, Wydoski and Whitney 1979). The body weight of smallmouth bass in our study ranged from 1300 to 1400 g.

Smallmouth bass from our study were compared to data reported in the BEST and NCBP databases (Table 9-23). The concentrations of all chemicals in smallmouth bass from the NCBP National database were higher than in our study. In particular, Aroclor 1254 was higher (68x) in the NCBP National database. The Aroclor concentrations in Columbia River Basin NCBP stations had higher detection limits than in our study.

Table 9-23. Comparison of ranges of chemical concentrations in whole body smallmouth bass.

	USGS- NCBP					USGS	EPA
Chemical	**Yakima (44)**	**Snake (42)**	**Salmon (43)**	**Willamette(45)**	**National**	**BEST**	**Our Study**
Chemical	***µg/kg***	***µg/kg***	***µg/kg***	***µg/kg***	***µg/kg***	***µg/kg***	***µg/kg***
Arsenic	No data	50 - 60	<30 - 50	250	40 - 670	<178 - 263	160 - 170
Cadmium	No data	10 - 50	6 - 60	50	2 - 50	<36 - 43	5 - 19
Copper	No data	380	1182	No data	257 - 1950	445 - 591	500 - 560
Lead	No data	<100	100 - 170	120	10 - 320	8 - 100	10 - 140
Mercury	140 - 270	150 - 280	210 - 360	130	60 - 1200	80 - 280	220 - 360
Selenium	No data	440	606 - 830	No data	80 - 1260	203 - 491	480 - 710
p,p'-DDE	940 - 1660	80 - 2540	280 - 690	60	10 - 950	10 - 65	970 - 1700
p,p'-DDT	200 - 420	80 - 170	80 - 170	20	<5 - 590	10 - 84	44 - 80
Aroclor 1254	100 - 600	<100	<50 - 400	<400	<50 - 6400	No data	46 - 94
Aroclor 1260	200	<100 - 800	<50 - 100	<200	<50 - 1300	No data	80 - 190

NCBP = USGS National Contaminant Biomonitoring Program 1969-1986. Range of average whole body composites. Station numbers are in parentheses.
BEST = USGS Biomonitoring of Environmental Status and Trends Program - 1995 Fish Samples from the Mississippi Delta.
EPA- Our Study = whole body composite samples from the Yakima River (study site 48)

9.2.7 Rainbow and Steelhead (*Oncorhynchus mykiss*)

Oncorhynchus mykiss are native to the Pacific Northwest and appear in two forms: the resident rainbow trout and the anadromous steelhead, both of which occur in the Columbia River Bbasin. It also has the greatest diversity of life history patterns of any Pacific salmonid species (Wydoski and Whitney 1979, Pauley et al. 1986). This diversity includes degrees of anadromy, differences in reproductive biology, and plasticity of life history between generations (Peven 1990, Busby et al. 1996).

The diet of rainbow trout and juvenile steelhead changes seasonally, depending on food availability. They may feed on aquatic insects, amphipods, leaches, snails, and fish eggs. The steelhead's diet in the ocean includes crustaceans, squid, herring, and other fish (Withler, 1966; Wydoski and Whitney, 1979). Adult non-migratory rainbow trout average 0.9 to 1.8 kg in weight and usually have a life span of 5 to 6 years (Simpson and Wallace, 1982; Sigler and Sigler, 1987). Steelhead can achieve 9 years of age, weights of 16 kg, and lengths to 122 cm (Scott and Crossman, 1973; Wydoski, and Whitney, 1979). The average body weight of rainbow trout in our study ranged from 47 - 571g. The steelhead average body weight ranged from 1633 to 6440g.

The chemical residues in rainbow trout measured in our study were compared to the NCBP databases (Table 9-24). The maximum concentration of p,p' DDE in rainbow trout was 300 times higher in the NCBP Columbia River Basin station (Snake River) than in our study.

Steelhead concentrations of metals in fish tissue were within the range of rainbow trout (Table 9-24). The maximum concentrations of arsenic and lead were higher (4x and 2x respectively) in the steelhead, while p,p'DDE was lower in the steelhead than the rainbow trout.

Table 9-24. Comparison of ranges of chemical concentrations in composite samples of whole body rainbow trout.

	USGS - NCBP		EPA (Our Study)	
Station Chemical	Snake (41) µg/kg	National µg/kg	rainbow trout µg/kg	steelhead
Arsenic	<50 - 145	<50 - 260	<50 - 560	290 - 1200
Cadmium	5 - 50	10 - 70	<4 - 58	29 - 88
Copper	680 - 3130	1130 - 4620	900 - 5000	1900 - 6800
Lead	9 - 100	10 - 650	<10 - 88	<10 - 360
Mercury	30 - 130	10 - 270	<33 - 380	<50 - 420
Selenium	220 - 540	170 - 3000	230 - 790	460 - 940
p,p'-DDE	80 - 25400	10 - 140	3 - 84	5 - 33
p,p'-DDT	5 - 70	5 - 40	<2 - 12	<1 - 6
Aroclor 1254	100 - 600	<50 - 300	<10 - 20	9 - 29
Aroclor 1260	<50	<50 - 100	<6 - 22	<6 - 21

NCBP = USGS National Contaminant Biomonitoring Program 1969-1986. Range of average whole body composites. Station numbers are i in parentheses.

EPA- Our study = range of composite fish samples from sites in the Columbia River Basin. See table 1-1 and 1-2 for description of sites.

9.2.8 Chinook Salmon (*Oncorhynchus tshawytscha*)

Chinook salmon are the largest of the Pacific salmon and have a variable life history. Timing of migration and spawning, and the duration of freshwater, estuarine, and ocean residencies varies for this species (Meehan and Bjornn 1991). 'Stream-type' and 'ocean-type' chinook are the two main races. Stream-type chinook are also referred to as spring or summer chinook salmon, and ocean-type as fall chinook salmon. Most (78%) of the chinook salmon in the Columbia River are ocean-type and they spawn from mid-September to late December. Ocean-type juveniles migrate to the estuary at 3 to 6 months of age when they are 70 to 90 mm in length (Meehan and Bjornn 1991). In the estuary, these juveniles prefer low banks and subtidal refuge areas and their diet consists of insect and crab larvae and small fish (Healey 1991). Stream-type juveniles overwinter in freshwater before out migrating as yearlings from April to June. Some will spend two winters in freshwater. Deep pools with rock crevices provide over wintering habitat. In freshwater, juvenile diet is primarily insects, both aquatic larvae and terrestrial adults. During outmigration, yearling smolts spend a brief period in the estuary where they occupy the outer part of the estuary, thus, their habitat does not overlap with the smaller ocean type chinook (Healey 1991).

Chemical concentrations of metals and organic chemicals measured in fall chinook salmon from our study of the Columbia River Basin were compared to fall chinook salmon measurements in PSAMP databse and the Bi-State study (Table 9-25).

The concentration of arsenic in chinook salmon was similar in our study, PSAMP, and the EPA 1994 database, while the Bi-State arsenic concentrations were lower (48x for fall chinook salmon; 52x for spring chinook salmon). The cadmium levels in chinook salmon were higher (13x fall chinook salmon; 3x spring chinook salmon) in the EPA 1994 database than our study. The maximum lead concentrations were higher in the spring chinook salmon in our study than in the Bi-State study (14x). Fall chinook and spring chinook salmon from our study had higher concentrations of Aroclor 1254 than the Bi-State study (35x and 24x, respectively).

The chemical concentrations in fall and spring chinook salmon from our study were similar to each other with the exception of cadmium, lead, and mercury which were higher in spring chinook (15x, 8x, and 5x, respectively; Table 9-25).

Table 9-25. Comparison of chemical concentrations in chinook salmon fillet with skin.

Station	EPA 1994 Database	PSAMP	Bi-State		EPA Our Study			
					fall chinook salmon		spring chinook salmon	
Chemical	range µg/kg	range µg/kg	ave µg/kg	max µg/kg	ave µg/kg	range µg/kg	ave µg/kg	range µg/kg
Arsenic	20 - 1110	570 - 1600	13	23	810	530 - 1100	850	560 - 1200
Cadmium	20 - 50	No data	2	2.5	<2	<4	2	<4 - 15
Copper	240 - 1900	370 - 1200	860	1010	640	540 - 760	790	240 - 1000
Lead	20 - 40	no data	7	10	7	<10 - 16	14	<10 - 140
Mercury	62 - 164	58 - 160	100	130	84	<50 - 150	100	<83 - 510
Selenium	360 - 370	no data	280	340	330	280 - 380	350	290 - 430
p,p'-DDE	no data	4 - 48	8.5	11	12	4 - 26	12	6 - 18
p,p'-DDT	3	0.5 - 4	1.5	3	2.5	<2 - 8	4	3 - 8
Aroclor 1254	18 - 20	5 - 88	0.9	0.9	17	9 - 35	16	9 - 24
Aroclor 1260	16 - 30	1 - 72	10	15	9.9	<19	11	<18
2,3,7,8-TCDD	0.00014	no data	0.0002	0.0006	0.00002	<0.00001-0.00005	0.00002	<0.00001-0.00005
2,3,7,8-TCDF	0.0009	no data	0.0016	0.00027	0.00068	<0.00003-0.0014	0.0006	0.0004-0.00074

Ave = average; max = maximum < = detection limit
EPA 1994 database = EPA survey of data from the Columbia River Basin from 1983-1994. Does not differentiate between spring and fall chinook salmon
Bi-State = 1995 concentrations in fillets of fish from the lower Columbia River, below Bonneville Dam. Does not differentiate between fall and spring chinook salmon (Tetra Tech, 1996) .
PSAMP =1992-1995, data is for fillet without skin. Does not differentiate between fall and spring chinook salmon
EPA- Our study = range of composite fish samples from sites in the Columbia River Basin. See table 1-1 and 1-2 for description of sites

9.2.9 Coho Salmon (*Oncorhynchus kisutch*)

Coho salmon are one of the five Pacific salmon species in North America. The life span of most coho is three years, during which they attain average weights ranging from about 3,000 to 6,000g (Wydoski and Whitney 1979). The average body weight of the coho salmon in our study was 2,855g to 3,960g.

The coho salmon fish typically spend up to 21 months in freshwater followed by approximately 16 months in the ocean before returning to freshwater where they will spawn and die. These fish rarely feed on non-moving food or off the bottom in streams (Sandercock 1991). Juveniles consume insects (larvae, pupae, and adults), worms, small fish, and fish eggs. In reservoirs, coho juveniles feed primarily on zooplankton and emerging insects (Wydoski and Whitney 1979).

Samples of coho salmon from our study were compared to data from PSAMP and the Bi-State study (Table 9-26). The maximum concentrations of several chemicals were higher in coho salmon from our study than the coho salmon from the Bi-State study: arsenic (85x), lead (25x), and Aroclor 1254 (19x).

Table 9-26. Comparison of chemical concentrations in coho salmon fillet with skin.

Station	PSAMP	Bi-State		EPA - Our study	
	range	mean	max	ave	range
Chemical	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*
Arsenic	570 - 1600	2.7	7	540	450 - 600
Cadmium	No data	3	5		<4
Copper	410 - 1010	810	850	1700	680 - 3600
Lead	No data	4	9	81	<10 - 230
Mercury	58 - 160	44	48	120	110 - 120
Selenium	No data	168	188	290	270 - 310
p,p'-DDE	1.3 - 26	3	5	33	29 - 35
p,p'-DDT	0.52 - 1.4	0.8	1	2	<2 - 4
Aroclor 1254	2 - 66	0.6	0.9	16	12 - 19
Aroclor 1260	1 - 32	3	4		<18
2,3,7,8-TCDD	No data	0.0003	0.0009	0.000017	<0.00001 - 0.00004
2,3,7,8-TCDF	No data	0.0007	0.0009	0.0005	0.0004 - 0.0005

Ave = average; max = maximum; < = detection limit
PSAMP = 1992-1995, data is for fillet without skin
Bi-State = 1995 whole body concentrations of fish from the lower Columbia River, below Bonneville Dam. (TetraTech, 1996)
EPA - Our study = range of composite fish samples from sites in the Columbia River Basin. See table 1-1 for site descriptions.

9.2.10 Pacific Lamprey (*Lampetra tridentata*)

The Pacific lamprey is a native anadromous fish with a widespread distribution in the Columbia River Basin (Wydoski and Whitney 1979).

The adults overwinter in freshwater, do not feed during this time, and spawn the following spring (Beamish 1980). Larvae (ammocoetes) leave the gravel approximately 2 to 3 weeks after hatching, drift down current, settle in slow back water areas, burrow in soft substrates with organic debris, and take up a filter feeding existence (Pletcher 1963, Kan 1975). The ammocoete life stage may range from 4 to 7 years, during which time they remain buried in the sediment (Beamish and Levings 1991, Close et al. 1995). Ammocoetes are reported to feed on vegetative material (Clemens and Wilby 1967), diatoms and desmids (Pletcher 1963), and detritus and algae suspended above and within the substrate (Moore and Mallatt 1980). Juvenile lampreys play an important role in the diets of many freshwater fishes, including channel catfish, northern pike minnow, and several species of cyprinids and cottids. Salmonid fry prey upon lamprey eggs, but do not feed on the ammocoetes. The larvae are also taken by several species of gulls and terns (Pletcher 1963, Close et al. 1995).

Metamorphosis occurs from July to October. Shortly thereafter, the downstream migration of young adult lampreys begins usually at night and with an abrupt increase in river flow. Pacific lampreys migrate to salt water where they take up a parasitic life, but feeding may start in freshwater (Pletcher 1963, Beamish 1980, Beamish and Levings 1991).

The ocean phase of the adult life cycle may last 3.5 years (Beamish 1980). In ocean and estuarine areas, adults are important prey for several pinniped species. After entering the Columbia River they become a prey item for white sturgeon (Wydoski and Whitney 1979, Roffe and Mate 1984, Close et al. 1995).

There were no comparable studies of Pacific lamprey in the literature.

9.2.11 Eulachon (*Thaleichthys pacificus)*

The eulachon occurs only on the west coast of North America, including the Columbia River Basin (Scott and Crossman 1973). This anadromous species spawns in the main channel of the Columbia River and periodically in the Grays, Cowlitz, Kalama, Lewis, and Sandy Rivers (Smith and Saafeld 1955).

It is believed that developing larvae do not to feed in freshwater, but rely on their yolk sac for nourishment until they reach the ocean (Smith and Sallfeld 1955, Scott and Crossman 1973). At sea, post-larval eulachon move into deeper water as they grow. They feed on plankton, mysids, ostracods, copepods and their eggs, and barnacle, cladoceran, and polychaete larvae (Hart 1973). Juvenile and adult fish feed primarily on euphausid shrimp, crustaceans, and cumaceans. Adults do not feed after they return to freshwater (Barraclough 1964).

As are other smelts, *T. pacificus* is a very important food item for a wide variety of predators. Adults are fed on by many piscivorus fishes including Pacific salmon and white sturgeon, marine mammals ranging from the harbor seal to the finback whale, seabirds, waterfowls, and gulls (Scott and Crossman 1973). The larval and post larval stages contribute modestly to the diet of small salmon off the Fraser River (Hart 1973).

There were no comparable studies of eulachon in the literature.

9.3 Comparisons across all species

9.3.1 Resident Fish

White sturgeon, mountain whitefish, whole body walleye, largescale sucker, smallmouth bass, and channel catfish had the highest concentrations of organic chemicals of all the species tested in this study (Table 9-27a,b). Bridgelip sucker and walleye fillet samples had much lower chemical residues, similar to the salmonids and eulachon.

The largescale sucker was the fish species with the most frequent detection of PAHs (Table 2-1a). The phenols were detected in only one white sturgeon sample from the main-stem Columbia River (study site 8) (Table 2-1a).

The basin-wide average concentrations of total DDT (Table 2-4) in the salmonids (chinook, coho, rainbow trout, and steelhead) and eulachon were much lower than, white sturgeon, mountain whitefish, largescale sucker, and smallmouth bass. The maximum concentrations p,p'DDE was found in whole body smallmouth bass followed by white sturgeon fillet, channel catfish fillet, and whole body largescale sucker (Table 9-27a).

The white sturgeon, mountain whitefish, whole body walleye, and smallmouth bass had the highest concentrations of Aroclors. The maximum concentration of TCDF was in the white sturgeon (Table 9-27a,b). The next highest average concentration was in the mountain whitefish.

The maximum concentrations of metals (arsenic, cadmium, copper, lead, mercury, selenium) were lower in the resident species than in the anadromous species, except for largescale sucker which had the highest concentration of cadmium (Table 9-27a,b). When doing a comparison of fish tissue across all species it is important to not only consider the maximum concentrations but also some measure of the variability. In this study, the average concentration is a measure of variability. While the maximum mercury and selenium concentrations were in the spring chinook salmon, the basin-wide average concentrations of mercury were highest in the largescale sucker, walleye, and white sturgeon.

The higher concentration of organic chemicals may be attributed to size in some species or lipid content. The white sturgeon were some of the largest fish measured in the study. The samples included only single fish. It is also known to have a very long life span. Thus, it is not clear whether the high levels of organic chemicals in this fish may be due to an anomaly in the few fish that were sampled, their size, or their age.

The association of organic chemical concentrations in the tissues of resident species and percent lipid was not particularly evident in this study. There was an association with lipid in the white sturgeon samples from one study site (study site 6). The difference in chemical content between the whole body walleye and the fillet was also associated with lipid. However, there were no other clear associations of whole body and fillet with lipid and organic chemicals in fish tissue.

There was an indication of high concentrations of organic chemicals in the resident fish collected from the Hanford Reach of the Columbia River (study site 9U). However, there is no information in this study to explain the levels in fish from this study site.

9.3.2 Pacific lamprey and eulachon

Of the anadromous fish species, Pacific lamprey had maximum concentration of organic chemicals (DDE and Aroclor 1254; Table 9-27b). The high concentration of organic chemicals in the Pacific lamprey may have been due to its high lipid content.
The metals content of the Pacific lamprey was not consistent across different metals. For example when compared to the other anadromous species, the arsenic concentrations were low for Pacific lamprey while concentrations of copper, lead, mercury, and selenium were within the range of the range of these other fish species.

While eulachon also had a high lipid content, they had some of the lowest levels of organic chemicals of all the species test. Aroclors and chlordane were not detected in the eulachon. Eulachon had the highest average concentration of arsenic and lead.

9.3.3 Salmonids

The salmonids had the lowest concentrations of organic chemicals with a few exceptions. There were no semi-volatile chemicals detected in the fall chinook salmon or coho salmon tissue samples. Pyrene was found at the highest concentrations of all the PAHs in a rainbow trout collected from the upper Yakima River (study site 49). The fillet or whole body samples of rainbow trout, eulachon, and coho salmon had no detectable concentrations of any of the chlordane compounds.

The concentrations of metals in the chinook salmon and steelhead were higher than the other resident or anadromous fish species. Steelhead had the maximum concentration of arsenic. When doing a comparison of fish tissue across all species it is important to not only consider the maximum concentrations but also some measure of the variability. In this study, the average concentration is a measure of variability. Thus, while steelhead had the maximum concentration of arsenic, the average concentrations were higher in eulachon, and chinook salmon (Table 2-14). From this study, the salmon, steelhead, and eulachon had higher concentrations of arsenic than the resident species and Pacific lamprey. Fall chinook salmon had the maximum concentration of lead (Table 9-27b). The average concentrations of lead were highest in eulachon, fall chinook salmon, and whole body walleye (Table 2-14).

Although the egg samples from the salmon and steelhead had high percent lipid, the concentration of organic compounds was generally lower than the fish tissue of the anadromous or resident fish with a few exceptions. The highest concentrations of total chlordane were in egg samples from the spring chinook salmon. The maximum concentrations of copper and selenium were in egg samples from the salmon and steelhead (Table 9-27b). The basin -wide average concentrations of copper were highest in the egg samples from the salmon and steelhead followed by the whole body Pacific lamprey. The basin-wide average concentrations for selenium were highest in spring chinook salmon egg samples followed by white sturgeon and mountain whitefish. The high concentration of selenium may also be associated with the high percent lipid in the egg samples.

Table 9-27a. Range of chemical concentrations in resident fish tissue samples from our study of the Columbia River Basin, 1996-1998.

Chemical	T	largescale sucker *µg/kg*	Bridgelip sucker *µg/kg*	rainbow trout *µg/kg*	mountain whitefish *µg/kg*	white sturgeon** *µg/kg*	walleye *µg/kg*	channel catfish *µg/kg*	smallmouth bass *µg/kg*
N-FS		*19*		*7*	*12*	*16*	*3*	*5*	
N-WB		*23*	*3*	*12*	*12*	*8*	*3*	*6*	
Arsenic	FS	50 - 100	NS	<50	51 - 140	150 - 640	290 - 400	50 - 330	110 - 170
	WB	74 - 320	260 - 300	<50 - 560	120 - 180	<200 - 640	480 - 510	110 - 430	160 - 170
Cadmium	FS	<4 - 24*	NS	<4 - 5*	<4 - 14*	<4 - 6*	<4	ND	ND
	WB	13 - 250	22 - 32	<4 - 58	4 - 54	15 - 95	100 - 110	13 - 26	5 - 19
Copper	FS	430 -870	NS	440 - 610	510 - 840	<210 - 410	500 - 600	310 - 360	510 - 560
	WB	800 - 5600	880 - 1800	900 - 5000	620 - 5000	260 - 1800	730 - 5700	410 - 590	500 - 560
Lead	FS	10 - 140	NS	<10	<10 - 26	<10 - 29*	<10	10 - 11*	10 -55
	WB	27 - 1100	37 - 78	<10 - 88	10 - 72	27 - 330	<10 - 490	12 - 33	10 - 140
Mercury	FS	71 - 370	NS	45 - 150	<49 - 140	38 - 430	160 - 200	240 -280	380 -470
	WB	<58 - 250	40 - 53	<33 - 380	<47 - 130	73 - 250	120 - 220	140 - 320	220 - 360
Selenium	FS	130 - 400	NS	180 - 250	300 - 720	310 - 2700	380 - 400	240 - 500	450 - 530
	WB	<180 - 500	<280	230 - 790	590 - 1800	<420 - 1100	410 - 540	410 - 630	480 - 710
p,p'-DDE	FS	14 - 740	NS	4 - 54	8 - 910	100 - 1400	44 - 52	330 - 1300	480 - 1200
	WB	28 - 1300	310 - 560	3 - 84	13 - 770	400 - 1100	350 - 440	280 - 900	970 - 1700
p,p'-DDT	FS	<2 - 92*	NS	<2 - 5*	<2 - 58	2 - 31	<2 - 3	2 - 87	23 - 48
	WB	<1 - 180	37 - 52	<2 - 12*	<2 - 49	<4 - 38	7 - 12	0.8 - 45	44 - 80
Aroclor 1254	FS	10-46	NS	10 - 20	<16 - 930	10 - 190	12 - 14	29 - 69	38 - 83
	WB	<14 - 65	18 - 32	<7 - 30	<21 - 140	38 - 120	54 - 98	25 - 58	46 - 94
Aroclor 1260	FS	<11 - 75	NS	<18	<9 - 190	<13 - 200	<19	37 - 130	68 - 220
	WB	<12 - 100	27 - 49	<6 - 22*	<18 - 130	41 - 160	47 - 61	32 - 140	80 - 190
2,3,7,8-TCDD	FS	<0.00001 - 0.00007	NS	<0.0000 - 0.00015	<0.00001 - 0.00021	0.0001 - 0.0014	0.00007 - 0.00008	0.001 - 0.0014	NA
	WB	<0.00001-0.00021	0.00006-0.00008	<0.00001 - 0.0002	<0.00001 - 0.00023	0.00006 - 0.0013	0.00036 - 0.00042	0.0010 - 0.0014	NA
2,3,7,8-TCDF	FS	0.0001 - 0.0015	NS	0.00014 - 0.00028	0.00014 - 0.014	0.0025 - 0.054	0.0006 - 0.00075	0.0022 - 0.0034	NA
	WB	0.0008 - 0.0036	0.0008 -0.001	<0.0004 - 0.00048	0.0002 - 0.012	0.008 - 0.047	0.0038 - 0.0055	0.0022 - 0.0034	NA

N=number of samples; FS- Fillet with Skin; WB = whole body;E=egg; NA = not analyzed; < detection limit; * detection frequency was less than 50% of the samples

**whitesturgeon were single fish and fillets without skin.

Table 9-27b. Range of chemical concentrations (µg/kg) in anadromous fish tissue samples from our study of the Columbia River Basin.

	T	steelhead	fall chinook salmon	spring chinook	coho salmon	eulachon	Pacific lamprey
N-Egg		*1*	*1*	*6*	*3*		
N-FS		*21*	*15*	*24*	*3*		*3*
N-WB		*21*	*15*	*24*	*3*	*3*	*9*
Arsenic	E	ND	240	<410 - 510	310 - 360		
	FS	280 - 1500	530 - 1100	560 - 1200	450 - 600	NS	280 - 360
	WB	290 - 1200	610 - 1000	570 - 1100	450 - 560	860 -930	150 - 370
Cadmium	E	34	<4	22 - 72	<4		
	FS	<4 - 9	<4	<4 - 15	<4	NS	16 - 30
	WB	29 -88	5 - 10	6 - 170	19 - 27	9 - 10	56 - 150
Copper	E	18,000	5800	5300 - 6600	4100 - 5000		
	FS	540 - 940	540 - 760	240 - 1000	680 - 3600	NS	1100 - 1400
	WB	1900 - 6800	1000 - 14000	1100 - 2300	720 - 2400	920 - 970	3700 - 5500
Lead	E	41	<10	<10 -50*	<10		
	FS	<10 -23*	<11 - 16	<10 - 140	<10 - 230	NS	<10
	WB	<10 - 360	11 - 1200	<10 -92	11 - 20	370 - 680	<10 - 69*
Mercury	E	<43	<50	<79	<100		
	FS	70 - 210	<50 - 150	<83 - 510*	110 - 120	NS	<110
	WB	<50 - 420	<50 - 200	<71 - 130*	11 - 20	<35	<91 - 210
Selenium	E	4500	2400	3700 - 5500	1100 - 1300		
	FS	<250 - 500	280 - 380	290 - 430	270 - 310	NS	410 - 450
	WB	460 -940	<380 - 570	360 - 680	330 - 420	270 - 300	520 - 760
p,p'-DDE	E	7	7	10 -16	31 - 33		
	FS	5 - 28	4 - 26	6 - 18	29 - 35	NS	46 - 55
	WB	5 - 33	5 - 53	11 - 22	31 - 37	10 - 11	35 - 77
p,p'-DDT	E	<2	<2	4 - 7	<2		
	FS	<1 - 5	<2 - 8	<2 - 7	<2 - 4	NS	28 - 38
	WB	<1 - 6	<2 - 7	3 - 8	<2 - 4	<4	6 - 29
Aroclor 1254	E	15	12	15 - 20	11 - 17		
	FS	8 - 21	9 - 35	9 - 24	12 - 19	NS	80 - 100
	WB	9 - 29	10 - 47	13 - 26	18 - 19	<37	60 - 150
Aroclor 1260	E	<20	<19	<18	<18		
	FS	<6 - 21*	<19	<18	<18	NS	<19
	WB	<6 - 21*	<19	<18	<18	<37	<13 - 20*
2,3,7,8-TCDD	E	<0.00003	<0.00004	<0.00001 - 0.00004	<0.00001-0.00005		
	FS	<0.00001 0.00008	<0.00001 - 0.00005	<0.00001-0.00005	<0.00001-0.00004		0.00001-0.00006
	WB	<0.00001-0.00006	<0.0000 - 0.00006	<0.00001 - 0.0001	<0.00001	<0.00005-0.0001	0.00002 - 0.0007
2,3,7,8-TCDF	E	<0.00022	0.00043	0.00036 - 0.00065	0.00029-0.00066		
	FS	<0.00018-0.00065	<0.00003-0.0014	0.0004-0.00074	0.00035-0.00054		0.0012-0.0017
	WB	<0.00025-0.0006	0.00043-0.0014	0.00057 - 0.0011	0.00036-0.00049	0.00058-0.00078	0.0011-0.0032

10.0 Uncertainty Evaluation

There are many uncertainties in completing a survey of contaminants in fish tissue and in estimating risks from consumption of these fish. This section provides a summary of the assumptions and uncertainties in evaluating the fish contaminant data and preparing the risk assessment. Some of the types of uncertainty which were encountered in this study include:

1) errors in sampling, fish preparation, and chemical analysis,

2) variability in fish tissue concentrations within fish, across species and tissue types, and among stations,

7) lack of comparable data-sets for comparisons, and

3) lack of knowledge regarding human exposure and toxicity.

10.1 Fish Tissue Collection

Uncertainty in toxic chemical levels is primarily associated with variability in fish tissue concentrations over space and time as well as errors in chemical analytical methods. The temporal (seasonal, annual) range of chemical concentrations in fish species was not known.

There was some measure of spatial variability in certain fish species which were collected at a number of sites (largescale sucker, white sturgeon, mountain whitefish, rainbow trout, chinook salmon, steelhead, Pacific lamprey). Coho salmon, bridgelip sucker, and eulachon were each only collected at one location, therefore there was no measure of spatial variability in these species. Pacific lamprey and walleye were only collected at two locations. Therefore, there were gaps in our information on contaminant levels in these species from other sections of the Columbia River Basin. In addition to a limited number of sampling locations, some of the sites included large stream reaches (Table 1-1). Therefore, the average concentrations from these sites represent sampling areas of several miles.

Individual fish tissue were composited to obtain a representative sample of the mean concentrations of fish tissue. However, by compositing the fish there is a loss of certainty in the variance among individual fish samples. To reduce some of the uncertainty associated with composites, an attempt was made to collect fish: 1) at the same time and 2) of the same size.

To maintain uniformity in sample size within composites the smallest individual within a composite was supposed to be no less than 75% of the total length of the largest individual. Seventy-nine percent of the composites were within this guideline. Of the composite samples not meeting the guideline, roughly one-half were within 70% of the total length of the largest individual. The compositing goals were not fully met in all samples because:

1) larger fish (rainbow trout and mountain whitefish) were added to some composites to gain enough fish tissue for analyses,
2) tribal members requested that small fall chinook salmon (jacks) be added to samples of larger adults, or
3) spatial and temporal variability in fish species limited the number of fish available for sampling.

To maintain uniformity across composites the relative difference between the average length of the individuals in the smallest-sized composite (i.e., the one with the smallest average body lengths) was to be within 10% of the average length of the largest-sized composite. Eighty-nine percent of the composites were within the 10% guideline. Of the 11% not meeting the guideline, 5 composites were steelhead, and one each were walleye, largescale sucker, rainbow trout, and spring chinook salmon.

In addition to collecting composites of the same size an attempt was made to collect replicate samples at each study site to provide a more accurate estimate of the variance in tissue analyses. The goal of collecting at least three replicate composite samples for each sample type from each study site was met at 92% of the study sites. Only two replicates or less were collected at 8% of the study sites. Replication was limited at study site 30 on the Umatilla River because the electro-fishing boat broke down, which prohibited additional collections of walleye and largescale sucker. There were a low number of rainbow trout available from study site 98 in the Deschutes River.

The uncertainty in the tissue concentrations is also associated with the sampling design. The fish type, tissue type, and sample location were all predetermined during the planning conference. This type of sampling is biased with unequal sample sizes and predetermined sample locations rather a random design. This bias is to be expected when attempting to provide information for individuals or groups based on their preferences. The results of this survey should not be extrapolated to any other fish or fish from other locations.

EPA's guidance for preparing fish tissue for chemical analysis recommends scaling fish (USEPA, 2000f). However, CRITFC's member tribes do not typically scale their fish (CRITFC tribes, personal communication). The results of some of the chemical analyses in this report may be affected by the amount of certain chemicals (e.g. metals) which may be concentrated in the fish scales.

The homogeneity of ground fish tissue can vary considerably, depending upon the nature of the tissue sample and the grinding procedures. In this project we attempted to minimize variability of chemical measurements by specifying the fish grinding procedure (See Volume 5) and by monitoring the homogeneity of composite samples.

With the exception of white sturgeon, fish tissue chemical residues were measured in fillet with skin and whole body. White sturgeon were the only species which were analyzed as fillet without skin. As discussed in Section 2, whole body fish tissue samples tend to be somewhat higher in lipids than fillet with skin samples for some fish species. This difference in lipids between whole body and fillet fish samples was not consistent across species. This was not surprising since the preparation of fillets with skin usually left a thin layer of subcutaneous fat remaining under the skin.

The fillet and whole body samples were not from the same fish. Therefore, any comparisons between them will be affected by the natural variability in fish samples as well as the tissue type.

10.2 Chemical Analyses

All data quality objectives established for this project were met. However, there were uncertainties in the chemical analysis due to interferences, detection limits, and method development.

A number of problems were encountered in the measurement of target compounds. For dioxins/furans, dioxin-like PCBs, non-acid labile chlorinated pesticides, and Aroclors, the primary analytical problem encountered by the laboratories was the interference of chlorinated and brominated non-target compounds in extracts of project fish samples. For dioxin-like PCBs, many sample extracts had to be diluted and re-measured because of high levels of dioxin-like PCB target compounds in some samples.

The metallic equipment used to grind fish samples was tested prior to sample analysis for possible interferences. The results indicated that lead, manganese, nickel, copper, aluminum, zinc, and PCB 105 were found in the rinsate blanks from the fish grinder. The levels of manganese, nickel, copper, aluminum, zinc, and PCB 105 were in negligible quantities and should not affect the study results. However, the lead levels (77 µg/l) in the rinsate were higher; therefore, the results reported in this study for lead may be increased over levels that would be found in tissue samples.

Modifications to digestion procedures for high levels of lipids in some project samples improved measurements of metals and mercury using EPA methods 200.8 and 251.6. The chemical analysis of chlorinated phenolics (EPA Method 1653) and neutral semi-volatiles (EPA Method 8270) had the largest number of data which were not acceptable due to high quantitation limits.

For this project, analytical methods were chosen to provide detection or quantitation limits which were as low as possible given available analytical methods and resources. The true value of chemicals which were "not detected" is actually somewhere between the reported detection limit and zero. For this study ½ the detection limit was used to estimate chemical concentrations. Appendix E lists each chemical concentration as equal to: 1) the detection limit, 2) zero, and 3) one-half the detection limit. The use of ½ the detection limit may have over or underestimated the true fish tissue concentration.

In the quality assurance review of the chemical data, certain chemical concentrations were qualified with a "J". The "J" qualifier designates a concentration which is estimated. EPA recommends that the J-qualified concentrations be treated in the same way as data without this qualifier with acknowledgment that there is more uncertainty associated with "estimated" data (USEPA, 1989). We chose to use these data in this assessment without conditions. Use of this data to calculate fish tissue concentrations may overestimate the true concentration since these levels may be incorrect. The data qualifiers are listed with each data point in Appendix D of Volume 1 and in Volume 4.

The percent difference in field duplicates was estimated for all chemicals analyzed. There was less than 10% difference between most of the duplicate samples. The samples with greater than 10% difference are shown in Table 10-1. The maximum difference was 157% in cobalt concentrations in fall chinook from study site 48 (Table 10-1). There was no consistent pattern of error in field duplicate by study site, chemical, or fish species.

The difference in duplicate fillets from the same fish is an indication of the variability of chemicals within fish tissue, since the fillets were from the opposite sides of the same fish. In this study, the duplicate values were averaged. By averaging the concentration of the duplicate samples fish tissue concentrations and risk estimates may be lower than the actual exposure that would occur if the higher fish tissue concentration was used.

Table 10-1 . Percent difference in field duplicate samples from the Columbia River Basin. Fish are listed with study site ID in parentheses. The maximum percent difference is given for the chemical within a chemical group.

	Percent difference for analytes (greater than 10%)			
Species (study sites)	**Dioxins & Furans**	**Metals**	**PCBs**	**Pesticides**
steelhead (96)	46 (OCDD)	68 (Ba)	56 (PCB 123)	67 (DDT)
spring chinook (94)	13 (HXCDF)	62 (Cd)	17 (PCB 189)	15 (DDT)
fall chinook (8)		29 (Hg)	14 (PCB 157)	11 (DDD)
fall chinook (48)	18 (TCDF)	107 (Cr); 157 (Co)	28 (PCB 126); 18 (Aroclor 1254)	
mountain whitefish (98)	29 (TCDD)	70 (Pb)	32 (PCB 167); 32 (Aroclor 1254)	35 (DDE)
white sturgeon (13)	29 (HxCD)	54 (Hg)	15 (PCB 118); 11 (Aroclor 1260)	124 (nonaclor)
white sturgeon (6)	57 (TCDF & HxCDF)	42 (Co)	39 (PCB 105); 109 (Aroclor 1254)	119 (DDT)
white sturgeon (9)	50 (OCDD)	144 (Co)	27 (PCB 169)	59 (oxychlordane)

10.2.1 Lipid analyses

All samples were measured for percent lipids according to the procedure described in EPA Method 1613B. Other percent lipid procedures such as the three extraction methods described in EPA Method 8290 would have produced different percent lipid results because of the different extraction solvents used and different extraction conditions. While the lipid values reported in our study were consistent because the analyses were all done within one laboratory using one method, there would be considerable uncertainty in comparing the lipid levels measured in this study with other data generated by different methods or different laboratories.

10.3 Comparing Chemical Data Across Fish Species and with Other Studies

The comparison of this study with other studies is confounded by the methods that were used to collect the samples, the tissue type, number of samples, and species as well as the inconsistency in chemical methods. In particular, methods for analyzing fish tissue for dioxins, furans, and PCB congeners have changed recently. Thus, chemical analysis of fish tissue data for these particular chemicals from the 1970's through the early 1990's will not necessarily give the same results as were seen in this study.

10.4 Risk Assessment

Uncertainties can occur in all parts of the risk assessment--exposure assessment, toxicity assessment, and risk characterization. An uncertainty evaluation has been done as a part of this risk assessment to show how the risk characterization could be affected if alternative assumptions had been made and/or different parameters had been used to calculate the cancer risks and non-cancer hazard indices.

10.4.1 Exposure Assessment

10.4.1.1 Contaminant Concentrations in Fish Tissue

As discussed earlier in this report, the fish species collected and the sampling study sites selected were based primarily on data from CRITFC's Fish Consumption Report (CRITFC, 1994) and discussions with tribal staff. Although samples were taken from the study sites used most frequently by the tribes, many other study sites used for fishing were not sampled. In addition, as discussed in Section 4.5, there were limited data on the species collected and fishing locations used by non-tribal populations in the Columbia River Basin. Therefore, while the concentrations of chemicals in fish tissue have been used to characterize risk for the general public in this study, this characterization was uncertain due to the lack of data on fishing practices for the general public.

Another source of uncertainty for this risk assessment involves the use of the average chemical concentrations for fish collected over a short period of time to estimate human exposure over 30 and 70-year durations. If average chemical concentrations in fish tissue have changed over time, or were likely to change in the future, the risk estimates presented in this report may either underestimate or overestimate the risk to individuals. The relatively small amount of existing historical data on chemical contaminants in fish within the Columbia River Basin was insufficient to reliably evaluate trends in chemical concentrations. The seasonal range of chemical concentrations in the target species evaluated in this risk assessment is also not known.

Thus, the risk estimates presented in this report could increase or decrease depending upon how concentrations vary over location and time.

As discussed in Section 1.7.5, to calculate average contaminant levels in fish, a value of one-half the detection limit was used in some cases for non-detected chemicals. Risk characterization based upon one-half the detection limit could be either an overestimate or an underestimate of the actual risks.

10.4.1.2 Tissue Type

For this study, both whole fish and fillets were analyzed when possible. The fillet and whole body sample types were chosen based on the fish consumption survey for CRITFC's member tribes (CRITFC, 1994). In this study, respondents were asked to identify the fish parts they consume for each species. For most of the fish species sampled as a part of this study, 50% or more of the respondents said that they consume fish skin. A smaller proportion of the tribal members consumed other fish parts (head, eggs, bones and organs). In addition to the question of people consuming fish parts, some chemicals preferentially accumulate in fat or internal organs, thus having both whole body and fillet fish tissue samples provides a more comprehensive picture of the amount of chemical accumulated throughout the fish tissue. Fillets were analyzed with skin because most tribal members consumed the skin with the muscle tissue.

Information on the portions of fish that are consumed most frequently by the general public were not available. However, respondents to the qualitative fish consumption survey of people from Wheatland Ferry to Willamette Falls Reach of the Willamette River, Oregon indicated that they consume primarily fish fillets as well as other fish parts and the whole body (EVS, 1998).

In Section 6.2.4, the ratios of the estimated hazard indices and cancer risks for whole body to filleted fish samples were calculated to determine the possible impact of tissue type on the risk characterization. These results were calculated for those species that had both fillet and whole body samples analyzed at a given site. For non-cancer effects, whole body to fillet ratios were calculated for the total hazard index as well as for the endpoints of immunotoxicity and reproduction. The number of whole body to fillet ratios that were greater than 1 compared to the total number of samples was also shown. These calculations (Table 6-23) did not show a consistent pattern in whole body to fillet ratios for the total hazard indices, the immunotoxicity hazard indices, or cancer risks at a given site for a species. The whole body to fillet ratios ranged from 0.2 to greater than 1 for a few species/sites (e.g. high of a ratio 6.6 for fall chinook, immunotoxicity hazard index). For reproductive effects, the ratios of the hazard indices for reproductive effects in whole body to fillet samples appear to be less than 1 more frequently than those for the other hazard indices or cancer risks. This may be because the hazard index for reproductive effects is based largely upon the contaminant mercury which is not lipophilic and binds strongly to protein (e.g., muscle tissue).

Any conclusions, however, on the results of whole body to fillet samples are limited by the small sample sizes (usually 3 or less) at each site and by the fact that whole body samples were always from a composite of fish different than those used for the whole body samples (i.e., fillet and whole body samples are not from the same fish).

10.4.1.3 Exposure Duration

Exposure duration is defined as the time period over which an individual is exposed to one or more contaminants. For adults, two different exposure durations were used for the risk assessment: 70 years, which represents the approximate average life expectancy of all individuals born in the United States in the late 1960s; and 30 years, which represents the 90^{th} percentile length of time that an individual stays at one residence (USEPA, 1997b).

The value of 70 years was assumed for lifetime exposure in this risk assessment because it is the value commonly assumed for the general population in most EPA risk assessments. Also, 70 years is the primary assumption used in the derivation of many of the cancer slope factors found in IRIS (USEPA, 2000c).

As was discussed in Section 4, changes in exposure duration do not impact the exposures estimated for calculating non-cancer health impacts. This is because the product of the exposure frequency (EF) times exposure duration (ED) is always equivalent to the averaging time (AT) (see Equation 4-1 in Section 4.3).

However, since the averaging time for estimating exposure for cancer risks is always a person's lifetime, changing exposure duration does impact the estimated risk. The cancer risk estimates for an individual who consumes fish over an exposure duration that differs from the exposure durations used in this report (ED_{new}) can be determined using the following equation:

(Equation 10-1) $$ECR_{new} = ECR_{70} \times ED_{new}/ED_{70}$$

where:

ECR_{new} = Excess cancer risk for the new exposure duration
ECR_{70} = Excess cancer risk estimate for a lifetime exposure duration of 70 years
ED_{new} = Individual exposure duration in years
ED_{70} = Default lifetime exposure duration of 70 years

Equation 10-1 shows that the excess cancer risk will change in direct proportion to the ratio of the new and default exposure durations. For example, if an exposure duration of 9 years was selected, which is the median length of time an individual stays at one residence, the lifetime exposure cancer risk estimates would be multiplied by a factor of 0.13 (9 years ÷ 70 years = 0.13) to obtain revised cancer risk estimates for a 9-year exposure duration. Thus, all total excess cancer risk estimates for 70 years exposure duration for the fish species and tissue types evaluated in this report would decrease by approximately an order of magnitude (i.e. ten-fold) for an exposure duration of 9 years.

10.4.1.4 Consumption Rate

In this risk assessment, exposures were estimated for both the general public and for members of CRITFC's member tribes. For the general public, adequate quantitative information on fish consumption rates for those areas of the Columbia River Basin sampled in this study was not available. Therefore, the ingestion rates assumed for those individuals in this risk assessment

were based on a national report of fish consumption (USEPA, 2000b). For CRITFC's member tribes, ingestion rates were taken from CRITFC's fish consumption study (CRITFC, 1994). For both the general population and the tribes, mean and a 99^{th} percentile ingestion rates for children and adults were selected to evaluate potential risks over a range of possible ingestion rates.

It is not known if the ingestion rates selected for this risk assessment are representative of the actual consumption practices of individuals consuming fish from the study area. The exposures estimated in this report are likely to be higher than those expected for a recreational fisherman who infrequently fishes at any of the study sites. On the other hand, as discussed in Section 4, Harris and Harper (1997) suggest that an ingestion rate of 540 g/day is more appropriate for a tribal member who pursues a traditional lifestyle. This is higher than the 99^{th} percentile CRITFC member tribal fish consumption rate of 389 g/day used in this report.

10.4.1.5 Multiple-Species Consumption Patterns

The hazard indices and cancer risk estimates in this report were primarily based upon the consumption of individual fish species and tissue types. However, these estimates which are based upon individual fish species may not be an adequate representation of risk for most individuals since most people likely eat a diet composed of multiple fish species. Therefore, as a part of the risk characterization, a hypothetical multiple-species diet was also evaluated using tribal fish consumption data from CRITFC's fish consumption study. For this hypothetical multiple-species diet, information from Table 17 of the CRITFC fish consumption study (CRITFC, 1994) was used. This table from the CRITFC consumption survey provides information on the percentage of adults that consumed 10 fish species evaluated in the study (CRITFC, 1994). As was shown in Table 6-24 and Figures 6-35 and 6-36 the resultant cancer risk and non-cancer hazards of the multiple species diet reflect the proportion of the different types of fish in the diet and the contaminant levels in those fish. Therefore, the estimated cancer risks and non-cancer hazards from consuming fish from the Columbia River Basin for any one individual depend upon the types and amounts of fish they eat and may be very different from those estimated in this report for individual species.

As part of this uncertainty analyses, an estimate of the total cancer risks and non-cancer hazards from a multiple species diet using data from Table 18 in the CRITFC fish consumption study in addition to that in Table 17 was calculated (CRITFC, 1994). Table 18 provides average consumption rates (grams per day) for each species for those adult respondents in the survey who consume fish. These rates were determined by combining the average consumption rate for each individual who consumed a particular species with the average serving size in ounces for that individual and then calculating the mean of all of the individual consumption rates. The differences in the consumption rates for the hypothetical multiple diet using the two CRITFC tables (Table 17 versus Table 18) are shown in Table 10-2. As can be seen from Table 10-2, the consumption rates, cancer risks and total hazards for each individual fish species differ using the results from the two different tables in the CRITFC consumption study (CRITFC, 1994). However, the total estimated cancer risks and total non-cancer hazard indices from consuming all species are approximately the same using either table.

Table 10. 2. Comparison of estimated total cancer risks and hazard indices for a hypothetical multiple species diet using data from Table 17 and Table 18 in the CRITFC fish consumption report (Source: CRITFC, 1994).

		Results using Table 17 in the CRITFC fish consumption study[1]				Results using Table 18 in the CRITFC fish consumption study		
Fish Species	**T**	**Percentage of Hypothetical Diet**	**Consumption Rate (grams/day)**	**Total Cancer Risk**	**Non- Cancer Effects (total HI)**	**Consumption Rate (grams/day)**	**Total Cancer Risk**	**Non Cancer Effects (total HI)**
salmon	FS	27.7%	17.5	6E-05	0.6	25.7	8E-05	0.9
trout	FS	21.0%	13.3	3E-05	0.3	9.6	2E-05	0.2
whitefish	FS	6.8%	4.3	9E-05	0.7	8.9	2E-04	1.5
smelt	WB	15.6%	9.9	3E-05	0.1	4.8	2E-05	0.0
lamprey	FS	16.3%	10.3	1E-04	0.7	4.7	5E-05	0.3
walleye	FS	2.8%	1.8	4E-06	0.1	3.8	9E-06	0.2
sturgeon	FW	7.4%	4.7	7E-05	0.6	3.3	5E-05	0.4
sucker	FS	2.3%	1.5	9E-06	0.1	2.8	2E-05	0.2
Totals		100.0%	63.2	4E-04	3.2	63.6	4E-04	3.8

(1) These results are those presented in Section 6.2.5 and Table 6-24
FS = fillet with skin FW = fillet without skin WB = whole body
T= tissue type
HI = hazard index

10.4.1.6 Effects of Cooking

It was assumed for this risk assessment, that (with the exception of skinless white sturgeon fillets) the skin and fatty areas of the fish are not removed during preparation, and that there is no net reduction in contaminant concentrations during cooking. Anglers who prepare fillets by skinning and trimming away the fatty area may reduce their exposure to chemicals (such as organochlorines) that accumulate in fatty areas. It has also been shown that cooking the fish may affect exposure concentrations of such chemicals, depending on the cooking method.

EPA's guidance (USEPA, 2000a) provides a summary of the effects on organochlorine (e.g., PCBs, DDT, chlordane, dioxins/furans) contaminant levels in fish as a result of fish preparation and cooking. This summary shows that the reductions in chemical concentrations vary considerably among the different studies because of different fish species, contaminants, cooking methods, etc. In these studies most of the percent reductions in chemical concentrations ranged from about 10 to 60%. However, much higher losses were also seen as were net gains of one contaminant (PCBs). Overall, these studies support the conclusion that organochlorines can be lost during cooking. But, based on the available information, it is difficult to quantify these losses for use in a risk assessment since the actual losses from cooking depend upon the cooking method (i.e., baking, frying, broiling, etc.), the cooking duration, the temperature during cooking, preparation techniques (i.e., trimmed or untrimmed, with or without skin), the lipid content of the fish, the fish species, and the contaminant levels in the raw fish.

Also as discussed in EPA guidance (USEPA, 2000a), several studies indicate that some organo-metal compounds bind to different fish tissues than the tissue which bind organochlorines. Mercury, for example, binds strongly to protein, thereby concentrating in the muscle tissue of fish. Mercury also concentrates in liver and kidney, though at generally lower rates. Thus, preparations such as trimming and gutting, can actually result in a greater average concentration of mercury in the remaining tissues compared with the concentration in the whole fish (Gutenmann and Lisk, 1991). As discussed previously in the discussion on effects of sample type on the risk characterization (Section 6.2.4 and Table 6-23), the ratios of the hazard indices for reproductive effects in whole body to fillet samples appear to be less than 1 more frequently than the ratios for the total hazard index, hazard index for immunotoxicity, and cancer risks. This may be because the hazard index for reproductive effects is based largely upon the contaminant mercury which is not lipophilic and binds strongly to protein (e.g., muscle tissue). However, any conclusions based on the ratios of whole body to fillet samples are limited by the small sample sizes (usually 3 or less) at each site and by the fact that whole body samples were always from a composite of fish different than those used for the whole body analysis (i.e., fillet and whole body samples are not from the same fish).

The impact of cooking on mercury levels was studied by Morgan et al., 1997. They found that mercury concentrations (wet weight basis) in pan-fried, baked and boiled walleye fillet ranged from 1.1 to 1.5 times higher than in the corresponding raw portions; in lake trout the range was 1.5 to 2.0 times higher.

10.4.2 Toxicity Assessment

There are also uncertainties in the toxicity assessment. These include uncertainties (1) in the toxicity values (i.e., reference doses and cancer slope factors) used; (2) in the toxicity equivalence factors developed for dioxins/furans and dioxin-like PCBs and in the relative potency factors used for PAHs; (3) in the lack of toxicity data for some of the chemicals that were detected in fish, and; (4) in the manner in which certain chemicals (Aroclors, dioxin-like PCBs, DDT/DDE/DDD, and arsenic) were evaluated.

10.4.2.1 Toxicity Values

As discussed in Section 5.0, the majority of the toxicity factors used in estimating hazard indices and cancer risks were taken from EPA's IRIS database which is a database of human health effects that may result from exposure to various substances found in the environment. For a small number of chemicals whose toxicity factors were not available in IRIS, toxicity factors developed by NCEA were used. Although the development of the IRIS toxicity factors has been reviewed by a group of EPA health scientists using consistent chemical hazard identification and dose-response assessment methods, there are still several sources of uncertainty in these factors and their relevance to the populations for which the risk assessment is being conducted. As discussed in EPA's guidance (USEPA, 1989), some of these uncertainties may include:

- using dose-response information from effects observed at high doses to predict the adverse effects that may occur in humans following exposure to the lower levels expected from human exposure in the environment;

- using dose-response information from short-term studies to predict the effects of long-term exposures;

- using dose-response information from animal studies to predict effects in humans; and

- using dose-response information from homogenous populations or healthy human populations to predict the effects likely to be observed in the general population consisting of individuals with a wide range of sensitivities.

In addition to the uncertainties in developing reference doses and cancer slope factors based upon the data that are available, there are also uncertainties in the fact that specific types of effects data are often not available for a given chemical. Some examples include the lack of data on a chemical's cancer and non-cancer impact on vulnerable populations (e.g., children) and a lack of information for some chemicals on non-cancer endpoints such as reproductive, developmental, and endocrine disruption. However, the lack of data on non-cancer effects is usually considered when determining what uncertainty factors and modifying factors should be used to develop a reference dose for a given chemical. The lack of data on cancer is partially addressed by using conservative assumptions (e.g., upper confidence levels, the most sensitive species) in estimating cancer slope factors. All of these assumptions are intended to provide a margin of safety to ensure that the health impacts for an individual chemical are not likely to be underestimated.

To better understand the uncertainties associated with the toxicity factors for each of the chemicals evaluated in this risk assessment, refer to the Toxicity Profiles in Appendix C. These profiles review the data upon which the reference doses and cancer slope factors were developed.

10.4.2.2 Toxicity Equivalence Factors for Dioxins, Furans, and Dioxin-like PCB Congeners and Relative Potency Factors for PAHs

Toxicity equivalence factors were used for the chlorinated dioxins and furans and the dioxin-like PCBs measured in this study to calculate toxicity equivalence concentration. These toxicity equivalence factors were calculated using all of the available data and were selected to account for uncertainties in the available data and to avoid underestimating risk (Van den Berg et al., 1998). Alternative approaches, including the assumption that all dioxin-like PCBs carry the toxicity equivalence of 2,3,7,8-TCDD, or that all chlorinated dioxins, furans, and dioxin-like PCB congeners other than 2,3,7,8-TCDD can be ignored, have been generally rejected as inadequate for risk assessment purposes by EPA and many other countries and international organizations. These toxicity equivalence factors are order-of-magnitude estimates relative to the toxicity of 2,3,7,8-TCDD. Therefore, their use creates uncertainty in the risk assessment, especially since chlorinated dioxins/furans and dioxin-like PCBs contribute significantly to the cancer risks estimated in this risk assessment.

Also, it should be noted that the cancer slope factor for 2,3,7,8-TCDD is being re-evaluated as part of a current review by EPA (USEPA, 2000e). A review of the most current draft document suggests that this cancer slope factor may increase. This change would affect both the cancer risk estimates associated with 2,3,7,8-TCDD as well as those risk estimates calculated for the other chlorinated dioxins, furans, and dioxin-like PCB congeners having toxicity equivalence factors. If the slope factor increases, cancer risks estimated for these classes of compounds would also increase.

As discussed in Section 5, EPA has developed provisional guidance on estimating risk from exposure to PAHs (USEPA, 1993). A cancer slope factor is available for only one PAH, benzo(a)pyrene. In this provisional guidance, relative potency factors have been developed for six PAHs relative to benzo(a)pyrene. These relative potency factors were used to estimate cancer risk from PAHs in this risk assessment. As with the toxicity equivalence factors these relative potency factors are order-of-magnitude estimates and, therefore, have inherent uncertainties. However, unlike the toxicity equivalence factors, these relative potency factors for the PAHs are considered to be more uncertain because they do not meet all of the criteria for the application of toxicity equivalence factors to mixtures.

In our study, with the exception of one composite sample of largescale sucker taken at study site 13 (see discussion in Section 6.2), PAHs do not contribute significantly to the levels of contaminants in fish or to cancer risk estimates from consuming fish. Therefore, the uncertainties in the use of relative potency factors for PAHs should not greatly impact the overall risks characterized in this report.

10.4.2.3 Chemicals Without Quantitative Toxicity Factors

As shown in Table 5-1, there were 23 chemicals that were analyzed for in fish tissue that do not have a cancer slope factor or reference dose. Of the 23 chemicals without toxicity values, the following 14 chemicals were not detected in any fish species: delta-BHC, dibenzofuran, gamma-chlordene, tetrachloroguaiacol, 4-bromophenyl-phenylether, 4-chloroguaiacol, 4-chlorophenyl-phenylether, 3,4-dichloroguaiacol, 4-chloro-3-methylphenol, 4,5-dichloroguaiacol, 4,6-dichloroguaiacol, 3,4,5-trichloroguaiacol, 3,4,6-trichloroguaiacol, and 3,5,6-trichloroguaiacol. Six additional chemicals were detected in less than 3% of the samples: acenaphthylene, alpha-chlordene, benzo(ghi)perylene, phenanthrene, retene, and 1-methyl-naphthalene. Of the remaining 3 chemicals, DDMU was detected less than 10%; 2- methyl-naphthalene and pentachloroanisole were detected greater than 10% of the time.

As discussed in the Toxicity Profiles (Appendix C), the toxicity and mechanism(s) of action(s) of pentachloroanisole are similar to those of its parent chemical, pentachorophenol. However, methylation of the chlorophenols makes them more polar, and thus likely to be somewhat less reactive in biological systems. Thus the extent of both acute and chronic toxicity of pentachloroanisole can be reasonably anticipated to be somewhat less than its chlorinated parent, PCP. DDMU is a breakdown product of the DDT. Little information is available on DDMU or 2-methyl-naphthalene.

It is impossible to predict how the lack of toxicity information on these 23 chemicals might impact the characterization of risk in this report. However, given the fact that only 2 of these chemicals (2- methyl-naphthalene and pentachloroanisole) were detected in greater than 10% of the samples, any under estimation of cancer risk and non-cancer hazards is unlikely to be great.

There are no EPA consensus reference doses available for the chlorinated dioxins and furans and the dioxin-like PCB congeners, therefore, the possible non-cancer health effects from exposure to these chemicals from fish consumption could not be estimated in this report. From the most recent draft of EPA's reassessment of the toxicity of these compounds (USEPA, 2000e), it is clear that these compounds can cause non-cancer effects at very low levels of exposure. The inability to characterize the non-cancer hazards from these compounds may result in an underestimate of the non-cancer hazards calculated in this report.

10.4.2.4 Risk Characterization for PCBs

As discussed in Section 1, two different measurements were used in this study to determine PCB concentrations in fish tissue: 1) analysis of Aroclors which are commercial mixtures of both dioxin-like and non-dioxin-like PCB congeners, and 2) analysis of individual dioxin-like PCB congeners. The Aroclor methodology included the analysis of 7 Aroclors: Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260. Only Aroclors 1242, 1254, and 1260 were detected. Eleven dioxin-like PCB congeners that exert toxicity similar to 2,3,7,8 -TCDD were also measured. PCB 170 and PCB 180, though measured, were not considered in the risk assessment as dioxin-like PCB congeners because they do not currently have associated toxicity equivalence factors.

Cancer Risks for PCBs

Because Aroclors are a mixture of both dioxin-like and non-dioxin-like PCB congeners, calculating and summing the risk associated with both Aroclors and with individual dioxin-like PCB congeners would likely overestimate cancer risk by accounting for the dioxin-like PCB congener risk both individually and within the risk estimates for Aroclors. Therefore, before using the Aroclor fish concentrations to calculate cancer risk, an adjustment was made to the Aroclor concentrations by subtracting the concentration of dioxin-like PCB congeners from the total Aroclor concentrations for each sample. This resulted in what is called the "adjusted Aroclor" value.

To estimate the impact of using this method on the cancer risk, a comparison was made for estimates of cancer risk from PCBs using different methods. The excess cancer risks calculated with these methods (using basin averages) for each fish species are shown in Table 10-3. The risk from dioxin-like PCB congeners alone ranged from 0.5 (coho salmon) to 3.5 (rainbow trout) times (column B/A) the risk calculated for total unadjusted Aroclors alone. Because the mass of dioxin-like PCB congeners is so small compared to that of the Aroclors, the risk estimated for adjusted Aroclors (subtracting the concentration of dioxin-like PCB congeners from the total Aroclor concentrations) (column C) is only slightly lower than that for total unadjusted Aroclors

(Column A). Characterizing PCB risks by combining either total Aroclors plus dioxin-like PCB congeners (A + B) or adjusted Aroclors plus dioxin-like PCB congeners (B + C) is approximately the same. The PCB risks estimated from using "adjusted Aroclors plus dioxin-like PCB congeners" is from 1.5 to 4.3 times that estimated from using total unadjusted Aroclors alone (Column B+C /A).

Table 10-3. Estimated Cancer Risks for PCBs Using Different Methods of Calculation. CRITFC's member tribal adult, average fish consumption, 70 years exposure using average Columbia River Basin-wide chemical concentrations.

	A	B	B/A	C	A+B	B+C	(B+C)/ (A+B)	(B+C)/A
	Total unadjusted Aroclors	Dioxin-like PCB congeners	Risk Ratio	Adjusted Aroclors only	Total Aroclors plus dioxin-like PCB congeners	Adjusted Aroclors plus dioxin-like PCB congeners	Risk Ratio	Adjusted Aroclors plus dioxin-like PCB congeners / total unadjusted Aroclors
bridgelip sucker	1.1E-04	1.2E-04	1.1	1.0E-04	2.3E-04	2.3E-04	0.98	2.1
largescale sucker	7.6E-05	1.1E-04	1.4	7.1E-05	1.8E-04	1.8E-04	0.97	2.4
mountain whitefish	3.5E-04	7.7E-04	2.2	3.0E-04	1.1E-03	1.1E-03	0.96	3.1
white sturgeon	2.0E-04	1.7E-04	0.8	1.9E-04	3.7E-04	3.6E-04	0.97	1.8
walleye	2.3E-05	2.6E-05	1.1	2.1E-05	4.9E-05	4.6E-05	0.95	2.0
rainbow trout	2.5E-05	8.7E-05	3.5	2.2E-05	1.1E-04	1.1E-04	0.97	4.3
coho	4.6E-05	2.5E-05	0.5	4.5E-05	7.0E-05	7.0E-05	0.99	1.5
fall chinook	3.1E-05	3.6E-05	1.2	3.0E-05	6.8E-05	6.6E-05	0.98	2.1
spring chinook	2.9E-05	4.8E-05	1.7	2.8E-05	7.7E-05	7.6E-05	0.98	2.6
steelhead	4.4E-05	7.5E-05	1.7	4.2E-05	1.2E-04	1.2E-04	0.99	2.7
eulachon	ND	9.5E-06	NA	ND	9.5E-06	9.5E-06	1.00	NA
Pacific lamprey	1.6E-04	3.3E-04	2.1	1.5E-04	4.8E-04	4.7E-04	0.98	3.0

ND = not detected NA = not applicable

Non-Cancer Effects from Aroclors

The immunological endpoint was based upon the toxicity of Aroclors. However, only one of the three Aroclors detected in the fish samples has a reference dose - Aroclor 1254. Therefore, two possible methods were available to estimate the non-cancer hazard for the immunotoxicity endpoint.

- (A) - estimate the hazard index using the concentration of Aroclor 1254 only and the reference dose for Aroclor 1254, or

- (B) - assume that the reference dose for Aroclor 1242 and 1260 are equivalent to that for Aroclor 1254; estimate the hazard index by summing all three Aroclor concentrations and use this sum with the reference dose for Aroclor 1254.

Method B was used in this risk assessment. To show the potential uncertainties with using Method B, the hazard indices calculated with both methods (using basin averages) for each fish species are shown in Table 10-4.

Table 10-4. Comparison of Hazard Indices for the Immunological Endpoint Based on Alternative Treatments of Aroclor Data. CRITFC's member tribal adult, average fish consumption, using average Columbia River Basin-wide chemical concentrations.

	Endpoint specific hazard index for immunotoxicity		
	(A) Aroclor 1254	(B) sum of Aroclors 1242, 1254, and 1260	(B/A) Ratio of the hazard index for the sum of Aroclors to the hazard index for Aroclor 1254 only
bridgelip sucker	1.1	2.7	2.5
largescale sucker	0.8	1.9	2.4
mountain whitefish	5.1	8.7	1.7
white sturgeon	2.6	5	1.9
walleye	0.6	0.6	1.0
rainbow trout	0.6	0.6	1.0
coho salmon	0.7	1.1	1.6
fall chinook salmon	0.8	0.8	1.0
spring chinook salmon	0.7	0.7	1.0
steelhead	0.7	1.1	1.6
eulachon	ND	ND	ND
Pacific lamprey	3.9	3.9	1.0

ND = Not Detected

Table 10-4 also shows the ratio of the hazard index calculated using (A) Aroclor 1254 concentrations only or (B) the sum of all three Aroclors. For walleye, rainbow trout, spring chinook, fall chinook, and Pacific lamprey, the method used has no impact on the hazard index calculated for the immunotoxicity endpoint. This is because for these five species, only Aroclor 1254 was detected in the fish sampled. For the other species, the hazard index based on Method B (using the sum of all Aroclor concentrations) is from 1.6 to 2.5 times higher than the hazard index based upon Aroclor 1254 alone (column B/A).

10.4.2.5 Non-Cancer Effects from DDT, DDD, and DDE

DDT and its derivatives, DDD and DDE, were measured in fish tissue samples; however, only DDT has a reference dose. The reference dose for DDT is based upon its toxic effects on the liver (hepatotoxicity). For the non-cancer hazard assessment done in this report, two possible methods for the estimation of the hazard quotient and hazard index from these chemicals were possible:

- (A) - estimate the hazard quotient using the concentrations of DDT only and the reference dose for DDT, or
- (B) - assume that the reference doses for DDD and DDE are equivalent to that for DDT. Therefore, first sum the concentrations of all of the DDD, DDE and DDT species in each sample and utilize the reference dose for DDT to estimate the hazard quotient from the summed concentrations of DDD, DDE, and DDD

.

Table 10-5. Comparison of Hazard Quotients and Hazard Indices for the Hepatic Health Endpoint Based on Alternative Treatments of DDT, DDD, and DDE Data. CRITFC's member tribal adult, average fish consumption, using average Columbia River Basin-wide chemical concentrations.

	Hazard quotient			Hazard Index for hepatic endpoint		
	A	B		C	D	
Species	DDT only	Total DDT	(B/A) HQ (Total DDT)/ HQ (DDT)	DDT only	sum of DDT, DDE, and DDD	(D/C) HI (Total DDT)/ HI (DDT)
bridgelip sucker	0.08	0.95	11	0.13	1.00	7.5
largescale sucker	0.04	0.44	11	0.10	0.50	5.0
mountain whitefish	0.03	0.76	27	0.19	0.93	4.8
white sturgeon	0.02	1.04	52	0.36	1.38	3.9
walleye	0.00	0.10	28	0.47	0.57	1.2
rainbow trout	0.01	0.05	8	0.04	0.09	2.1
coho salmon	0.00	0.01	4	0.06	0.07	1.2
fall chinook	0.00	0.03	7	0.08	0.10	1.4
spring chinook	0.01	0.04	4	0.08	0.11	1.3
steelhead	0.00	0.03	8	0.07	0.10	1.4
eulachon	ND	0.02	NA	0.05	0.07	1.4
Pacific lamprey	0.06	0.17	3	0.22	0.33	1.5

ND = not detected; NA = not applicable
HS = hazard quotient
HI = Hazard index
Total DDT = sum of DDT, DDD, DDE

Method B was used to characterize non-cancer health effects in this study. Because DDT has been identified as having a hepatic (liver) toxicity endpoint, the treatment of DDT and its derivatives will affect not only the hazard quotient for the these species, but also the hazard index for the hepatic (liver) toxicity endpoint.

Table 10-5 compares the hazard quotients for DDT and its derivatives (in columns A and B) as well as the hazard indices for the hepatic endpoint (in columns C and D) using the two methods. As can be seen from Table 10-5, the hazard quotient increased from about 3 times for Pacific lamprey to 52 times for white sturgeon when all three species (DDT, DDE, DDD) are summed to calculate the hazard quotient compared to calculating the hazard quotient using DDT data alone. The impact on the hepatic endpoint is less because for some fish species other chemicals in addition to DDT and its derivatives are included in the calculation of the hazard index for hepatotoxicity. The ratio between the hepatic hazard index using DDT, DDE, and DDD to the hepatic hazard index using DDT alone ranges from between 1.2 for coho salmon to 7.5 for bridgelip sucker, with the highest ratios seen in some of the resident fish species. Thus, the endpoint specific hazard indices for hepatotoxicity that are discussed in Section 6 may be an overestimate if DDE and DDD are less toxic to the liver than DDT. This is primarily true for several of the resident species.

10.4.2.6 Risk Characterization for Arsenic

As discussed in Section 5.3.3, total arsenic was measured in fish tissue samples in this study. Because a reference dose and cancer slope factor are available for only inorganic arsenic, an assumption about the percent of inorganic arsenic in fish had to be made to estimate the non-cancer hazards and cancer risks. The non-cancer hazards and cancer risks discussed in Section 6.2.1 and 6.2.2, respectively, assumed that for all fish species (resident fish and anadromous fish) caught in this study, 10% of the total arsenic was inorganic arsenic. The data in Section 5.3.3 also suggests that an alternative assumption for anadromous fish species should be considered - the assumption that 1% of the total arsenic is inorganic. Therefore in Section 6.2.6, the non-cancer hazards and cancer risks were recalculated for anadromous fish species using basin data assuming that 1% of the total arsenic was inorganic.

This comparison of the results from using the two different assumptions (1% versus 10%) for arsenic in fish shows that the reduction of the non-cancer hazards is less than 12% for all anadromous fish species, except eulachon which had about a 50% reduction. However, the impact is greater on the estimates of cancer risk. With the exception of lamprey for which cancer risks were reduced by only 6%, the reductions in cancer risks for steelhead were about 29%. The cancer risks for the other anadromous fish species were reduced from about 40% to 50%. Thus, the assumptions used for percent inorganic arsenic have the most impact on the cancer risks estimated for salmon, steelhead and eulachon and on the non-cancer hazards for eulachon.

10.4.3 Risk Characterization

10.4.3.1 Cancer Risk Estimates

As recommended by EPA's guidance on mixtures (USEPA, 2000g), the total cancer risk from a sample is calculated by summing the risk of individual carcinogenic compounds in that sample. This approach for carcinogens (response addition) assumes independence of action by the components in a mixture (i.e., that there are no synergistic or antagonistic interactions among the carcinogens in fish and that all chemicals produce the same effect, cancer). If these assumptions are incorrect, over- or under-estimation of the actual risks could result. The underlying biological basis for assuming synergism is that cancer is a multistage process where a series of events transforms a normal cell into a malignant tumor. If two carcinogens act at different stages, their combined effect can be greater than either acting alone. For example, initiation-promotion studies have demonstrated synergistic effects for some pairs of carcinogens. On the other hand, similar-acting carcinogens can compete with each other to result in antagonism. For example, the presence of one metal can decrease the absorption or effectiveness of a similar metal. Interactions can be quite complex and can depend on dose or other factors, including background exposures to other carcinogens. In general, available information seldom allows quantitative inferences to be made about potential interactions among carcinogens. In the absence of such information, the practice is to assume additivity, particularly at low doses for mixtures.

Summation of carcinogenic risks for substances with different weights-of-evidence for human carcinogenicity is also an uncertainty. The cancer risk equation for multiple substances sums all carcinogens equally, giving as much weight to class B or C as to class A carcinogens. Using the assumption of additivity gives equal weight to all slope factors without regard to their basis from human data. In this assessment, only arsenic is in the class A carcinogen group (human carcinogen based on human data) and all of the other major contributors to cancer risk (e.g., DDT and DDE, DDD, Aroclors, dioxin-like PCB congeners and chlorinated dioxins and furans) are in the class B2 group (probable human carcinogen based on sufficient evidence in animals and inadequate or no evidence in humans). It should be noted, however, that EPA's most recent draft document on the toxicity of 2,3,7,8-TCDD and related compounds (USEPA, 2000e) characterizes the complex mixtures of dioxins to which humans are exposed as "likely human carcinogens".

The cancer slope factors used in this risk characterization are primarily from EPA's database, IRIS. Most of the IRIS cancer slope factors are considered to be plausible upper bounds to the actual lifetime excess cancer risk for a given chemical. Concern has often been raised that adding multiple carcinogens, whose slope factor are upper bound estimates, will lead to unreasonably high estimates of the actual risk. Statistical examination of this issue suggests that the error in the simple addition of component upper bounds is small compared to other uncertainties, and that as the number of mixture components increases, summing their upper bounds yields an inflated but not misleading estimate of the overall risk (Cogliano, 1997). In fact, division by a factor of two can be sufficient to convert a sum of upper bounds into a plausible upper bound for the overall risk. If one or two carcinogens predominate the risk, however, this is not of concern.

10.4.3.2 Non-Cancer Health Effects

In Section 6, non-cancer health impacts were evaluated in several ways. First, the hazard quotient was calculated. The hazard quotient, which is the ratio between an individual's estimated exposure to a chemical compared to the reference dose for that chemical, assumes that there is a level of exposure (i.e., the reference dose) below which it is unlikely for even sensitive populations to experience adverse health effects. As a rule, the greater the value of the hazard quotient, the greater the level of concern. However, it is important to emphasize that the level of concern does not increase linearly as the reference dose is approached or exceeded for each chemical because reference doses for different chemicals do not have equal accuracy or precision and are not based on the same severity of toxic effects. Therefore, the possible health impacts resulting from exposures greater than the reference dose can vary widely depending upon the chemical.

Based on EPA guidance (USEPA, 1986a; USEPA, 1989; USEPA, 2000g), the hazard quotients calculated for each chemical in a sample were then summed to give a hazard index. This approach of adding all of the hazard quotients regardless of endpoint (dose addition) has several uncertainties because it assumes that all compounds in a mixture have similar uptake and pharmacokinetics (absorption, distribution, and elimination in the body) and it results in combining chemicals with reference doses that are based upon very different critical effects, levels of confidence, uncertainty/modifying factors, and dose-response curves. Since the assumption of dose additivity is most properly applied to compounds that induce the same effect by the same mechanism of action, EPA guidance recommends that when the total hazard index for a mixture exceeds 1, the chemicals in that mixture should be segregated by effect and mechanism to derive endpoint-specific hazard indices (USEPA, 1986a).

Although deriving endpoint specific hazard indices, as was done for this risk assessment, likely reduces the uncertainty in the non-cancer hazard evaluation in this risk assessment, these uncertainties are not eliminated. For example, calculation of endpoint specific hazard indices may still be incorrect estimates of non-cancer health impacts. Although two chemicals may affect the same organ (e.g. the liver), they may not necessarily do so by the same specific toxicological process.

However, it should be noted that in this assessment the majority of the estimated non-cancer hazards resulted from a limited number of chemicals: Aroclors, mercury, total DDTs, and arsenic. The highest endpoint specific hazard indices were for immunotoxicity (due to Aroclors), central nervous system and reproduction/developmental (due to mercury), liver (due primarily to DDT, DDE and DDD), and hyperpigmentation/cardiovascular (due to arsenic). These endpoint specific hazard indices are based in large part on a single chemical or class of chemical (e.g. total DDTs). Therefore, the many uncertainties regarding calculation of endpoint specific hazard indices using a mixture of chemicals should not play a major role in the characterization of non-cancer hazards.

10.4.3.3 Cumulative Risk from Chemical and Radionuclide Exposure

Risks were combined for all carcinogens to equal a total cancer risk. However, radionuclides were not included in this estimate because radionuclide analyses were not completed for all species in this assessment.

10.5 Risk Characterization for Consumption of Fish Eggs

As discussed in Section 4.5, a small number of egg samples were collected for some of the anadromous fish species. Although the fish consumption studies discussed in this report suggest that both CRITFC's member tribes and some of the general public consume eggs, none of these studies provided information on the amount of eggs consumed. Therefore, a risk characterization of eggs was not included in Section 6. However, to provide information on the potential risks from consuming eggs, the average fish ingestion rates for adults and children (general public and CRITFC's member tribes) were used for estimating cancer risk (adults only) and non-cancer hazards (adults and children) for eggs. These estimates for eggs, which are shown in Appendix P, are very uncertain but they serve as a useful comparison to the results for fish consumption.

Three samples of eggs were collected from coho salmon (Umatilla), fall chinook (Columbia, site 8), and steelhead (Columbia, site 8) and six egg samples were collected from spring chinook (3 at the Umatilla and 3 at Looking Glass Creek).

Endpoint specific and total hazard indices for eggs were calculated using the average fish ingestion rates for each population (adult and child, general public and; adult and child, CRITFC's member tribes)(Tables 1.1 and 1.2 (coho salmon), 2.1 and 2.2 (fall chinook salmon), 3.1 and 3.2 (spring chinook salmon), 4.1 and 4.2 (steelhead)). This provides estimates of the non-cancer hazards for two ingestion rates for adults (7.5 and 63.2 g/day) and children (2.83 g/day, up to age 6; and 24.8 g/day, up to age 15). No endpoint specific hazard indices and no total hazard indices greater than 1 were found using the average fish consumption rate for the general public, adult or child. At the average consumption rate for CRITFC's member tribal adults and children, some of the total hazard indices were greater than 1 for eggs, the highest being approximately 4 for steelhead eggs at the average fish consumption rate for CRITFC's member tribal children. Endpoint specific hazard indices greater than 1 (high of 2) for liver, immunotoxicity, and selenosis were seen for CRITFC's member tribal child, average ingestion rate for spring chinook and steelhead; an immunotoxicity endpoint specific hazard index of approximately 1 was seen for coho. Endpoint specific hazard indices greater than 1 were due to exposures greater than the reference dose for total Aroclors (immunotoxicity) and selenium (selenosis and liver).

Cancer risks for eggs were calculated using the average fish ingestion rates for both adult populations (general public adult and CRITFC's member tribal adult) for both 30 and 70 years of exposure. These results are found in the tables in Appendix P (Tables 1.3 (coho salmon), 2.3 (fall chinook salmon), 3.3 (spring chinook salmon), and 4.3 (steelhead). As can be seen from these tables, cancer risks from consumption of eggs ranged from 4×10^{-6} for both fall chinook and steelhead at the lowest exposures (general public adult, average fish ingestion rate, 30 years exposure) to a high of 8×10^{-5} for the highest exposure calculated (average fish consumption rate, CRITFC's member tribal adult, 70 years of exposure). For these same exposures, coho salmon eggs ranged from 7×10^{-6} to 1×10^{-4} and spring chinook eggs from 9×10^{-6} to 2×10^{-4}.

11.0 Conclusions

The goals of this study were to determine:

1) if fish were contaminated with toxic chemicals,

2) the difference in chemical concentrations among fish species and study sites, and

3) the potential human health risk due to consumption of fish from the Columbia River Basin.

The results of the study showed that all species of fish had some levels of toxic chemicals in their tissues and in the eggs of chinook and coho salmon and steelhead. The concentration of organic chemicals in the egg samples was lower than expected, given the high lipid content of the egg samples. The fish tissue chemical concentrations were quite variable within fish (duplicate fillets), across tissue type (whole body and fillet), across species, and study sites. However, the chemical residues exhibited some trends in distribution. The concentrations of organic chemicals in the salmonids (chinook and coho salmon, rainbow and steelhead trout) were lower than any other species. The concentrations of organic chemicals in three fish species (white sturgeon, mountain whitefish, largescale sucker) were higher than any other species. Pacific lamprey had higher organic chemical concentrations than anadromous species but lower than resident species. The concentrations of metals were variable with maximum levels of different metals occurring in a variety of species. The distribution across stations was variable although fish collected from the Hanford Reach of the Columbia River and the Yakima River tended to have higher concentrations of organic chemicals than other study sites.

The concentrations of toxic chemicals found in fish from the Columbia River Basin may be a risk to the health of people who eat them depending on:

A. the toxicity of the chemicals,

2) the concentration of chemicals in the fish,

3) fish ingestion rates

4) fish species, and tissue type

The chemicals which contributed the most to the hazard indices and cancer risks were the persistent bioaccumulative chemicals (PCB, DDE, chlorinated dioxins and furans) as well as some naturally occurring metals (arsenic, mercury). Some pollutants persist in the food chain largely due to past practices in the United States and global dispersion from outside North America. Although some of these chemicals are no longer allowed to be used in the United States, a survey of the literature indicates that these chemical residues continue to accumulate in a variety of foods including fish. Human activities can alter the distribution of the naturally occurring metals (e.g. mining, fuel combustion) and thus increase the likelihood of exposure to toxic levels of these chemicals through inhalation or ingestion of food and water.

Many of the chemical residues in fish identified in this study were not unlike levels found in fish from other studies in comparable aquatic environments in North America. The results of this study, therefore, have implications not only for tribal members but also the general public.

While contaminants remain in fish, it is useful for people to consider ways to still derive beneficial effects of eating fish, while at the same time reducing exposure to these chemicals. Fish are a good source of protein, low in saturated fats, and contain oils which may prevent coronary heart disease. Risks can be reduced by decreasing the amount of fish consumed, by preparing and cooking fish to reduce contaminant levels, or by selecting fish species which tend to have lower concentrations of contaminants.

Reducing dietary exposure through cooking or by eating a variety of fish will decrease the consumer's exposure, but not eliminate these chemicals from the environment. Reduction of many of the man-made chemicals from the environment will take decades to centuries. Regulatory limits for new waste streams and clean up of existing sources of chemical wastes can help to reduce exposure. The exposure to naturally occurring chemicals can be reduced through better management of our natural resources. The results of this study confirm the need for regulatory agencies to continue to pursue rigorous controls on environmental pollutants and to remove those pollutants which have been dispersed into our ecosystems.

There are many uncertainties in this risk assessment which could result in alternate estimates of risk. These uncertainties include our limited knowledge of the mechanisms which cause disease, the variability of contaminants in fish, changes in fish tissue concentrations over time, ingestion rates, and the effects of food preparation. The uncertainties in our estimates may increase or decrease the risk estimates reported in this study.

The chemicals which were estimated to contribute the most to potential health effects (PCB, DDE, chlorinated dioxins and furans, arsenic, mercury) are the chemicals for which regulatory strategies need to be defined to eliminate or reduce these chemicals in our environment.

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This document does not substitute for EPA regulations; nor is it a regulation itself. Thus, it does not and cannot impose legally binding requirements on the EPA, the states, tribes or the regulated community, and may not apply to a particular situation based on the circumstances. If there are any differences between this web document and the statute or regulations related to this document, the statute and/or regulations govern. The EPA may change this guidance in the future.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MEMORANDUM

OFFICE OF WATER

SUBJECT: Compliance with CWA Section 303(c)(2)(B)

FROM: Martha G. Prothro, Director
Office of Water Regulations and Standards (WH-551)

TO: Water Management Division Directors, Regions I-X

The purpose of this memorandum is to reiterate that to fulfill the statutory requirements of the Clean Water Act Section 303(c)(2)(B), States need to adopt both aquatic life and human health numeric criteria for Section 307(a) toxic pollutants. Some States have adopted criteria to protect only aquatic life even though designated uses include activities related to human health (e.g., human consumption of fish, drinking water). Others have adopted inappropriate human health criteria (e.g., a maximum concentration limit (MCL) when fish ingestion is considered an important activity). Although States are required to adopt standards only for pollutants, "the discharge or presence of which in the affected waters could reasonably be expected to interfere with...designated uses", there is no statutory, regulatory or policy exclusion for human health related criteria.

To comply with the statute, a State must adopt aquatic life and human health criteria where necessary to support the appropriate designated uses. Criteria for the protection of human health are needed for waterbodies designated for public water supply. The Agency policy on use of MCLs developed under the Safe Drinking Water Act or Section 304(a) human health criteria is stated at 45 FR 79318, November 28, 1980. For the protection of public water supplies, EPA encourages the use of MCLs. When fish ingestion is important, then the water quality criteria value developed under Section 304(a) of the Clean Water Act based on fish consumption should be used.

For those pollutants designated as carcinogens, the recommendation for a human health criterion generally is more stringent than the aquatic life criterion for the same pollutant. In contrast, the aquatic life criteria recommendations for non-carcinogens generally are more stringent than the human health recommendations.

When a State adopts a human health criterion for a carcinogen, the State must select a risk level. EPA provides criteria values at risk levels of 10^{-5}, 10^{-6}, and 10^{-7} in its criteria documents under one set of exposure assumptions. A State is not limited to choosing among the risk levels published in the Section 304(a) criteria documents nor is a State limited to the base case exposure assumptions. The State will need to choose the risk level for its program even if it adopts EPA's criteria guidance by reference, because the criteria documents are not self-implementing standards in the absence of this information.

If a State has not adopted enough criteria or appropriate criteria to address human health, the State should immediately establish an accelerated schedule to achieve compliance with Section 303(c)(2)(B). The EPA Regional Offices should be sure there is explicit agreement with regard to the additional State actions needed and the schedule for State action. The schedule should reflect a compliance date which is prior to February 4, 1990 (three years after the enactment of the Water Quality Act of 1987). When necessary, the Regional Office may grant an extension to this requirement to States that were close to completing a triennial review at the time the Water Quality Act was passed. These States may have until the end of FY 1990 to comply with Section 303(c)(2)(B). Regional Offices are responsible for assuring that States understand that time is of the essence in complying with Section 303(c)(2)(B), and that delays until a subsequent triennial revision are not allowed under the law.

If you have any questions on this matter, please contact me or have your staff contact David K. Sabock at FTS 475-7318.

cc: Rebecca W. Hanmer

Commenter ID: 7

Commenter Name: Judith Biller

Commenter Association: Citizen

Comment received via online comment form

Comment:

We must do better with regards to these water supplies!!

EARTHJUSTICE

April 21, 2016

Via Email

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Via Federal Express
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RE: (Proposed) Water Quality Standards for Surface Waters of the State of Washington—Chapter 173-201A WAC (WQS): Comments of Waterkeepers Washington and Pacific Coast Federation of Fishermen's Associations and Institute of Fisheries Resources

Dear Ms. Conklin:

The comments below and supporting documents on Washington's proposed Water Quality Standards for the protection of Human Health for Surface Waters of the State of Washington, are submitted by Earthjustice on behalf of Waterkeepers Washington (Columbia Riverkeeper, Puget Soundkeeper Alliance, Spokane Riverkeeper, and North Sound Baykeeper), the Pacific Coast Federation of Fishermen's Associations, and Institute for Fisheries Resources (collectively "Waterkeepers Washington"). The commenters are all non-profit organizations dedicated to protecting the environment and natural resources of Washington State and the Pacific Northwest region; ensuring that all communities of Washington and the Pacific Northwest have fishable and swimmable water; protecting the family-wage jobs that depend on fishing in Washington waters through scientifically sound policy; and seeking positive solutions to the challenge of water pollution and its human health implications. These joint comments supplement, and are in addition to, any individual comment letters submitted by each group.

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Ecology's proposed human health water quality standards rule provides Washington the opportunity to recognize and safeguard the diverse communities in this state who consume fish and to protect their cultural, historical, subsistence, and recreational consumption of fish. *See* Declarations from Waterkeepers Washington staff and members provided with these comments. Unfortunately, rather than embrace this opportunity, Ecology has instead offered a rule that depends on dubious math and arbitrary choices to largely leave old standards in place, while simultaneously providing new avenues for polluters to avoid complying with all water quality standards. The people of Washington State deserve better.

Ecology's proposed rule and components of the equation used to develop human health water quality standards have several shortcomings discussed in detail below: (1) the fish consumption rate of 175 grams per day ("g/day"), while an improvement, is still inadequate because survey data shows significantly higher consumption rates by Native American and Asian/Pacific Islander communities in the state; (2) Ecology's change of assumed body weight (and refusal to change other components of the equation that would make standards more protective) is arbitrary; (3) the proposed human health water quality standards that are the ultimate result of Ecology's tinkering with the equation are arbitrary and not the result of the application of best science and for three of the most dangerous and persistent chemicals in our waters—Polychlorinated biphenyls ("PCBs"), arsenic, and methylmercury—Ecology's proposal would let inadequate protections stand or even, in the case of arsenic, allow a 555-fold increase in the concentrations of the toxic in our waters; and (4) Ecology's proposals for new and expanded water quality compliance off-ramps are unsupported, unsupportable, and are unlawful under the Clean Water Act.[1]

Waterkeepers Washington objects to finalization of these rules as proposed and requests Ecology (or the U.S. Environmental Protection Agency) to finalize more protective rules that utilize an accurate fish consumption rate, that retains a protective 10^{-6} cancer risk rate for all human health criteria, protectively regulates all chemicals, and that eliminates unlawful and inappropriate compliance off-ramps.

Waterkeepers Washington submits the detailed comments below and supporting documents in support of its objection and request. Waterkeepers Washington further adopts and incorporates by this reference, the comments submitted by the Northwest Indian Fisheries Commission.[2]

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[1] In particular and as discussed below, the compliance off-ramps for *all* pollutants and *all* polluters find no justification in the minimally-increased protections in this rule and Ecology offers no other justification for loosening pollution requirements across the state.

[2] Waterkeepers Washington also expect Ecology to include in the record for this rulemaking, NWIFC and EPA's comments submitted in march of 2015 on the prior rulemaking effort as many of those comments and criticisms remain relevant and applicable to the current proposed rule.

I. INTRODUCTION AND BACKGROUND

A. The States Have Failed To Meet The Purpose, Intent, and Timelines of the Clean Water Act.

Over forty years ago, Congress made the promise to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a). To that end, Congress established a national goal to eliminate discharges of pollutants into navigable waters by 1985. Congress also set the national goal of achieving levels of water quality necessary to protect all human contact uses of the Nation's waters and quality necessary for the protection of fish, shellfish, and wildlife by 1983. 33 U.S.C. § 1251(a)(1) and (2). Congress further established national policy prohibiting the discharge of toxic pollutants in toxic amounts. 33 U.S.C. § 1251(a)(3).

Unfortunately, those promises and goals still await fulfillment. *See, e.g.*, EPA, Nat'l Rivers and Streams Assessment (Feb. 2013) (EPA reports that well over 50% of the waters assessed exhibited poor conditions and only 20% were classified as "good"); *see also*, EPA, National Summary of State Information (last visited Apr. 12, 2016) (showing that states have a poor record of assessment, but of the waters assessed, 53% of assessed rivers and streams, 68% of assessed lakes, and 66% of assessed bays/estuaries are failing to meet one or more water quality standards), *available at* https://ofmpub.epa.gov/waters10/attains_nation_cy.control. Further, in a recent report, the Izaak Walton League notes that states have extremely poor track records in terms of monitoring and accurately assessing and reporting the cleanliness of their waters, meaning that the numbers reported by EPA may in fact be optimistic. http://www.iwla.org/docs/default-source/conservation-docs/water-docs/clean-water/righttoknow_front-matter.pdf?sfvrsn=2.

In Washington, this problem is abundantly evident from Washington's most recent Section 303(d) list of impaired waters. According to EPA's state summary data for 2008, the latest year EPA has summarized the available information, Washington has assessed only a tiny fraction—2.8%—of total river and stream miles in the state. http://ofmpub.epa.gov/waters10/attains_state.control?p_state=WA#total_assessed_waters. That means the pollutant load and water quality status of 97% of the state's rivers and streams is currently unknown. Of the assessed rivers and streams, over 79% are listed as impaired—failing to meet one or more water quality standards. *Id.* Over 60% of those impaired streams still need Total Maximum Daily Load ("TMDL") cleanup plans. *Id.* Many of the impairments listed are for toxic contaminants[3] subject to this rulemaking, such as metals and PCBs. Washington's latest list of impaired waters shows the list of waters needing cleanup grows and the data still only reflects 10% of the freshwaters in the state. And again, according to the recent Izaak Walton report, Washington's waters are likely far worse, given the state's poor grade.

[3] Waterkeepers Washington uses "toxics" as a shorthand for toxic contaminants and toxicants herein.

http://www.iwla.org/docs/default-source/conservation-docs/water-docs/clean-water/righttoknow_front-matter.pdf?sfvrsn=2.[4]

Similar to the findings of the Izaak Walton League report, the Government Accountability Office ("GAO") had previously reviewed the water quality standards program and the use and implementation of TMDLs. In its report, the GAO found that states are not adequately implementing these programs—either at the front end or in following through and ensuring TMDLs are adequate and getting the job done. U.S. Government Accountability Office, CLEAN WATER ACT: Changes Needed If Key EPA Program Is to Help Fulfill the Nation's Water Quality Goals, GAO-14-80 (December 2013).

Plainly, discharges of pollutants into our nation's water have not been eliminated, and the nation and the state of Washington must do better. Almost thirty years after the deadline set by Congress, the nation still uses its waters as disposal sites for a vast number of pollutants, including toxic pollutants in toxic amounts. The proposed rulemaking presents a valuable and important opportunity for the state of Washington to advance protections for water and human health by setting more protective water quality standards than Washington's currently outdated standards, but Waterkeepers Washington finds that under the current proposal, the Washington Department of Ecology ("Ecology") has missed that opportunity and may move backwards with the proposed compliance off-ramps.

B. Ecology's Recent Efforts at Human Health Water Quality Criteria Have Fallen Short, Necessitating Action by EPA.

On January 12, 2015, after over a decade of delay and constant urging by EPA, tribes, fishing groups, environmental groups, and other communities, Ecology finally proposed revised human health criteria water quality standards for Washington State's surface waters. Those changes would have left the status quo of polluted conditions and under-protective standards unchanged, constructing in many instances only a façade of protections while providing compliance off-ramps and loopholes for polluters. That proposal was widely and soundly criticized—by Waterkeepers Washington, tribes, and the U.S. Environmental Protection Agency ("EPA"), (as well as many, many citizens) and Ecology ultimately withdrew that proposed rule after failing to finalize it under state law deadlines.

On September 14, 2015, EPA explicitly determined under 33 U.S.C. § 1313(c)(4)(B) that Washington's fish consumption rate and accompanying water quality standards are not adequate. 80 Fed. Reg. 55,063, 55,066-67 (Sept. 14, 2015). EPA found that

> the 6.5 g/day [fish consumption rate] that EPA used to derive the current human health criteria applicable to Washington does not account for these more recent local data, nor suppression in fish consumption (as discussed earlier). In addition, the 6.5 g/day FCR

[4] Copies of the Executive Summary and Washington detail of the Izaak Walton League report are included as attachments hereto.

> does not account for EPA's 2000 recommendation to use an upper percentile of fish consumption data for the target general population (as with EPA's current national FCR of 22 g/day) rather than an average.

Id. At the same time, EPA issued its own proposed rule to replace the inadequate standards. *See id.* The issuance of the proposed rule triggered EPA's duty to finalize a protective rule within ninety days. 33 U.S.C. § 1313(c)(4). EPA has not finalized a rule revising Washington's water quality standards, violating its mandatory duty under the Clean Water Act, 33 U.S.C. § 1313(c)(4). For that reason, Waterkeepers Washington brought suit against EPA to enforce its mandatory Clean Water Act Duty. *See Puget Soundkeeper Alliance v. U.S. E.P.A.*, No. 2:16-cv-293 (W.D. Wash. 2016).

On February 1, 2016, Ecology again proposed its own revised water quality standards and an accompanying package of loopholes and compliance off-ramps, or, as Ecology euphemistically calls them, "implementation tools" to allow noncompliance with all water quality standards. Unfortunately, as explained below, the underlying rule does not, contrary to the requirements of the Clean Water Act, protect designated uses, is not scientifically sound, is contrary to EPA guidance and is far less protective than the EPA proposed rule. While Ecology has proposed a 175 g/day fish consumption rate (a rate below what surveys show certain consumers such as members of Native American tribes eat) and protective 10^{-6} cancer risk rate, it uses other parts of the calculation to weaken standards and is severely under- or non-protective for three of the most important pollutants: mercury, arsenic, and PCBs. Likewise, the intake credits, compliance plans, and variances proposed would undo much or all of the progress made through the minimal strengthening of the underlying rule. Moreover these proposed compliance off-ramps would go further and actually weaken compliance with other, existing water quality standards.

II. LEGAL BACKGROUND

The Clean Water Act requires states to develop water quality standards necessary to meet the requirements of the Clean Water Act, including to protect designated uses of water. 33 U.S.C. § 1313. Those designated uses encompass the "fishable and swimmable" protections of the Clean Water Act: protecting and cleaning up our nation's waters so that they are clean enough for drinking, for direct human contact for fishing and recreation, for healthy aquatic resources, and for catching and consuming fish and shellfish. Water Quality Standards must include criteria, often numeric, sometimes narrative, necessary to ensure that the designated uses are attained and protected. When states fail to develop adequate standards, the Environmental Protection Agency ("EPA") must step in and do so within specified time deadlines. 33 U.S.C. § 1313.

"Fishability" is shorthand for and encompasses the ability of people to engage in harvest of fish and shellfish and to safely eat the harvested fish and shellfish in quantities that those individuals would normally consume. As recently stated by EPA in its letter to Maine disapproving portions of Maine's water quality standards, for tribal fishing rights and lands, the designated use must recognize and encompass the manner in which tribes use the water, including for sustenance fishing. *See* Attachment A to Decision Letter dated February 2, 2015, from EPA to the state of Maine at 2-3 and 28 (copy attached) ("Maine Letter"). In Washington, harvesting and eating fish, including for subsistence (sustenance) by tribes is the designated use of the waterbody that the Clean Water Act requires be protected.

Many toxic pollutants at issue in this rulemaking accumulate in fish and shellfish tissue, biomagnifying up the food chain. EPA, Water Quality Standards Handbook § 3.1.3 ("EPA WQS Handbook") ("The consumption of contaminated fish tissue is of serious concern because the presence of even extremely low ambient concentrations of bioaccumulative pollutants (sublethal to aquatic life) in surface waters can result in residue concentrations in fish tissue that can pose a human health risk."), available at http://water.epa.gov/scitech/swguidance/standards /handbook/chapter03.cfm#section13,m.

Because state and federal regulators have an obligation to set water quality standards to allow individuals and communities to harvest and eat shellfish safely in the quantities they would normally eat, it is incumbent upon the regulators to determine the amount of fish people actually consume when setting the human health water quality criteria for toxic pollutants. In numerous guidance documents, EPA has made clear that states must use locally-accurate and protective fish consumption rates to set water quality standards. *See, e.g.*, EPA, *Methodology for Deriving Ambient, Water Quality Criteria for the Protection of Human Health* at 2-13 (Oct. 2000) ("EPA 2000 Guidance"). Accurately determining the fish consumption rate is integral to regulators' ability to set protective human health water quality standards such that the level of toxic pollutants are low enough that fish remain safe to eat, even for people who eat greater amounts of fish than others. *Id.*; *see generally* National Environmental Justice Advisory Council, *Fish Consumption and Environmental Justice* at 30-32 (Dec. 2001); *see also*, Maine Letter at 2-3 and 37-42. If a state sets the foundational fish consumption rate lower than the amounts actually consumed, the commensurate human health water quality standards will be too lenient and people consuming fish may ingest levels of toxics that will put them at increased and unacceptable risk for adverse health consequences. EPA 2000 Guidance. Failure to adopt human health water quality standards based on an accurate fish consumption rate, including a rate adequate to protect sustenance fishing by tribes and other cultures, is a failure to promulgate water quality standards that meet the requirements of the Clean Water Act.

Other components of the human health water quality standards equation are also critical to ensuring adequately protective standards. As important as the fish consumption rate is the acceptable cancer risk rate, i.e. the risk that a person consuming fish will contract cancer during his or her lifetime because of exposure to toxics that may accumulate in fish. In Washington State, that number has been set at 10^{-6}, a one in one million chance that the average fish consumer would contract cancer from eating fish from the state. A $1x10^{-6}$ risk factor is generally considered protective. 40 C.F.R. § 131.36(b)(1). *See also* Maine Letter at 3.

Finally, additional components of the equation that affect the outcome are assumptions about a person's body weight, lifespan, the relative amount of toxics from ingestion of fish, as opposed to other sources (the "relative source contribution" number), and the use of bioconcentration or bioaccumulation factors. At every step, Ecology has selected the less protective option for the equation, often rejecting EPA's best-science instruction and recommendations.

III. THE PROPOSED HUMAN HEALTH WATER QUALITY STANDARDS ARE NOT SUFFICIENTLY PROTECTIVE OF DESIGNATED USES, FAIL TO CONFORM TO THE REQUIREMENTS OF GUIDANCE AND LAW, AND ARE ARBITRARY.

Despite the near-uniform recognition that Washington's human health water quality standards are inadequate, Ecology has proposed a rule that does not provide the improved standards necessary to protect fish consumers in Washington. Instead, Ecology's proposal fudges the math to reach an end-result with very few changes, none meaningful, and largely ignores (or even dramatically decreases protections for) the three most important chemicals to regulate in Washington.

A. Ecology Should Use a More Accurate Fish Consumption Rate.

Surveys of Washington communities show fish consumption rates far higher than the 175 g/day proposal, even without considering suppressed consumption due to severely reduced stocks of salmon, shellfish, and other fish relied upon by many Washington residents. In its determination that Washington's water quality standards are inadequate, EPA noted consumption survey data as high as 1,600 g/day and a Suquamish 95th percentile fish consumption rate of 767 g/day. *See* 80 Fed. Reg. at 55,066 n.18. Another recent EPA document noted survey data showing adult Suquamish tribal members have a fish consumption rate totaling 584.2 g/day. EPA, Record of Decision: Lower Duwamish Waterway Superfund Site App'x B at 33 & n.46 (Nov. 2014), excerpt attached. EPA also highlighted that the Muckleshoot and Suquamish Tribes have raised the issue of their fish consumption rates being suppressed as a result of fishing conditions. *Id.*; 80 Fed. Reg. at 55,066 n.18 ("Extensively researched historical average FCRs for the Columbia River Basin Tribes range from 401 to 995 g/day . . . ."); *see also* Comment Letters from Confederated Tribes and Bands of the Yakama Nation, March 25, 2014 (noting Yakama has higher consumption rates and never "agreed" to 175 g/day); The Tulalip Tribes, March 28, 2014; Puyallup Tribe of Indians, April 9, 2014; Stillaguamish Tribe of Indians, April 2, 2014 (noting that consumption has been suppressed due to efforts to build up salmon runs decimated by non-Indian actions); and Northwest Indian Fisheries Commission, September 5, 2014 (all currently in Ecology's record, available on Ecology's web page for this rulemaking and part of the record for this rulemaking).

Ecology's proposed 175 g/day fish consumption rate is insufficiently protective of the many Washington residents who eat fish in excess of that rate. The increase from 6.5 g/day is a step in the right direction, but survey data supports even stronger protection based on actual amounts of fish consumed by many members of the community affected by this rule. This is doubly important because of the substantial environmental justice concern the fish consumption rate presents as its effects are most acutely felt by people of color such as Tribes, certain immigrant groups, and subsistence fishers.

EPA is currently acting on a more protective fish consumption rate based on historical and sustenance fishing rates in Maine. EPA recently proposed a 286 g/day fish consumption rate for Maine and derived human health water quality standards based on that rate. 81 Fed. Reg. 23,239, 23,245 (Apr. 20, 2016). This rate is meant to protect unsuppressed fish consumption levels. *Id.* at 23,244-46. Surveys in Washington show even higher consumption rates than Maine. EPA's action in Maine makes it clear that a protective fish consumption rate based on the most accurate data, including sustenance fishing and historical fishing numbers, is the only reasonable and lawful outcome.

Moreover, as explained below, the fish consumption rate does not exist in a vacuum and must be considered simultaneously with the other components of the human health water quality standards. Ecology's decision to tinker with various components of the human health criteria equation negates much or all of the progress that may have occurred as a result of finally using a fish consumption rate that moves toward a more accurate reflection of what residents of Washington actually eat.[5]

B. Ecology Appropriately Retains the $1x10^{-6}$ Cancer Risk Rate as a Necessary Component of the Water Quality Standards Equation.

Washington's cancer risk rate for human health criteria water quality standards has always been one in one million or $1x10^{-6}$, as part of the National Toxics Rule. 40 C.F.R. § 131.36. Indeed, Washington approved of the $1x10^{-6}$ cancer risk rate when the NTR was put into effect. In its official comments, Washington asked EPA to use a cancer risk level of 10^{-6}. 80 Fed. Reg. at 55,068 (citing 57 Fed. Reg. 60,848 (Dec. 22, 1992)). EPA, in its proposed rule, maintained the one in one million rate. 80 Fed. Reg. at 55,068. EPA found that that rate was consistent with its 2000 methodology. *Id.* EPA went on to find that

> The [tribal] treaties themselves could be interpreted to require a certain level of risk; e.g., a de minimis level of risk that would most reasonably approximate conditions at the time the treaties were signed and the fishing rights were reserved.

Id. EPA also based a one in one million cancer risk rate on Oregon's 175 g/day fish consumption rate and 10^{-6} risk rate and many Washington rivers' being upstream of Oregon. *Id.*

[5] Waterkeepers Washington is willing and has been willing to accept a 175g/day consumption rate based on Waterkeepers' understanding that a number of tribes have agreed to this figure as a compromise. However, the law and the facts support a much higher consumption rate as set forth herein, and Waterkeepers advocates for Ecology and EPA to adopt more protective consumption rates in accordance with the law and surveys. Moreover, should the tribes decide that they can no longer accept such a compromise, Waterkeepers will also then discontinue its support.

Surprisingly, Ecology in its 2015 draft rule, for the first time, proposed to weaken the standards by increasing the allowable rate of cancer to one in one hundred thousand or $1x10^{-5}$ in its human health water quality standards equation; that effort was widely criticized, and Ecology has now correctly returned to a $1x10^{-6}$ proposal for cancer risk rate.

The cancer risk rate is crucial to determining the in-the-water protections this rule will provide. The very point of protecting fish consumers under the Clean Water Act would be compromised by a rate of less than one in one million, because those who eat the most fish make up the exact population for whom these numbers matter most and the group for which Ecology must not compromise its consideration of cancer. Adopting a greater risk tolerance would mean that cancer risk for one segment of the population, high fish consumers, can be ten-times higher than for the general population. That proposal to value the health of one group of people differently from another would be unacceptable, a violation of the Clean Water Act, and a likely violation of state and federal civil rights law.

C. Ecology Must Abandon Its Arbitrary, Selective, and Unscientific Tinkering with Components of the Water Quality Standards Equation.

As with its earlier failed effort, Ecology adjusted some, but not all, components of the human health water quality standards equation in reference to EPA's Exposure Factors Handbook ("EFH"). In so doing, Ecology picked only EPA recommendations that would weaken water quality standards while rejecting those that would strengthen the standards. Again, Ecology's actions appear to be results driven and are not based on the best science or what will be most protective of the most residents of Washington. This is the hallmark of arbitrary agency action.

The factors Ecology engineered in its standards equation are body weight, life expectancy, relative source contribution, and the use of bioconcentration as opposed to bioaccumulation factors. Each of these components affects the outcome of the human health criteria equation and the amount of concentrations allowed in Washington water. Each of these components is based upon EPA's long work in developing the science that supports use of particular factors in order to protect designated uses, and EPA has provided the results of that science in its recommendations to states. Yet Ecology ignored the science and EPA recommendations based on that science in favor of a one-sided results-driven approach. For body weight, Ecology chose to adopt EPA's recommendation, a choice that would drive the standard downward or in a less-protective direction. For life expectancy and source contribution however, Ecology rejected EPA's recommendations, on thin "states-rights" grounds, because those factors would strengthen the standards. On the bioconcentration as opposed to bioaccumulation issue, it appears from the Overview document that Ecology is confused about the science and the difference between these two factors as its discussion is muddled and inconsistent with the science and the Clean Water Act. Nonetheless, Ecology's choice again drove the resulting standard away from EPA's recommended approach and in a less-protective direction. Overall, Ecology's justifications in how it calculated the standards are unclear and unsound.

1. *Ecology's selection of a higher body weight results in a less protective standard and fails to consider implications for subsistence communities and the relationship between increased weights, related health effects and access to traditional foods.*

Ecology's proposed rule moves from a 70 kg (154.32 lbs.) body weight assumption, to 80 kg (176.37), *see* Ecology, *Overview of key decisions in rule amendment* at 23-24 (Jan. 2016) ("Overview"), *available at* https://perma.cc/SX88-PU2W, that will make standards less-protective. By assuming that people consuming fish weigh more than EPA assumed in the National Toxics Rule, which sets the current standards in Washington, concentrations of toxics will be permitted to be as much as 10% to 15% less protective. Catherine O'Neill, *Washington State's Weakened Water Quality Standards Will Keep Fish Off the Table, Undermine Tribal Health*, Center for Progressive Reform Blog (Mar. 4, 2014), available at http://goo.gl/7R04n3 (copy attached).

This component of the equation is also important for considering discriminatory impacts of weakening the standards equation in this and similar ways. Traditional foods are crucial to the health of native people and to tribes. Reduced access to traditional foods has resulted in myriad health problems in tribal areas, *including increased body weights*. A study commissioned by the Karuk Tribe found that "[t]he loss of traditional food sources is now recognized as being directly responsible for a host of diet-related illnesses among Native Americans, including diabetes, obesity, heart disease, tuberculosis, hypertension, kidney troubles, and strokes." Kari Marie Norgaard, *The Effects of Altered Diet on the Health of the Karuk People* at 5 (2004) (copy attached). The United States Centers for Disease Control & Prevention has also recognized the importance of traditional foods in fighting diseases in American Indian communities. *See* Native Diabetes Wellness Program, Centers for Disease Control & Prevention, Traditional Foods in Native America: A Compendium of Stories from the Indigenous Food Sovereignty Movement in American Indian and Alaska Native Communities (2013) (copy attached). This effort is of crucial importance because the rate of diabetes for American Indians and Alaska Natives is two to three times that of other groups in the U.S. Centers for Disease Control & Prevention, MMRW Weekly Summary (Aug. 1, 2003). For the Yakama Nation, the rate of diabetes is twice that of other populations in Washington. *See* O'Neill, *Washington State's Weakened Water Quality Standards*.[6]

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[6] Efforts in the Northwest to reinvigorate traditional foods and food systems would be undermined by the Ecology plan to use an increased body weight as one part of its efforts to weaken the water quality standards equation. The Northwest Indian Fisheries Commission outlined such an effort by the Muckleshoot Tribe. NWIFC, Muckleshoot food program fosters creative solutions (Feb. 8, 2012), *available at* http://nwifc.org/2012/02/muckleshoot-food-program-fosters-creative-solutions/. That program, which received USDA funding, and the CDC effort to promote traditional foods demonstrates the inefficiency and inequity of spending public funds to combat diabetes and other ills by encouraging traditional foods if states are permitted to allow contamination of those traditional foods.

It is unjust in the extreme to use one of the results of taking away healthy subsistence foods for native communities—increased body weight—as a reason to then further weaken water quality health protections for eating those foods. Ecology's action in this regard is discriminatory.

There is evidence that Ecology's decision came at the urging of industry polluters, not due to some scientific assessment. *See* Email from Nancy Judd, Wind Ward Environmental Consulting, to Cheryl Niemi, Washington Dept. of Ecology (Dec. 16, 2013) ("The result of using [a higher] average body weight is HH WQC that are still protective but are 10-15% higher") (copy attached); O'Neill, Washington State's Weakened Water Quality Standards Will Keep Fish Off the Table. Ecology needs to distance itself from such efforts and ensure that it is applying EPA's best science recommendations and in a way that protects all consumers and is not discriminatory.

As for other communities that consume high amounts of fish and shellfish, using an 80kg body weight significantly overstates weight, particularly for those in Asian-American/Pacific Islander communities, again resulting in reduced protections for those communities. A study of fish consumption by ten such communities in King County indicated an average body weight of 62 kg for men and women. Ruth Sechena et al., *Asian and Pacific Islander Seafood Consumption Study* at 62 (May 27, 1999), available at http://goo.gl/ptLiZZ. (copy attached). A dietary survey assessing fish consumption of Japanese and Korean women found similar body weight results to the King County study of the Asian and Pacific Islander community for women (57 kg, according to a presentation by one of the study's co-authors). Ami Tsuchiya et al., Fish intake guidelines: incorporating n-3 fatty acid intake and contaminant exposure in the Korean and Japanese communities, 87 Am. J. Clinical Nutrition 1867-75 (2008), available at http://ajcn.nutrition.org/content/87/6/1867.long. (copy attached). The mean weight of the participants in the Tsuchiya et al. study was 55 kg for the Japanese women and 59 kg for the Korean women. *Id.* There is simply no support for Ecology's contention that 80kg body weight results in a protective standard for all consumers of fish in Washington.

2. Ecology's selective rejection of other EFH recommendations further weakens protections and is arbitrary and contrary to best science.

Ecology's reduced protections based on body weight is cherry-picking the one component of the standards equation that would lower protections from among the relevant recent default values found in EPA's EFH. While body weight assumptions may increase, the 2011 EFH contains other values that would be more protective, such as those for life expectancy, drinking water intake, and relative source. Instead of simply adopting all EPA's recommended values along with body weight, Ecology has instead chosen only to modify the one default (body weight) that is now less protective.

Ecology refuses to use EPA's recommendations regarding Relative Source Contribution (applicable to non-carcinogens). EPA rightly points out that people's burden of toxics, and relative risk, come from a variety of sources. EPA, Human Health Ambient Water Quality

Criteria and Fish Consumption Rates: Frequently Asked Questions, *available at* http://water.epa.gov/scitech/swguidance/standards/criteria/health/methodology/upload/hhfaqs.pdf (copy attached). EPA therefore recommends that, absent scientific data about relative contributions of sources of toxics to the populations that are to be protected by the water quality standards, states should use a default value of 20 percent (.20) in the water quality standards equation to account for the obvious fact that not all toxics a person ingests will necessarily come from fish. *Id.* EPA further states that if the sources of exposure to a chemical are well-known and documented, a state may use a calculated relative source contribution but EPA recommends that the value not be greater than 80% (.80). Indeed, in its proposed rule, this is the path EPA followed: using a 20 percent relative source contribution or (in some circumstances 80 percent). 80 Fed. Reg. at 55,068.[7] Ecology pays no heed to EPA's recommendation and uses a relative source contribution value for all its calculations of 1.0—that is, Ecology irrationally assumes, with no foundation in fact or research, that a person in Washington ingests toxics only from fish or shellfish and not from any other source. As Ecology admits, using .20 for the relative source contribution, as opposed to 1.0, would have made the resulting water quality standards more stringent. Overview at 25. Ecology does not provide evidence suggesting that it has good scientific data in Washington about sources of toxics or that sources of exposures are "well-known and documented."

Ecology also rejects EPA's recommendation that life expectancy factors must be increased. Ecology, Proposed Rule Language at 6 (Jan. 2016) ("Proposed Rule"), *available at* https://perma.cc/645X-WD5M; Overview at 45-46. The seventy years life expectancy relied upon by Ecology in its calculations is no longer best science. Rather, EPA recommends an average life expectancy for men and women combined of 78 years. EPA Exposure Factors Handbook at 18-1 (2011), available at http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf. Again, retaining the outdated life expectancy figure results in a less-protective water quality standard. Ecology excuses its arbitrary choice by claiming that lifespan is not an "explicit" part of the criteria equations. Overview at 16. While lifespan is not called out explicitly in the equation, it certainly affects the results, and, as Ecology acknowledges, a change would result in changes to the calculated results of the equation. Overview at 44. Likewise, these numbers matter for "discharge limits for episodic discharges." Overview at 46. Yet, instead of using the most current guidance, Ecology simply accepts outdated 1994 and 2000 guidance documents.[8] Ecology should use the 78-year lifespan.

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[7] EPA also follows its own recommendations in this regard in its proposed rule for Maine. 81 Fed. Reg. at 23,247.

[8] Ecology cites this guidance as EPA's Water Quality Standards Handbook, updated according to Ecology in 2012. The passage Ecology cites, however, was last updated in 1994. EPA, Water Quality Standards Handbook Chapter 3: Water Quality Criteria at 4 (Aug. 1994), *available at* https://www.epa.gov/sites/production/files/2014-10/documents/handbook-chapter3.pdf. The link Ecology provided in its references section points to an entirely different site. *See* Overview at 47 ("EPA, 2012" linking to "Drinking Water Requirements for States and Public Water Systems"). Ecology must use the updated 2011 guidance.

Ecology also rejects EPA's recommendation (and indeed the recommendation of the scientific community) to use bioaccumulation instead of bioconcentration figures in the water quality standards equation. And again, the result is a less-protective standard. Since as early as 2000, EPA has made clear that it favors use of the more protective BAF over BCF. EPA 2000 Guidance at 1-5.

Bioaccumulation reflects how toxics move in the environment and how they ultimately affect people consuming fish and shellfish. It is the accurate figure to use for assessing how much of a toxic a person takes in when eating fish and shellfish and must be the figure used if Ecology is properly assessing risk and exposure from eating fish. While those fish and shellfish may have accumulated those toxics a variety of ways—directly from the water, from contaminated sediments in the water (that became contaminated because of pollution discharges to the water), from eating smaller fish that were contaminated from the water/sediments—the basic fact remains that these toxics got into the fish that people consume because of pollutants getting into the water. The BCF captures only a subset of the BAF because it does not measure all routes through which aquatic organisms are exposed to toxics in aquatic environments. Jon A. Arnot and Frank Gobas, *A review of bioconcentration factor (BCF) and bioaccumulation factor (BAF) assessments for organic chemicals in aquatic organisms*, 14 Environ. Rev. 257, 259-62 (2006), *available at* http://goo.gl/9P1hUO. These terms are not interchangeable. *Id.* This is because "[f]or some chemicals (particularly those that are highly persistent and hydrophobic), the magnitude of bioaccumulation by aquatic organisms can be substantially greater than the magnitude of bioconcentration. Thus, an assessment of bioconcentration alone would underestimate the extent of accumulation in aquatic biota for these chemicals." EPA 2000 Guidance, at 5-2 (emphasis added). Based upon this science, EPA's proposed standards for Washington and those proposed quite recently for Maine, both use BAF, *not* BCF in their calculations and development of human health water quality criteria. *See, e.g.*, 81 Fed. Reg. at 23,247 (proposed Maine rule).

In attempting to justify its continued use of EPA's outdated 1980 guidance recommending use of BCF, instead of the 2000 EPA Guidance's clear command otherwise, Ecology misrepresents (or at least misunderstands) the nature of the Clean Water Act requirements and the relationship between bioconcentration and bioaccumulation. Ecology makes the following statement: "BCFs are more closely related to the specific environmental media (water) that is regulated under the Clean Water Act." Overview at 43. This is a grossly irrelevant statement and one that does not square with the law. The Clean Water Act requirement to protect designated uses of the water must be met, and if sediment affects the concentrations of pollutants that can be in the water, that must be considered. Water quality standards set the standards for water bodies, regardless of the source of pollutants.

The Clean Water Act regulates water pollution two basic ways—one is regulating point source discharges, but Ecology's statement ignores the entire second half of the Clean Water Act. Congress also directed states and EPA to set water quality standards to protect all uses of water—these standards are set independent of the permitting system—they are standard of cleanliness applicable regardless of pollution sources. *Pronsolino v. Nastri*, 291 F.3d 1123, 1126

(9th Cir. 2002) ("At the same time, Congress decidedly did not in 1972 give up on the broader goal of attaining acceptable water quality. CWA § 101(a), 33 U.S.C. § 1251(a). . . [t]he 1972 statute therefore put in place mechanisms other than direct federal regulation of point sources, designed to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." § 101(a).") (citations omitted). These standards then drive the TMDL cleanup process which encompasses all sources of pollutants to water, point and non-point. *Pronsolino*, 291 F.3d at 1131-32. Ecology's statements in this regard border on shocking in their ignorance of the point of setting standards. Ecology is wrong on the law.

Similarly, Ecology's statements trying to distinguish why it chooses to use the old, outdated BCF are wrong on the science. The use of BAF relative to BCF has nothing to do with how a pollutant got into a water body. Instead, these distinct factors consider how the pollutant got into fish or other aquatic organisms after getting into the water. The BCF considers only dermal and inhalation exposure of aquatic organisms, whereas BAF considers the BCF plus aquatic organisms' exposure through the food they eat. Arnot, 14 Environ. Rev. at 259-62. How the pollutant got into the water initially before being taken up by the aquatic organism is irrelevant. *See id.* Ecology should have simply looked to the 2000 EPA Guidance's clear and scientifically-supported recommendation that states use a BAF, but instead chose, once again and in extremely garbled fashion, to reject EPA's recommendation in favor of a weaker, less-protective approach.

In sum, Ecology's choices in this rulemaking appear to be dictated entirely by keeping the water quality standards from becoming more protective. Ecology's actions are arbitrary and divorced from the science and the law and Waterkeepers Washington urges Ecology to reject this approach and redo the water quality standards with an approach that is protective of all Washington residents and consistent with the best science and recommendations from EPA.

IV. ECOLOGY'S ARBITRARY APPROACH RESULTS IN STANDARDS THAT ARE WEAKER THAN THEY WOULD BE WITH A SOUND, SCIENCE-BASED APPROACH.

While Ecology's move to a more accurate fish consumption rate and maintenance of the 10^{-6} cancer risk rate is moving in the right direction, much of that progress is undone by changes to other parts of the water quality standards equation as set forth above. Likewise, for four of the most important pollutants—arsenic, mercury, PCBs, and dioxin—Ecology creates exceptions to its process that result in lower standards than called for in the equation (and substantially lower than EPA's proposed rule). For all of Ecology's effort in preparing this proposed rule, many standards will actually become <u>weaker</u> than under the current National Toxics Rule and one, arsenic, will get dramatically worse. The majority of standards are far weaker than those proposed by EPA only a few months ago and weaker than the standards approved in Oregon.

It is important to recall that EPA's, environmental groups', commercial fishing group's, and Tribes' criticism of Ecology's low and inaccurate 6.5 g/day fish consumption rate was not because there is intrinsic value in a more-protective fish consumption rate. Rather, the fish consumption rate should be scientifically-supported and should be used in a regulatory system that will result in actual protections in designated uses for all consumers of fish and shellfish. In this instance, where we know that the existing standard, based upon a grossly-inaccurate fish consumption rate is not protective, increased protection from that non-protective state should, indeed must, be the result. Ecology's proposed rule cannot be demonstrated to be adequately protective of designated uses and it certainly does not result in more stringent human health criteria—in many instances criteria get weaker or simply stay as they were under the old, obviously non-protective rate.

A. Many Pollutant Concentrations Will Actually *Increase* Under the Inaccurate and Non-Scientific Proposed Rule.

When, in 2015, Ecology proposed to increase the cancer risk rate to 10^{-5}, it tried to soften the effect of weakening cancer protections by combining that change with a program it called "anti-backsliding" so that no criteria for chemicals (other than arsenic) would become less protective. *See* 2015 Proposed Rule at 13 n.A, *available at* http://www.ecy.wa.gov/laws-rules/wac173201a/p1203.pdf. The result was a muddled hodgepodge of sometimes more protective criteria and sometimes the same concentrations as are allowed under the currently-inadequate and non-protective NTR. Yet, ironically, that anti-backsliding rule meant that—at the very least—health protections would not decrease (other than for arsenic). But the same cannot be said for Ecology's latest attempt: for freshwater alone, there are 23 chemicals[9] for which health protections would decrease under the new rule even before the off-ramps and loopholes are considered. *Compare* Proposed Rule at 7-11, *with* National Toxics Rule, 40 C.F.R. § 131.36; *see* Ecology, Preliminary Cost-Benefit and Least-Burdensome Alternative Analyses at vii (Feb. 2016) ("Preliminary CBA"), *available at* https://fortress.wa.gov/ecy/publications/documents/1610009.pdf.[10] Ecology touts reduced (or nonexistent) compliance costs as a benefit of the decreased protections under the current proposed rule, *id.* at 54, while only listing one chemical (bis(2-ethylhexyl) phthalate) where the new proposed rule will produce benefits from

[9] These include arsenic, 1,2-Dichloroethane, 1,2-Dichloroethylene, 1,4-Dichlorobenzene, dioxin, alpha-endosulfan, benzo(a) anthracene, benzo(b) fluoranthene, benzo(k) fluoranthene, beta-endosulfan, bromoform, chlorodibromomethane, chrysene, dichlorobromomethane, endosulfan sulfate, hexachlorobutadiene, indeno(1,2,3-cd) pyrene, isophorone, methyl bromide, methylene chloride, nitrobenzene, and tetrachloroethylene.

[10] Waterkeepers Washington acknowledges that, by its count, standards for fifteen of these chemicals would also decrease under EPA's proposed rule. The decreases, on their own, are not Waterkeepers Washington's primary concern since refined cancer slope factors and other measures can result in revised requirements. But, the differing ways in which EPA and Ecology arrived at those determinations are important, where EPA does not appear to have picked selectively from its guidance, and Ecology's standards remain weaker for most chemicals. Further, for at least eight chemicals in freshwater, Ecology has proposed decreases in protection where EPA has proposed increases in protection relative to the NTR. *See* EIS App'x B (1,4-dichlorobenzene, dioxin, arsenic, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, hexachlorobutadiene, and nitrobenzene).

reduced cancer risk. It appears from Ecology's discussion that only 13 facilities must change in order to comply with one new standard, the more stringent bis(2-ethylhexyl) phthalate standards and (possibly) 2 facilities (one of which appears to be closing already) for complying with other chemicals. *Id.* at 39-43 (total quantifiable costs are $10,600).[11]

Equally alarming, Ecology's proposal would mean 76 pollutants will have less protective standards than those EPA proposed in its 2015 proposed rule, again even before Ecology's generous compliance off-ramps and loopholes are considered. *Compare* Proposed Rule at 7-11, *with* 80 Fed. Reg. at 55,075-76. Some of the differences between EPA's and Ecology's proposals are staggering. *See, e.g.*, the allowed concentration for anthracene would be 40 µg/L for EPA and 3100 µg/L for Ecology (775 times higher); flourene would be 5 µg/L for EPA and 420 µg/L for Ecology (84 times higher); hexachlorocyclopentadiene would be .4 µg/L for EPA and 150 µg/L for Ecology (375 times higher); *compare* Proposed Rule at 7-11, *with* 80 Fed. Reg. at 55,075-76; *see also* DEIS App'x B. And by way of comparison, Ecology's proposal is for more lax regulation of 72 pollutants than Oregon, the vast majority of pollutants for which criteria are being developed. *Compare* Proposed Rule at 7-11, *with* Ecology, *Washington Proposed HHC vs. Oregon Adopted HHC* (used to determine Oregon pollutant concentration levels), *available at* http://www.ecy.wa.gov/programs/wq/swqs/ECYPropvsORHHC.pdf. EPA's 2015 proposal is based on sound and complete science and is compliant with EPA's own direction and recommendations for calculating protective human health water quality criteria. Plainly, in falling so far short of that, Ecology's current proposed standards cannot be approved by EPA and Ecology must reconsider its arbitrary and inadequately protective approach.[12]

It is disheartening, to say the least, that so many pollutants would actually be allowed in *greater* quantities in our water, especially since two of those (arsenic and PCBs) are among the most dangerous regulated and the most prevalent. For four of the most hazardous and persistent chemicals in our waters—PCBs, arsenic, and mercury—the proposed rule does nothing or actually *increases* the amount of chemical allowed in Washington waters. *See* detail below. The entire point of this exercise is to correct the current situation where Washington's human health water quality standards for toxics are too weak and not adequately protective. Ecology's current proposed rule is not in accord with the science or with the law and must be withdrawn as well as disapproved by EPA.

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[11] Note that Ecology has entirely failed to analyze costs to health, lost wages, and other impacts from weakening standards for over twenty chemicals, including arsenic.

[12] Ecology's proposal also stands in stark contrast to EPA's recent action in Maine where EPA uses BAF, not BCF and follows its own EFH guidance as to application of all factors in the human health criteria calculation. As a result, EPA proposes a standard of $4.5E^{-6}$ for PCBs and has much stricter standards for pollutants like anthracene and flourene. 81 Fed. Reg. at 23,260-62. For mercury, EPA develops a fish tissue standard (which is the way many states are developing protective standards for mercury). *Id.* at 23,262 n.a.

B. Four of the Most Dangerous Chemicals—PCBs, Arsenic, Mercury, and Dioxins—Will Continue To Be Allowed in Current Hazardous Amounts or Even Allowed to *Increase*.

Ecology's (once-again) tortured treatment of PCBs is particularly emblematic of the arbitrary nature of Ecology's actions here. PCBs are some of the most dangerous chemicals in Washington's waters. As Ecology has acknowledged

> [h]ealth effects that have been associated with exposure to PCBs include acne-like skin conditions in adults, and neurobehavioral and immunological changes in children. PCBs have been shown to cause cancer in animals (EPA 2014). Studies of exposed workers have shown changes in blood and urine that may indicate liver damage.

Overview at 52. Yet, Ecology chose to leave the standards exactly the same as under the plainly inadequate NTR, with no steps forward even with a somewhat more accurate fish consumption rate. *Id.* at 51. Ecology proposes to allow a dramatically higher cancer risk rate for PCBs—rather than one in one million; it proposes allowing a one in 25,000 cancer risk for PCBs alone. Proposed Rule at 11-12 & n.E; Overview at 53-54. Ecology does so with no explanation for why it would allow a significantly increased cancer risk—forty times more—for fish-consuming residents of Washington for this known carcinogen and produces no scientific evidence to support its decision to allow the public to be at increased risk from PCBs relative to other pollutants. And, when Ecology applied the dumbed-down PCB formula, the resulting standard for allowing PCB's in Washington's waters ended up (not surprisingly) being less protective, or weaker, than the current inadequate NTR standard. Proposed Rule at 13 n.E At that point, to make it "come out" Ecology applied an "anti-backsliding" concept reminiscent of the 2015 proposed rule to keep the PCB water quality standard exactly where it is now—the under-protective NTR criterion. Ecology offers no rational explanation for singling out PCBs for this special, arbitrary treatment, and there is no explanation. The entire exercise appears to be one geared to ensuring the standard ends up where Ecology wanted to land—at a standard unchanged—and that Ecology tinkered with the math and methodology until it got there.

For methylmercury (a highly toxic metal with neurotoxic effects), applying the updated fish consumption rate and the proper factors from EPA's EFH recommendations would have resulted in a more protective water quality standard. Instead, Ecology simply proposes to put off any new regulation, leaving the inadequate mercury standard as is. Overview at 63-66. Again, EPA has already found that the mercury standard, as part of the NTR, is inadequate to protect designated uses, necessitating a new, more stringent, standard. To justify its failure to act, Ecology asserts it is simply too difficult to complete a mercury standard. This assertion that "it is too hard" is neither supported, nor supportable. First, Ecology's complaint rings hollow given the years and years that Ecology has supposedly been working on this. Second, Ecology could simply rely on a correct equation and accept the result—it is, after all, already engaged in that task for many other chemicals and it simply requires doing a single calculation. Third, Ecology could look to other states that apparently were able to address mercury or look to EPA's proposed standard. For example the State of Minnesota has a protective fish consumption and mercury standard and even addressed the fact that different bioaccumulation standards (and therefore different water quality standards) should apply in the northern part of the state where geologic and vegetative conditions aid methylation requiring a stricter standard. *See* http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/special-projects/statewide-mercury-tmdl-pollutant-reduction-plan.html; http://www.pca.state.mn.us/index.php/view-document.html?gid=288; http://www.pca.state.mn.us/index.php/view-document.html?gid=8507. And, Minnesota has taken the matter a step further and developed and implemented a mercury TMDL. *Id.* Ecology's claim that it's just "too hard" to do its job and regulate this dangerous metal—despite EPA's, Oregon's, and other states' ability to do so is simply unsupported. Ecology's "too hard" complaint is baseless and certainly finds no support in the Clean Water Act.

For arsenic Ecology is proposing a *555-fold increase* in the permitted amount of arsenic in Washington's fresh water. Overview at 57 (comparing 2015 proposal allowing 10 µg/L arsenic vs. 0.018 µg/L in the current standard). Ecology attempts to justify this change by citing the higher concentrations of naturally-occurring arsenic in some parts of the western United States. *Id.* While some waters in Washington may in fact have higher naturally-occurring arsenic, not all do and Ecology makes no attempt to distinguish nor to determine what natural levels might be to ensure that human-caused pollution does not add to the risk. Ecology also seems to suggest that by simply adopting the "drinking water standard," it has met its Clean Water Act section 304 obligations. Ecology's understanding of the law is incorrect. EPA has directly addressed this issue and has made plain that Safe Drinking Water Act ("SDWA") standards are not to be used as a substitute for Clean Water Act section 304(a)(1) human health standards and that it is not scientifically-supportable to do so:

> The section 304(a)(1) criteria also [should] include fish bioaccumulation and consumption factors in addition to direct human drinking water intake. These numbers were not developed to serve as "at-the-tap" drinking water standards, and they have no regulatory significance under the SDWA. Drinking water standards are established based on considerations, including technological and economic feasibility, not relevant to section 304(a)(1) criteria. Section 304(a)(1) criteria are more analogous to the maximum contaminant level goals. . . of the SDWA. . .[which] do not take treatment, cost, and other feasibility factors into consideration. . .

EPA WQS Handbook, § 3.2.4. As noted by EPA, drinking water standards are simply standards that a municipal entity has to meet "at the tap" for a community water supply, and that statute, unlike the Clean Water Act requirements for ambient water quality standards, allows cost and other factors to be taken into account. Nowhere does the Clean Water Act allow for cost and technology and economic feasibility to be considered when setting standards. Those factors might come into consideration in permitting or other regulatory decisions but have no place in setting the standards to be met for human health and to protect designated uses such as catching and consuming fish and shellfish. Congress has allowed for or directed consideration of cost and/or feasibility in other environmental laws, for example the Clean Air Act, but has pointedly omitted those considerations here. Finally, Ecology's misapplication of a drinking water standard from a different statutory paradigm fails completely to develop a standard based upon BAF and consumption of the toxic in fish—there is no discussion or justification by Ecology for how or why a drinking water standard will protect fish consumers, the point of Ecology's rulemaking exercise here. Ecology's recommendation regarding arsenic is based on incorrect interpretation and application of the Clean Water Act and the SDWA and lacks a scientific and statutory underpinning.[13]

Ecology has also proposed human health criteria for dioxins that are lower than the NTR standards, far lower than EPA's proposal, and 25 times less protective than Oregon's. Ecology reaches this result by calculating 2,3,7,8-Tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) only based on its non-cancer health effects. Overview at 30. This is unacceptable given that EPA has determined that 2,3,7,8-TCDD is, along with other dioxin-like compounds, carcinogenic to humans. Ecology's proposal is contrary to EPA's guidance and should be redone based on cancer risk.[14]

V. THE PROPOSED RULE INCLUDES COMPLIANCE OFF-RAMPS THAT ARE INCONSISTENT WITH AND UNDERMINE THE CLEAN WATER ACT.

Despite having proposed only modest changes to some human health water quality standards, Ecology's Proposed Rule contains new and expanded off-ramps and loopholes that would allow polluters many avenues of delaying and avoiding compliance with clean water standards. These off-ramps will allow polluters to escape compliance with potentially all water quality standards, not just the few toxics standards that have become ever-so-slightly more stringent. There is no factual or legal justification for any of Ecology's off-ramps, in particular the expanded variance loophole and extremely long compliance plans. Rather, it is plain that Ecology is working with polluters to use the handful of slightly more stringent human health water quality standards as a stalking horse or excuse for relieving polluters from the application of many different water quality standards. This is particularly true because Ecology has only been able to tally a meager $10,600 in total quantifiable costs from the new rule and has acknowledged that there will be cost-savings to industry in complying with weaker standards. *See* Ecology, *Preliminary Cost-Benefit and Least-Burdensome Alternative Analyses* at 39-43, 54 (Feb. 2016) ("Preliminary CBA"). Plainly there is no pressing need to relieve polluters from a burdensome requirement (and, as set forth below, even if the requirement were more stringent, that is in fact the way the Clean Water Act works.)

In addition to expanding harmful off-ramps, Ecology failed to look at any implementation rules that would reduce toxic pollution such as, for example, banning mixing zones (areas of waterbodies at the end of a polluter's pipe that are allowed to violate water quality standards) for bioaccumulative toxics that are a concern for human health as in EPA's

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[13] Waterkeepers Washington also adopts and hereby incorporates the comments of the tribes and Northwest Indian Fisheries Commission related to the proposed arsenic standards.

[14] Waterkeepers Washington also adopts and hereby incorporates the comments of the tribes and Northwest Indian Fisheries Commission related to the proposed dioxins standards.

requirements for the Great Lakes Initiative, 40 C.F.R. Pt. 132. Ecology should reexamine its mixing zone policy instead of focusing on policies designed to allow polluters to escape compliance with protective water quality standards.

A. Ecology's Variance Proposal is Not Compliant with the Clean Water Act and Lacks a Rationale.

1. Variances do not create a new "designated use."

Ecology's variance proposal has unlawfully confused important concepts in the Clean Water Act. Ecology's proposed rule defines a variance as "a time-limited designated use and criterion as defined in 40 C.F.R. 131.3." Proposed Rule at 15. The proposed rule goes on to explain that the variance is a change to the designated use itself, "Variances for individual facilities, a group of facilities, or stretches of waters may be issued for the criteria and designated uses. *Id.* at 14. This problem is repeated through the rule for every type of variance Ecology proposes to use. *See id.* (defining individual variances, multi-discharger variances, water-body variances); *id.* at 15 ("A variance is a time-limited designated use and criterion.").

This is an unacceptable conflation of Clean Water Act terms and directly contrary to the Act and EPA regulation. The designated use, as explained above, is the use that must be protected under the Clean Water Act. 33 U.S.C. § 1313. A variance cannot changed for either the long- or short-term. 40 CFR § 131.14(a)(2) ("(2) Where a State adopts a WQS variance, the State must retain, in its standards, the underlying designated use and criterion addressed by the WQS variance, unless the State adopts and EPA approves a revision to the underlying designated use and criterion consistent with §§131.10 and 131.11. All other applicable standards not specifically addressed by the WQS variance remain applicable.")

Indeed, variances should not be used at all, as explained below, but in any case they cannot change the designated uses—at most, they would excuse (in Waterkeepers' opinion unlawfully) a discharger from meeting the requirements that exist based on and derived from the designated uses.

2. Water quality standards drive many important components of the Clean Water Act and variances disrupt, rather than aid, implementation of the Act.

In general, variances are a tool that have outlived their usefulness, if they were ever a legitimate application under the Clean Water Act. Ecology's justification for the use(s) of variances is inconsistent with the basic structure and requirements of the Clean Water Act, and Waterkeepers Washington strongly question their proposed expanded use. Variances generally, and certainly the ones proposed here, appear to be nothing more than an off-ramp away from meeting standards and from steadily improving water quality. Variances are not an "aid" to meeting water quality standards or a tool that results in "implementation," but an excuse to avoid them. Their continued and expanded use does not comply with the basic requirements of the Clean Water Act.

As noted above, states must set water quality standards to protect designated uses and in many instances those standards are not being met, in Washington or elsewhere. Where water quality standards are not attained, a state must report this fact to EPA, and the water is added to a § 303(d) or impaired water list. 33 U.S.C. § 1313(d). Once on the list, the water body is in the queue for preparation of a clean-up plan—a Total Maximum Daily Load ("TMDL") plan. States have a significant amount of time to prepare and finalize TMDLs.

A TMDL sets Waste Load Allocations ("WLAs"), which assign specific load limits to specific point source discharges. In setting WLAs, a state determines the discharge limits necessary to return the water to meeting water quality standards, along with whatever reductions have been assigned to the Load Allocation ("LA"). If the WLAs do not meet that definition, the TMDL is deficient and must be redone. Similarly, if the WLA and LA reductions are expected to take an extremely long time it could be argued that the TMDL is deficient because it is impossible to say with any reasonable assurance that the reductions will actually occur, a requirement in EPA's TMDL guidance. Rather, as work on a water body progresses, states reassess and readjust a TMDL as necessary. The water body remains "impaired" in status (and thereby subject to the TMDL clean up plan) until it achieves water quality standards.

This is the straight-forward way that waters are to be cleaned up under the Clean Water Act structure adopted by Congress. The water quality standards set to protect the designated uses of the water serve as the goal and guiding principle toward which the TMDL and its implementation must always be geared. It serves no purpose and in fact wholly disrupts this structure, to gut the process by rewriting or eliminating the applicable water quality standard. Point sources must have permits to discharge and those permits are to include effluent limitations and other provisions (for example compliance plans) to ensure that the permit is designed to not cause or contribute to violations of water quality standards. In a TMDL situation, a point source will have been assigned a wasteload allocation, a part of the TMDL with which point sources must comply. The point source's permit must include limits as necessary to comply with the wasteload allocation. Again, compliance plans, within reasonable timeframes, are a method to help point sources reach compliance over the course of a permit. *See also below.*

3. Ecology's justification for expanded variances lacks legal or factual support.

Given this Clean Water Act structure, there is no reason to allow "variances" from water quality standards. Ecology argues that expanded variances are needed because updated variables in the water quality standards equation "these new, more protective criteria may be difficult to meet." Overview at 78. As discussed above, however, the standards for numerous chemicals will actually become <u>less</u> stringent under the new rule, and for four of the most important pollutants (arsenic, mercury, dioxins, and PCBs) the changes are at best non-existent or at worse (for arsenic) 555-times worse. *See supra* Section IV. Indeed, Ecology has apparently only tallied a total quantifiable cost of $16,000 for the few more stringent standards, but has acknowledged that compliance costs will go down where standards are weakened. *See* Preliminary CBA at 39-43, 54. Rather than point to specific pollutants and measures that will now be more difficult to meet and in what ways, Ecology only provided a vague statement about difficulty that is undermined by much of its own analysis. There is no justification (and of course Ecology has provided none), for an expansion of off-ramps like variances for this combination of slightly-improved, unchanged, and weakened toxics standards, much less for all pollutants. And again, Ecology is going even further expanding the variance off-ramp for *all* pollutants, not just those that are part of this particular rulemaking with no rationale at all for doing so.

Ecology also claims variances are desirable to provide time to make progress towards attaining standards. This implies, incorrectly, that the Clean Water Act imposes some sort of penalty on a state for failing to achieve water quality standards by a certain date. Regrettably, it does not. A variance does not "create" additional time; whatever time is genuinely needed to meet water quality standards, that time will be taken regardless of whether the state adopts a variance. Rather a variance undoes the water quality standard that has already been determined necessary to protect designated uses of the water by excusing compliance and ultimately removes the incentives to move forward on a timeline toward compliance. Variances will, in fact, have the opposite effect of making progress by removing the impetus for progress.

Further, the purported "time" issue is not a genuine problem. Once a water is on the list, states have ample time to prepare a TMDL for EPA approval (and many states, including Washington, take far longer than is reasonably needed). This is not the timeline for completing the TMDL and bringing the water into compliance with standards. This is just the period of time a state has to propose and finalize the cleanup plan. During that time, states should be working aggressively with point sources, at a minimum, to ensure that permits are meeting the requirements of 40 C.F.R. § 122.44(d), which will make the TMDL process easier. Once the TMDL is approved by EPA, again regrettably, there is nothing in the Clean Water Act requiring that the TMDL goals be met in some set period of time. While it is true that a water body may not yet attain water quality standards even when the point sources implement their reductions, it simply means that the water will remain listed under 303(d) as impaired until standards are attained. The claim that "long term" strategies necessitate variances is not consistent with the Clean Water Act; the "long term strategy" is the TMDL itself—the clean up plan to meet water quality standards, not weaken them. There is no need to weaken protections, even temporarily, for our nation's waters under the existing structure.

To weaken water quality standards will simply confuse, exacerbate, perpetuate, (or possibly even create) an impairment situation by allowing more pollution over more time making ultimate cleanup lengthier and more difficult. It is self-defeating. This is the opposite of the Clean Water Act goals and requirements. If dischargers need time to employ new technologies or methods to meet stricter permit limits, the use of compliance plans and schedules ensures they use that time to install aggressive pollution controls, without weakening standards.

In fact, variances can work against the very things Ecology claims might require time. For example, if the problem is primarily a non-point source, downgrading and weakening standards through variances provides a disincentive to moving quickly and aggressively to deal with water quality problems. Application of a loophole like variances simply derails the statutory process of identifying troubled bodies of water and getting to work on a plan for clean-up. Waterkeepers Washington urges Ecology to rethink this failed, unnecessary, and counterproductive policy and eliminate it from the proposed rule. At a minimum, Ecology should not be expanding the use of variances, but should be striving to narrow their use to very limited circumstances.

4. If used at all, variances must be significantly narrowed and circumscribed, not expanded, to ensure they do not defeat the proper function of the Clean Water Act.

Variances to water quality standards are currently allowed (but certainly not required) by EPA rule, but the rule is plain they must be used sparingly. 40 C.F.R. § 131.10. If Ecology insists on the continued use of variances (again, a choice that is not consistent with the requirements of the Clean Water Act), then significant tightening of the rule is necessary.

Ecology proposes to require a five-year interim review schedule. Proposed Rule at 16. This is unlawful under the Clean Water Act and EPA regulation. Variances are water quality standards in their own right and as such, must be approved by EPA and must be revisited every <u>three</u> years as part of the required triennial review, with accompanying public process, to justify retention. 33 U.S.C. § 1313(c) and 40 C.F.R. § 131.10(g) and (h). *See also* EPA WQS Handbook, parts 2.7 and 2.8. Renewal of a variance must be fully-justified at each three-year mark as again, they are highly contrary to Clean Water Act requirements and purposes and should be carefully monitored and generally disfavored. Variances are required to be as short as possible and during the course of the variance, the discharger must regularly demonstrate that reasonable progress is being made to attain water quality standards. *Id.* This should require, in every permit where a variance is utilized, monthly monitoring and reporting of discharges and progress on reductions; and very specific interim milestones and deadlines for action and progress. (Again, however, it must be noted that this describes a compliance plan, and there does not appear to be any legal or factual support for anything other than a compliance plan—there is no need to "write down" the applicable water quality standard in order to give a discharge time to come into compliance with the applicable standard.) Variances should in most instances not extend beyond three years—at most, they might extend for the length of a single permit term with a review as to necessity for continuation at the three-year mark.

Ecology is also proposing variances for entire stretches of water. Proposed Rule at 14, 16. Again, Ecology's large expansion of this suspect concept is at odds with the Clean Water Act and federal regulation. Variances are not appropriate for anything other than portions (generally small) of water bodies and they pertain only to a single discharge or possibly a very small group of geographically-proximate and substantively-similar discharges into that reach. Ecology's proposal is contrary to the most basic principles underlying the Clean Water Act and its implementing regulations. The scope of the variance must be both discharger- and water body-specific, and it should also be pollutant-specific; it should extend for the shortest distance possible in the water body[15] and must be decided and supported with a full rulemaking record, with public comment, on a case by case basis every three years. Ecology also proposes to introduce, for the first time, multiple discharger variances. Ecology must make explicit in the rule that there are no variances allowed for an entire water body or an entire region or state for any pollutant.

Certain conditions for a variance are more prone to abuse, such as where human conditions supposedly have permanently altered the water body such that it is not possible to meet standards or would be more environmentally damaging to attempt to do so or where it is it is economically prohibitive to return the water to meeting standards, and Ecology must tighten those restrictions and not use them as an excuse to expand here. It is never appropriate to grant a variance where standards can be attained with reductions on point and nonpoint sources, including elimination of discharges. 40 C.F.R. §§ 131.10(d) and (g).

Consistent with the requirements of the Clean Water Act and EPA regulation, Ecology must specify in rule that a variance absolutely cannot be adopted if the water quality criterion can be achieved with either or a combination of technology-based requirements and aggressive permit requirements for best management practices such as low impact development for new development and retrofits for existing sources. Again, Ecology must not promulgate rules that are a disincentive to consistent forward progress on improving water quality and meeting water quality standards.

Ecology's rule must make clear that a variance does not replace or otherwise alter the underlying designated use, including fish consumption, fish and shellfish breeding, rearing, sheltering, recreational uses (e.g. boating, swimming), or wildlife uses. And finally, the rule must specify that variances can *never* be an option for new or expanding sources or discharges as such a concept is completely contrary to the requirements of the Clean Water Act and existing EPA regulation. Moreover, if a new or expanded source or discharge will be discharging to the same waterbody reach (or perhaps waterbody as a whole) where a discharger has or desires a variance, the variance must be denied as it will be impossible to weaken a water quality standard with a variance for one and not run afoul of the law.

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[15] This is generally consistent with EPA guidance now, but it is abused and Ecology will be well-served to make that clear in this rule. This also highlights the fact that variances aren't necessary—mixing zones do the same thing—another idea that is enormously abused and contrary to basic Clean Water Act principles. At least one of either mixing zones or variances—both anti-Clean Water Act concepts—should be eliminated as together they ensure the impaired status of waters for decades with little to no actual compliance by pollutant dischargers of all types.

B. Compliance Schedules Should Not Be Expanded but Used Carefully to Promote and Enhance, Not Avoid, Compliance With the Clean Water Act.

Compliance schedules are recognized by EPA as an acceptable tool in permitting under some circumstances. 40 C.F.R. § 122.47. Ordinarily, compliance schedules are appropriate where an existing permittee needs time to comply with a new standard such as a new water quality standard or a new technology standard or both. Ecology's rules already provide for the use of compliance plans in permitting. The justification for compliance schedules is that compliance with a new standard cannot happen instantly, and so a plan may be created that includes interim, enforceable milestones with a firm date by which time permit requirements must be met. While EPA's regulations do not set a maximum allowable time for compliance schedules, they must ensure compliance "as soon as possible." *Id.* at § 122.47(a)(1). Case law has warned against compliance plans cannot exceed the five-year term of a permit. *Citizens for a Better Environment v. Union Oil Co. of Cal.*, 83 F.3d 1111, 1120 (9th Cir. 1996). Further, "schedule of compliance" as defined in the Clean Water Act plainly contemplates a period of time constrained by the four corners of a five-year permit. 33 U.S.C. § 1362(17); *see also* 40 C.F.R. § 122.2.

Generally, the five-year term of a permit should be more than adequate to bring a facility into compliance—by adding the necessary new technology or entering into pre-treatment agreements or implementing process changes. While Ecology rules currently provide for two permit terms or a full decade—this length of time is unlikely to be necessary and as noted above, is contrary to existing law and policy. Ecology now seeks even further expansion and that proposal is simply unwarranted by the facts or the law. Proposed rule at 18-21. Anything more than a permit term is an attempt to avoid compliance as opposed to working diligently on addressing a pollutant discharge problem. If a discharger of pollutants is unable to come into compliance over the course of a decade, then that discharge should not be allowed. Dumping pollutants into our waterways is not a right. Under no other area of the law are violators allowed a decade to come into compliance with the law (for example worker or patient safety codes, tax laws, traffic codes) and then given an indefinite pass if it is "just too hard." Neither should it be acceptable with requirements for clean and healthy water.

Ecology's primary justification for the elimination of the current (illegal because it is already too long) ten-year cap on compliance plans is its claim that it is required to do so by statute. *See* Overview at 72-73 (citing RCW 90.48.605). The Washington Legislature cannot dictate action contrary to the requirements of the Clean Water Act. Therefore, either the cited statute need not be read so expansively or, if that is indeed the intent, it is in conflict with federal law and must give way under basic principles of federalism. Moreover, it cannot be approved by EPA and as such is a pointless exercise by Ecology.

Given that Ecology's only two justifications for an extreme expansion of compliance plans (basically "noncompliance plans") fail on the facts and the law, Ecology should withdraw the proposal for expanded compliance plans and move to narrow the availability of variances altogether.

C. Intake Credits Must Be More Carefully Tailored to Specific Waterbody Circumstances.

Ecology proposes to allow intake credits. Proposed Rule at 16-18. The intake credits system "address[] situations where facilities bring in and discharge levels of background pollutants contained in the intake water, referred to as intake credits." Proposed Rule Overview at 53. In other words, intake credits allow dischargers to discharge water that violates ordinarily-applicable limits if the discharger has not added pollutants to the water.

Intake credits are a particularly problematic concept for toxics such as those at issue in this rulemaking. Many chemicals for which such exceptions will be sought are for chemicals that accumulate in fish tissue and water over time such that even small additions are ultimately harmful and harmful in the very way the water quality criteria is supposed to avoid. Allowing intake credits could weaken the ability to rid Washington's waters of these dangerous pollutants and would contribute to and/or perpetuate the death by a thousand cuts problem of bioaccumulation that Washington is currently experiencing with these pollutants.

If intake credits will be included in the rules, and Waterkeepers objects to their inclusion, Ecology must strengthen the rules to protect against abuse and the bioaccumulation problem.

Ecology's record for this rulemaking demonstrates that industry complains toxics are difficult to measure and detect in their discharge in the small amounts dictated by standards and that is why an intake credit is necessary. Close inspection of this rationale shows a lack of logic in then applying intake credits in anything other than a very tightly-controlled manner. If these toxics are indeed difficult to discern, it is not then clear how industry and Ecology think they will be able to discern whether the polluter is adding to the problem. Many small, "undetectable" amounts appear later as a violation of standards downstream, and as a huge bioaccumulation problem at the mouth of the Columbia, the Duwamish, and in Puget Sound. This is unacceptable and simply perpetuates the current problem.

Ecology should impose strict laboratory and testing requirements on any discharger seeking an intake credit and ensure that monitoring occurs frequently with full public disclosure. Further, permits should be written with no-detect limits such that as laboratory methods improve at detection, the amounts of these toxic pollutants is steadily pushed downward—the plain intent and requirement of the Clean Water Act. Any permit allowing an intake credit must strictly enforce specific testing at the point of intake to determine the background level of the subject pollutant and testing again at the point of discharge (in the pipe or facility, not once it hits the water) and *any* increase in the pollutant must be considered a permit violation. Finally, Ecology's intake credit must be pollutant, waterbody, and discharger specific—anything more broad and loosely-regulated will simply be subject to abuse and will be nothing more than a permit to perpetuate pollution.

VI. THE DEIS IS INADEQUATE IN ITS FAILURE TO CONSIDER REASONABLE ALTERNATIVES.

Ecology failed to consider and evaluate numerous important alternatives, rendering the DEIS inadequate. For example, Ecology entirely failed to consider any fish consumption rate higher than 175 g/day, even though numerous studies show fish consumption rates well in excess of that rate. DEIS at 20. Ecology also failed to consider maintaining a 70 kg body weight or increasing the life expectancy used in its calculation and how those changes would affect the chosen proposal. Instead, Ecology only considered a no-action alternative, EPA's proposed rule, and the Ecology proposed rule. *Id.* Lastly, Ecology unacceptably limited its comparison of the alternatives it did present, providing only one paragraph on "usability" and one on "environmental protection." *Id.* at 21-22. That discussion does not differentiate between, for example, the environmental protection differences in EPA's much stronger proposed rule. *Id.* In the tables presented, the qualitative ratings of alternatives 2 and 3 are the same, but there is essentially no explanation as to why one was selected over other. *Id.*

CONCLUSION

The effect of Ecology's proposed rulemaking is to reduce health protections for many chemicals—including one of the most dangerous, arsenic—leave others nearly unchanged and to expand and create loopholes for all pollutants from all pollutant sources. While rightly proposing an increased fish consumption rate and maintaining a one in one million cancer risk rate, Ecology otherwise manipulates the water quality standards equation and methodology such that it avoids increasing protections for the designated use of fishing and eating fish and shellfish for residents of the state, the basic requirement for setting standards under the Act. At the same time, Ecology expands the avenues for non-compliance with those inadequate standards for polluters—and for all water quality standards—by proposing to allow variances from water quality standards for an indefinite period of time, potentially decades. On top of dumbing down the standards with lengthy variances, Ecology will write compliance plans for polluters, again of indefinite length and ultimately proposes to allow polluters to give up at some point in the future. With these proposed rules, Ecology has written away many of the basic water quality protections of the Clean Water Act.

Ecology should not settle for this outcome. Ecology must again return to the drawing board and propose a fish consumption rate that is in-line with tribal survey data and that will ensure strong protections for the highest fish consuming populations in the state. The current proposal includes unacceptable and arbitrary games (PCBs, for example) with math that will not result in on the ground protections. Lastly, Ecology should abandon plans to expand existing loopholes and off-ramps, especially where Ecology has acknowledged that its new rules are unlikely to change anything in practice for polluters.

Respectfully submitted this 21st day of April, 2016.

Earthjustice

Janette K. Brimmer
Matthew R. Baca

On behalf of:

Puget Soundkeeper Alliance
Columbia Riverkeeper
Spokane Riverkeeper
North Sound Baykeeper
Pacific Coast Federation of Fishermen's Associations
Institute for Fisheries Resources

cc: U.S. Environmental Protection Agency, Region 10 and Office of Water
Northwest Indian Fisheries Commission
Columbia River Intertribal Fish Commission
Puyallup Tribe
Swinomish Tribe

INDEX OF ATTACHMENTS

NO.	TITLE
1.	Asian and Pacific Islander Seafood Consumption Study (EPA 910/R-99-003) (May 27, 1999)
2.	O'Neill, Catherine A., Fishable Waters, Volume I, Issue II – Spring 2013 American Indian Law Journal
3.	Columbia River Basin Fish Contaminant Survey (1996-1998) U.S. Environmental Protection Agency, Region 10
4.	January 17, 2012 letter to Ted Sturdevant, Director, Washington Department of Ecology, from Gary W. Passmore, Director, Office of Environmental Trust
5.	March 23, 2015, Cover Letter to Comments Letter to Washington State Department of Ecology (#56 below)
6.	O'Neill, Catherine A., Washington State's Weakened Water Quality Standards Will Keep Fish Off the Table, Undermine Tribal Health (March 4, 2014)
7.	A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin, Technical Report 94-3 (October 1994)
8.	First Declaration of Allan B. Chartrand (December 2, 2014)
9.	Second Declaration of Allan B. Chartrand (January 9, 2015)
10.	Declaration of Bart Mihailovich in Support of Plaintiffs' Motion for Summary Judgment (January 22, 2014)
11.	Declaration of Brett Vandenheuvel in Support of Plaintiffs' Motion for Summary Judgment (February 12, 2014)
12.	Declaration of Chris Wilke in Support of Plaintiffs' Motion for Summary Judgment (February 25, 2016)
13.	Declaration of Glen H. Spain in Support of Plaintiffs' Motion for Summary Judgment (February 29, 2016)
14.	Declaration of Jeremy Brown in Support of Plaintiffs' Motion for Summary Judgment (April 5, 2016)
15.	Declaration of John Green in Support of Plaintiffs' Motion for Summary Judgment (February 7, 2014)

NO.	TITLE
16.	Declaration of Katelyn Kinn in Support of Plaintiffs' Motion for Summary Judgment (February 19, 2016)
17.	Declaration of Matthew James Warning in Support of Plaintiffs' Motion for Summary Judgment (February 24, 2016)
18.	Declaration of Michael T. Harves in Support of Plaintiffs' Motion for Summary Judgment (February 26, 2016)
19.	Declaration of Roben White in Support of Plaintiffs' Motion for Summary Judgment (January 30, 2014)
20.	Declaration of Wendy Steffensen in Support of Plaintiffs' Motion for Summary Judgment (January 31, 2014)
21.	Declaration of Janette K. Brimmer in Support of Plaintiffs' Motion for Summary Judgment (March 1, 2016)
22.	Declaration of Jerry White, Jr., in Support of Plaintiffs' Motion for Summary Judgment (February 24, 2016)
23.	Declaration of Joel Kawahara in Support of Plaintiffs' Motion for Summary Judgment (February 29, 2016)
24.	Declaration of Lee First in Support of Plaintiffs' Motion for Summary Judgment (February 23, 2016)
25.	United States Environmental Protection Agency – Excerpt of Environmental Justice Analysis for the Lower Duwamish Waterway Cleanup (February 2013) [Draft]
26.	Elwha Presentation – Tribal Fish Consumption Rates
27.	Fish intake guidelines: incorporating n-3 fatty acid intake and contaminant exposure in the Korean and Japanese communities (Am J Clin Nutr June 2008 vol. 87 no. 6 1867-1875)
28.	Technical Support Document for EPA's Disapproval Action on Idaho's Revised Human Health Criteria
29.	Centers for Disease Control and Prevention – Morbidity and Mortality Weekly Report, Health Disparities Experienced by American Indians and Alaska Natives (August 1, 2003)
30.	December 16, 2010 letter to Becca Conklin from Jannine Jennings

NO.	TITLE
31.	Human Health Ambient Water Quality Criteria and Fish Consumption Rates: Frequently Asked Questions (January 18, 2013)
32.	January 20, 2015 letter to the Honorable Senator Doug Ericksen from Dennis J. McLerran
33.	May 10, 2012 letter to Barry Burnell from Michael A. Bussell
34.	April 3, 2014 letter to the Honorable Governor Jay Inslee from Tim Ballew II, Chairman Lummi Nation
35.	January 17, 2012 letter to Kelly Susewind and Jim Pendowski from Jannine Jennings
36.	April 8, 2014 letter to Maia Bellon from Dennis J. McLerran
37.	June 21, 2013 letter to Maia Bellon from Dennis J. McLerran
38.	December 18, 2014 letter to Maia Bellon from Dennis J. McLerran
39.	June 1, 2010 letter to Neil Mullane from Michael A. Bussell
40.	November 10, 2010 memo to Susan Braley from Jannine Jennings
41.	September 6, 2012 letter to Ted Sturdevant from Dennis J. McLerran
42.	Lummi Nation Seafood Consumption Study (August 31, 2012)
43.	Analysis Support EPA's February 2, 2015 Decision to Approve, Disapprove, and Make No Decision on, Various Maine Water Quality Standards, Including Those Applied to Waters of Indian Lands in Maine
44.	Fish Consumption and Environmental Justice – A Report developed from the National Environmental Justice Advisory Council Meeting on December 3-6, 2001 (November 2002 revised)
45.	The Effects of Altered Diet on the Health of the Karuk People: A Preliminary Report by Kari Marie Norgaard, Ph.D. (August 2004)
46.	April 9, 2004 letter to Governor Jay Inslee from Herman Dillon, Sr., Puyallup Tribe of Indians
47.	April 2, 2014 letter to Governor Jay Inslee from Shawn Yanity, Stillaguamish Tribe of Indians

NO.	TITLE
48.	Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region (August 2000)
49.	Issues in Evaluating Fish Consumption Rates for Native American Tribes – Risk Analysis, Vol. 28, No. 6, 2008
50.	The epidemic of obesity in American Indian communities and the need for childhood obesity-prevention programs[1–3]
51.	Traditional Foods in Native America – A compendium of stories from the Indigenous food sovereignty movement in American Indian and Alaska Native communities (2013)
52.	March 28, 2014 letter to Governor Jay Inslee from Melvin Sheldon
53.	A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region (October 1996)
54.	December 16, 2013 email communication to Cheryl Niemi from Nancy Judd
55.	Whyte, K.P. Forthcoming. Food Justice and Collective Food Relations. *The Ethics of Food: An Introductory Textbook* (2009)
56.	Comments of Waterkeepers Washington and Pacific Coast Federation of Fishermen's Associations/Institute for Fisheries Resources (collectively "Waterkeepers Washington") to Washington State Dept. of Ecology (March 23, 2015)
57.	March 25, 2014 letter to Governor Jay Inslee from Phil Rigdon, Yakama Nation
58.	December 28, 2015 letter to Erica Fleisig (EPA) from Janette K. Brimmer and Matthew R. Baca
59.	March 23, 2015 letter from EPA to Cheryl Niemi from Daniel D. Opalski
60.	Sascha C. T. Nicklisch et al., Global marine pollutants inhibit P-glycoprotein: Environmental levels, inhibitory effects, and cocrystal structure (2016)
61.	March 23, 2015 letter to Maia Bellon from Lorraine Loomis, Northwest Indian Fisheries Commission
62.	Clean Water: Your Right to Know – Part 1 (2016)
63.	Clean Water: Your Right to Know – Part 2 (2016)

Commenter ID: 9

Commenter Name: Kerry R. Brooks

Commenter Association: Citizen

Comment received via online comment form

Comment:

Please reduce time allowed for polluters to meet the standards

Include mercury, arsenic and lead standards. Any amount of these is not acceptable.

Severely limit variances -- make polluters do the right thing.

Thank you.

Commenter ID: 10

Commenter Name: Brian Durheim

Commenter Association: Spokane Canoe and Kayak Club

Comment received via online comment form

Comment:

As a group who recreates on Washington's water ways, and has been and continues to be involved with the health of the those eco systems. It is our strong belief that the proposed rule does NOT do enough to protect those water systems. Some concerns are:

PCB's, arsenic and mercury are not address enough or at all in the standards proposed.

Fish consumption rates are not realistic especially to those of us who depend on fish we have caught on a regular weekly basis.

Polluters should have stricter schedules of compliance and not give more variances.

This only allows for or makes legal polluting easier than it does not under the current EPA standards.

Thank you for your consideration.

American Exploration & Mining Association

10 N Post St. Ste. 305 | Spokane WA 99201-0705
P. 509.624.1158 | F. 509.623.1241
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April 20, 2016

Becca Conklin
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98503-7600

Submitted Via Email: *swqs@ecy.wa.gov*

Subject: **Comments on Human Health Water Quality Criteria and Implementation Tools**

Dear Becca:

Thank you for the opportunity to provide comments on rulemaking in Washington Administrative Code (WAC) 173-201A related to Human Health Water Quality Criteria (HH WQC) and Implementation Tools, which was issued on February 1, 2016. We appreciate the time and effort that Washington State Department of Ecology (Ecology) staff have invested in engaging stakeholders and the public on these complex issues, and in the development of this second proposal. We strongly support development of HH WQC by Washington State rather than the US Environmental Protection Agency (EPA). We also support the need for implementation tools.

As part of its outreach on these issues, Ecology has hosted an extensive series of educational and discussion programs (Ecology Policy Forums) and worked diligently to engage community members (both stakeholders and affected parties). The key principles for community involvement in risk management identified by the National Research Council (PCCRARM 2001), with the consideration of the Presidential/Congressional Commission on Risk Assessment and Risk Management (CRARM 1997), are "(1) involve the community from the beginning; (2) provide the community with the resources they need to participate effectively in the decision-making process; and (3) build an effective working relationship with the community." These processes take time and commitment, particularly for important and complex issues such as the development of HH WQC for Washington State.

EPA states that Washington State may try to provide final criteria prior to EPA's finalization of its HH WQC for Washington State (EPA 2015). However, this is an unrealistic goal given the state requirements for public review, which is a critical part of the process. EPA's Federal Register notice also stated that if EPA finalizes its rule and Washington State subsequently submits HH WQC that are approved by EPA, the previously approved, EPA-developed HH WQC for Washington State would no longer apply (in favor of the Washington State-developed HH WQC). This eventuality would be extremely inefficient for all parties involved, and would create a tremendous amount of regulatory uncertainty. The uncertainty would likely lead to inaction for both compliance and enforcement activities—and therefore no improvement in water quality during that period—as well as significant economic impacts. Washington State should work aggressively to avoid this possibility.

Ecology's 2016 proposed HH WQC are, overall, significantly more protective than current Washington State HH WQC. This letter focuses on areas of support and some areas of concern for the HH WQC, Implementation Tools, and associated documents identified below:

- *Preliminary Cost-Benefit and Least-Burdensome Alternative Analysis: Chapter 173-201A WAC, Water Quality Standards for Surface Waters of the State of Washington* (Ecology 2016b), hereafter referred to as the Cost-Benefit Analysis (CBA)
- *Draft Environmental Impact Statement- Revised: Washington State's Proposed Changes to Water Quality Standards for Surface Waters of the State of Washington – WAC 173-2-1A* (Ecology 2016a), hereafter referred to as the Environmental Impact Statement (EIS)
- *Washington State Water Quality Standards: Human Health Criteria and Implementation Tools: Overview of Key Decisions in Rule Amendment* (Ecology 2016c), hereafter referred to as the Key Decisions Overview

Our comments are provided below in descending order of priority.

1. A relative source contribution (RSC) of 1 is reasonable for a fish consumption rate of 175 g/day, but the rationale for the selection of this RSC should be more developed in the Key Decisions Overview.

   Ecology's Key Decisions Overview (Ecology 2016c) includes strong rationale for the selection of an RSC of 1. However, the document did not discuss the history of the use of the RSC or the conservative nature of reserving exposure for other pathways. This rationale would provide important context and should be included in the RSC section of the Key Decisions Overview.

   The RSC approach was originally developed to calculate maximum contaminant level (MCL) goals for safe drinking water. MCLs, unlike HH WQC, are not directly enforceable regulations. EPA's 1989 draft National Primary and Secondary Drinking Water Regulations (EPA 1989) are often cited as the source for the 80/20 RSC approach. This EPA document provides no data to support this approach for drinking water (or any other exposure routes), but instead states that the 80/20 RSC approach was used because data were inadequate. EPA received many divergent comments on the use of a 20% floor and 80% ceiling for the RSC as applied to drinking water. EPA's discussion of comments received (EPA 1991) focuses on whether the RSC properly accounted for volatilization and dermal exposure, indicating that the critical review of the RSC (in general) and the 80/20 RSC approach (more specifically) did not focus on issues relevant to HH WQC.

   Consumption of surface water in the proposed freshwater HH WQC is assumed to be 2.4 L/day (Ecology 2016c); the 90^{th} percentile of drinking water consumption is 2.35 L/day (EPA 2011). Presumably, if a person is drinking surface water (as is assumed in the freshwater HH WQC), he or she is not also being exposed to other drinking water (as covered by the MCLs for drinking water), so "reserving" exposure for the drinking water pathway (with an 80/20 RSC approach) is unnecessary.

   In addition, because HH WQC are for organism-only (marine) or organism-plus-water (freshwater) pathways, they address a major exposure pathway not covered by drinking water regulations: fish and shellfish consumption. For many of the bioaccumulative chemicals of greatest concern (e.g., mercury, polychlorinated biphenyls [PCBs]), fish and shellfish consumption overwhelmingly dominates exposure for populations that consume high quantities of fish (e.g., 175 g/day, or about five 227-g meals of fish and/or shellfish every week for 70 years). Marine and anadromous fish and shellfish make up more than half of the total consumption reported in the studies that Ecology considered (Ecology 2013a) in selecting a fish consumption rate (FCR) for HH WQC. Hence, the marine/anadromous portion alone is at least 10-fold higher than the assumed consumption rate (i.e. 6.5 g/day of freshwater and estuarine fish and shellfish) used for EPA's national HH ambient water quality criteria (AWQC) when the 80/20 RSC approach was initially proposed by EPA for inclusion in HH WQC.

2. The selected PCB criteria are reasonable for this ubiquitous legacy chemical, but additional rationale should be presented in the Key Decisions Overview.

   The section entitled Challenging Chemicals: PCBs in the Key Decisions Overview (Ecology 2016c) should discuss the preponderance of PCB-listed waterways, the Governor's directive (Office of the Governor 2014) as it pertains to unregulated sources of chemicals, and PCB source identification work on the Spokane River.

   The Key Decisions Overview (Ecology 2016c) discusses environmental fate in general, with additional information on sources compared in the 2015 Key Decision Overview (Ecology 2015), but does not discuss specific water and fish concentration data from Washington State. Many, if not most, Washington State water bodies could qualify as impaired based on the current PCB criteria and listing policy. Information showing that 70% of all freshwater fish samples state-wide exceed the "fish tissue equivalent concentration-listing trigger "were presented in the Ecology Policy Forums (Ecology 2013b). Ecology completed its state water quality assessment and 303(d) list (which would provide the most recent PCB 303(d) listings) and submitted it to EPA on September 28, 2015. Ecology should update its discussion on PCBs in Washington State surface waters in the Key Decisions Overview (Ecology 2016c) with information from that submittal package.

   Per Governor Inslee's directive (Office of the Governor 2014), "While we are increasing levels of protection on discharges from permitted facilities, the fact remains that facilities are often not the sources of the chemicals we are most concerned about. Focusing only on these facilities will have limited benefit in reducing toxics regulated under this rule and will not address the larger universe of unregulated contaminants." For example, Ecology's source assessment of the Spokane River (Ecology 2011) indicates that only 20% of the PCB loading was due to municipal and industrial dischargers. Thus, further reduction of PCB HH WQC would do little to reduce concentrations of PCBs in Washington State fish.

3. The selected arsenic criteria represent a reasonable approach for this abundant, naturally occurring element; some additional support should be included in the EIS and inconsistent language corrected.

   As discussed in the Key Decisions Overview (Ecology 2016c), the selection of the MCL for arsenic in drinking water as the HH WQC for arsenic is reasonable for this naturally abundant element, and is consistent with criteria in many other states. The EIS (Ecology 2016a) states on page 25 that surface water samples would infrequently exceed Ecology's 2016 MCL based on proposed HH WQC for arsenic, and would frequently exceed Washington State's current National Toxics Rule (NTR)-based criteria. This section should also state that EPA's proposed 2015 HH WQC for arsenic for Washington State would almost always be exceeded, as should the "usability" table in the EIS (Ecology 2016a).

4. Language about the use of all known and available reasonable treatment (AKART) from b) Human health protection in WAC 173-201A-240 Toxic substances should be removed.

   The sentence "Dischargers have the obligation to reduce toxics in discharges through the use of AKART" should be removed. This removal would be consistent with language in a) Aquatic life protection. The use of AKART is discussed elsewhere in the rule as it pertains to meeting WQC.

5. A more robust rationale for the selected FCR is needed; this rationale should be added to the Key Decisions Overview, and the inaccurate description of the selected rate as an "average" value should be corrected.

   Ecology added more discussion of the datasets used to develop the FCR, and the populations and percentile(s) of the populations that the FCR is intended to represent, in the Key Decisions Overview (Ecology 2016c) than were included in the 2015 draft Key Decisions Overview (Ecology 2015c). However the description of 175 g/day as an average rate is inaccurate. This language should be corrected, and a more robust and defensible rationale based on the extensive efforts by Ecology to develop an FCR for Washington State should be provided.

Permittees will have to meet the requirement of the new HH WQC as soon as the criteria go into effect. Thus, any small change in the criteria could mean the difference between compliance and non-compliance, trigger the need for very expensive treatments options (if such options are available), and/or impact an entity's ability to open a new business. The selected FCR is stated to be representative of the "average" consumption of three high-consuming populations used in the Key Decisions Overview (Ecology 2016c) (see pages 4, 18, 19, 23, 54). However, the average consumption by these groups is 127 g/day; the 175 g/day FCR proposed is 38% higher than the stated average value. The differences in these numbers may have big implications for some permittees.

6. Ecology's use of bioconcentration factors (BCFs) over bioaccumulation factors (BAFs) is primarily based on the assumptions used to develop and apply BCFs, and is reasonable. Further consideration of EPA's recently developed BAFs is not needed.

   Based on the rationale for BCF selection provided by Ecology (Ecology 2016c) and the recent history of BAF development by EPA, BCFs should be used in Washington State HH WQC. Ecology provides a thorough discussion supporting the use of the BCFs over BAFs in the proposed rule (Ecology 2016c). Support for the use of BCFs includes the following facts: per EPA guidance, BCFs are acceptable for use in HH WQC development; they are more closely related to water quality than are BAFs; they require fewer assumptions based on data non-specific to Washington State than do BAFs; and they require fewer inputs than do BAFs. None of Ecology's reasons for using BCFs relate to the quality of the BAF calculations. However, the Key Decisions Overview states that Ecology will review EPA's supporting material on BAFs (Ecology 2016c), which was posted on EPA's website in early 2015.

   Draft BAFs were made available as part of EPA's 2014 draft HH AWQC. Since then, the national HH AWQC have been finalized with revised BAFs. EPA received numerous comments related to how the BAFs were calculated (EPA 2015a). Between the draft 2014 (EPA 2014) and final 2015 HH AWQC (EPA 2015b), the BAFs for all 94 chemicals were changed. BAFs for Trophic Level 4 (which is applied for all fish consumption in EPA's proposed HH WQC for Washington State) were increased by up to 92% or decreased by as much as 5,242%. The majority of Trophic Level 4 BAFs changed by at least 50% between 2014 and 2015. This instability indicates high uncertainty in these BAFs and how they are derived.

7. Provisions for the option of state-wide variances should be added to Section 2, Types of Variances, under WAC 173-201A-420 Variance.

   The approval and effective dates of the Implementation Tools are not linked. Thus, HH WQC could be approved even though all of the Implementation Tools may not yet be available. Alternatively, if the HH WQC are not approved, the proposed Implementation Tools may not be adequate. For example, if EPA promulgates HH WQC for Washington State, there may be an urgent need for state-wide variances for PCBs. State-wide variances should be added to Section 2, Types of Variances, under WAC 173-201A-420 Variance.

8. The CBA understates the costs and challenges of the proposed rule and the adoption of new, more sensitive analytical methods. The EIS should better represent the importance of analytical sensitivity relative to HH WQC as well.

   The CBA assumes that dischargers out of compliance under baseline conditions will face the same compliance costs (regardless of reduced HH WQC), understates the influence of improved analytical methods and increased listings, and states that no action will be needed in several cases without rationale.

The CBA assumes that the only dischargers with “yes” results from the reasonable potential analysis (RPA) that previously received “no” results will bear additional costs. This is a misrepresentation, as coming into compliance with HH WQC that are 20 times lower (for some chemicals) will cost more. Costs will become greater as analytical methods improve. This is supported by the discussion in Section 6.6, wherein “reduced costs of complying with less stringent criteria” are identified as a (cost saving) benefit.

Chapters 5 and 7 of the CBA (Ecology 2016b) understate the cost of the proposed HH WQC. In Chapter 5, Ecology notes all new 303(d) listings are expected on waterbodies with no dischargers. This is curious, as the 2015 CBA (Ecology 2016a) identifies 55 expected new listings for waterbody segments, 5 of which have dischargers. The 2016 CBA identifies 306 expected new listings for waterbody segments with no dischargers on any of them. Is there no overlap between these lists, or have the discharging entities all ceased to operate? The possibility of waterbody listings will discourage potential development on many Washington State waterways, a fact that should be recognized in Chapter 5.

The process of total maximum daily load (TMDL) development is slow, and there will likely be many more 303(d)-listed waterbodies than waterbodies with TMDLs for several decades. However, Ecology’s discussion of costs in Chapter 7 focuses on the cost of more sensitive analytical methods (driven in part by lower criteria) associated with TMDLs. More sensitive analytical methods will mean more listings (and more TMDLs with more stringent requirements). Again, Chapter 7 does not discuss the loss of development (i.e., new or expanding dischargers) on listed waterbodies or water bodies with TMDLs. New development may be forced to locate elsewhere, and dischargers needing to expand their facilities may choose to relocate. These costs should be discussed in Chapters 5 and 7, and in the summary and conclusions in Chapter 8.

In the CBA, several “no cost” scenarios are identified wherein the discharger is unlikely to need to take further action; for example, “it is unlikely further treatment is necessary” even though the facilities are out of compliance with HH WQC (see page 37)(Ecology 2016b). In addition, facilities for which a limited amount of data indicate a potential lack of compliance (with proposed HH WQC) are assumed to bear no additional costs. As discussed previously, reducing chemicals in discharge to comply with HH WQC that are 20 times lower (for some chemicals) will be more expensive than compliance under baseline.

The tables including HH WQC and analytical sensitivities in Appendix B of the EIS (Ecology 2016a) are helpful. They would be much more useful, however, if criteria below approved analytical method sensitivity were listed in bold type. This would help readers more easily understand how current and proposed HH WQC compare to analytical methods, and help frame many of the discussions in the CBA (Ecology 2016b).

9. Allowance for “as soon as possible” in compliance schedules and variances is an improvement on these Implementation Tools; however, the limited utility of variances should be recognized in the CBA.

   The potential extension of compliance schedules to be longer than 10 years (without a standardized time limit) is a positive amendment, as are variances specified to be concluded “as soon as possible,” rather than being limited to 10 years as in EPA’s 2013 Water Quality Standards Regulatory Clarifications (EPA 2013). The variance usability table in the EIS (Ecology 2016a) correctly classifies the usability of variances as low because of the uncertainty regarding EPA’s approval and the limited duration. The low likelihood of the use of variances should be discussed in Section 6.3.3 of the CBA (Ecology 2016b), as this is a “benefit” that is unlikely to be realized by most dischargers.

10. There are no Implementation Tools available to new or expanding dischargers; this should be clarified in the Key Decisions Overview and identified in the CBA.

    As has been clear for some time, compliance schedules and variances will not be available to new or expanding dischargers. Because this is not a change from the baseline, it is not discussed in the CBA other than to state that new dischargers are expected to behave similarly to existing dischargers (Ecology 2016b). The CBA should recognize that a discharger facing criteria that may be 20 times lower and with no access to compliance schedules and variances may face additional costs and obstacles to operation, and therefore behave differently than an existing discharger (e.g. they may choose not to expand or not to operate in Washington State). This is mentioned briefly at the end of the section on Compliances in the Key Decisions Overview, but not at all in the section on Variances (Ecology 2016c). This is an important issue that needs to be clearly identified for all readers, even if no solution is currently endorsed by Ecology. Thus, a new section that calls out the issue of new and expanding dischargers being unable to use variances or compliance schedules should be added to the Key Decisions Overview.

Thank you for your consideration of these comments.

American Exploration & Mining Association is a Spokane, WA based 121-year old, 2,100 member national association representing the minerals industry with members residing in 42 U.S. states (including Washington, six Canadian provinces or territories, and 10 other countries). AEMA is the recognized national voice for exploration, the junior mining sector, and maintaining access to public lands, and represents the entire mining life cycle, from exploration to reclamation and closure. Our broad-based membership includes many small miners and exploration geologists as well as junior and large mining companies, engineering, equipment manufacturing, technical services, and sales of equipment and supplies. More than 80% of our members are small businesses or work for small businesses. Most of our members are individual citizens.

Respectfully submitted,

Matthew Ellsworth
Government Affairs

A. References

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Becca Conklin
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600

Via e-mail: swqs@ecy.wa.gov

April 22, 2016

RE: WAC 173 201A draft language public comment

Dear Ms. Conklin,

Thank you for the opportunity to comment on the updated proposed language for WAC 173 201A regarding surface water quality criteria.

RE Sources for Sustainable Communities is a local organization in northwest Washington, founded in 1982. RE Sources works to build sustainable communities and protect the health of northwest Washington's people and ecosystems through the application of science, education, advocacy, and action. Our North Sound Baykeeper program is dedicated to protecting and enhancing the marine and nearshore habitats of northern Puget Sound and the Georgia Strait. Our chief focus is on preventing pollution from entering the North Sound and Strait, while helping our local citizenry better understand the complex connections between prosperity, society, environmental health, and individual wellbeing. Our North Sound Baykeeper is the 43rd member of the Waterkeeper Alliance, with 280 organizations in 34 countries around the world that promote fishable, swimmable, drinkable water. We have over 20,000 members in Whatcom, Skagit, and San Juan counties and submit these comments on their behalf.

Scope of Water Quality Standards Rule Changes:
RE Sources recognizes that the scope of comments is limited under this rulemaking to two specific areas of the WQS: (1) development and adoption of human health criteria, and (2) revision and expansion of some of the tools in the standards that help in criteria implementation. To reduce pollution and protect human health, the state water quality standards are a critical tool. The currently proposed update to Washington's water quality standards falls short of protecting Washington communities.

Proposed Updates to Human Health Criteria

Fish Consumption Rates:
While the rule changes that the Washington Department of Ecology (Ecology) has proposed take several steps in the right direction, such as switching the daily assumed fish consumption rate from 6.5 grams per day to 175

grams per day, it does not go far enough. The very agency proposing the rulemaking, Ecology, revealed in a 2012 study that some tribal members eat up to 797 grams of fish per day.[1] Additionally, many tribal members within the Washington state area have been shown in local surveys to eat no less than 250 grams per day of fish. The Clean Water Act demands that state and tribal waters should support safe consumption of fish and shellfish, and that the standards need to be set to enable residents to safely consume from local waters the amount of fish they would normally consume. Thus, under the Clean Water Act, equal protection is deserved for all people, including Tribal members, Asian-Pacific islanders, commercial and recreational fishermen, all of whom eat the most fish in our state. The currently proposed 175 grams of fish per day is still unprotective of populations that deserve to be protected.

Additionally, fish consumption advisory signs are not sufficient to protect our residents. Warning signs in our state have shown to be ineffective. Therefore, it is important that fish consumption rate standards are set to protect those who are most sensitive.

The 175 grams per day fish consumption rate is a step in the right direction, but should be increased to be fully protective of our state's population. Ideally, this rate should be set to 797 grams per day to be protective of our most sensitive populations. At the very least, it should be set to 250 grams per day as this would be satisfactorily protective of our state population. This will be more protective of not only humans, but also marine life in the Salish Sea.

Cancer Risk Rates:
In the State of Washington, the daily fish-consumption rate and the acceptable risk of cancer are key components that are a part of equations that determine how policy makers regulate discharges by industry and municipalities into our waterways. Setting a chemical contamination pollution level based on an anticipated human cancer rate is a risk management and policy decision. Fish consumption and acceptable cancer rates thus become a significant component of the mechanism that is used to regulate Salish Sea water quality.

In addition to economic justice issues for human individuals and cultural groups that consume higher than average amounts of Salish Sea fish, nonprotective criteria could pose health issues for marine life that is higher on the food chain. In the process of consumption of one marine species by another, chemical contaminants become bioconcentrated. Please keep the more protective 1 in 1 million human cancer risk rate as it is more protective of the marine environment than the previous one in a one hundred thousand risk level.

The cancer risk rate of 1 in 1 million should be kept to be protective of our state's human health.

Water Quality Criteria:

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[1] Toxics Cleanup Program, Washington Department of Ecology. (2013). *Fish Consumption Rates Technical Support Document - Version 2.0* (Publication No. 12-09-058). Accessed from: https://fortress.wa.gov/ecy/publications/publications/1209058.pdf

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PCBs and mercury are already dangerously high in our waterways, so working towards better standards is important. The newly proposed legislation does not have strong enough standards concerning PCBs, mercury, and arsenic. In fact, the standards recommended by Ecology are weaker than what the EPA currently recommends. Among the many health effects, PCBs and mercury are known to cause cancer, neurological damage, and other serious health impacts. Additionally, PCBs and mercury are the cause of over 90 percent of the fish consumption advisories in Washington. These contaminants need to be taken seriously and strong standards are necessary.

All of these toxics bioaccumulate in the food chain in such a way that makes fish problematic for the public to consume. In some cases, fish in the Spokane River are edible under the specific amounts and frequencies recommended in Department of Health fish advisories. But depending on the age, species and river reach, many other types of fish are too toxic to eat. The standards for PCBs are still exceeded in some fish and statewide mercury advisory remains in place making their consumption extremely problematic for pregnant women, children and folks who for cultural and economic reasons consume far more than the recommended allowance. Currently, the EPA has put forward PCB standards that are more protective and more up to date. The more protective EPA guidelines should be followed to ensure public health and safety.

Additionally, the EPA standards for both arsenic and mercury should be adopted. While we recognize the difficulty in cleaning up these toxics, inaction is not a solution. Using the older National Toxics Rule criteria is not adequate and leaves the public vulnerable to higher levels of these pollutants over time.

Our Washington Water Quality Standards need to move us forward towards greater protections, not to maintain a level comfortably close to the status quo. Our state standards need to be as protective, if not more protective, than the current EPA standards.

Criteria Implementation Tools

Compliance Schedules:
Loopholes in the implementation process of the proposed legislation could lead to delays in water quality improvements. Instead of relying on dischargers to simply meet the new water quality standards “as soon as possible”, additional framework should be included to create a strict timeframe in which standards are met. Language instead should read “as soon as possible <u>or within ten years</u>” or otherwise provide encouragement for compliance sooner than ten years, but set a deadline to ensure our public is not unnecessarily exposed to contaminants longer than they have to be. Protection of our waterways are simply too important to be delayed any further.

Variances:
The increased availability and potential use of variances in the proposed rule is unacceptable. Ecology policy should be pushing dischargers to lower their output of dangerous chemicals at the end of pipe, precisely because of the nature and amount of pollution in a water body can be excessive and challenging instead of

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allowing for variances simply for difficult circumstances. Ecology should not be providing off-ramps from meeting existing standards or providing the designated, attainable uses.

Intake Credits:
In regards to the implementation of intake credits we acknowledge that dischargers should not fully be held responsible for removing the pollutants already present in the water as it enters their site. However, we feel that it would be beneficial to establish an incentive program for dischargers to work to clean up Washington's waterways. A proactive incentive program would be of benefit to all and provide motivation to dischargers to engage in more than just the bare minimum.

Conclusion:
In conclusion, we believe that our State of Washington Water Quality Standards need to move us forward towards greater protections, not maintain a level comfortably close to the status quo. Water quality standards should protect us and other animals in Puget Sound, including apex predators. Given the strong economic and social ties the state of Washington has to its local waterbodies, it is imperative that water quality standards effectively protect safe and clean water for all.

Therefore, we ask that the state of Washington, do the following:

- ***Increase the proposed 175 grams per day fish consumption rate to at least 250 grams per day. Ideally it should be set to 797 grams per day in order to protect our sensitive populations, as is part of the water quality standard to be more protective of our state's population.***
- ***Retain the 1 in 1 million cancer risk rate.***
- ***Set water quality standards for PCBs, mercury, and arsenic to the stronger current EPA recommended criteria.***
- ***Set concrete timeframes for compliance schedules while encouraging faster compliances.***
- ***Push for dischargers to lower their outputs of dangerous chemicals rather than allowing for more variances.***
- ***Do not allow the implementation of intake credits and instead provided incentives for net decreases in pollutants.***

These comments are made with the idea that we should be working towards the ultimate elimination of discharge to the nation's waters. Ecology's proposed rulemaking should help us get there. Please do not provide provisions that stall our progress, or avoid the tough work of getting our public waters fishable and swimmable. Thanks for the opportunity to comment.

Sincerely,
Lee First, North Sound Baykeeper
Eleanor Hines, Lead Scientist
RE Sources Clean Water Program

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THE SUQUAMISH TRIBE

PO Box 498 Suquamish, WA 98392-0498

April 20, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Becca Conklin
Washington State Department of Ecology
Water Quality Program
swqs@ecy.wa.gov

RE: Comments on the State's 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon,

The Suquamish Tribe ("Tribe") has reserved treaty rights and resources under the 1855 Treaty of Point Elliott that protect the right to safely access and harvest treaty and natural resources throughout the Tribe's federally adjudicated Usual and Accustomed fishing area. Because tribal health and well-being are inextricably linked to the land, air, water and all forms of life within the natural system, the Tribe has an enduring commitment to future generations to preserve, restore, and protect treaty rights and resources that have been degraded or put at risk due to environmental contamination. The Tribe devotes significant effort to co-manage Washington's finfish and shellfish harvests for conservation and human health concerns, and to support the development of environmental rules and standards that are protective of tribal people and resources.

Washington's environmental laws are meant to protect human health and the environment for all citizens, tribal and non-tribal. These laws, however, are not purely state issues and have a direct nexus to tribal and federal interests. Washington State is required to meet the provisions of the Federal Clean Water Act and to adopt water quality standards that preserve the beneficial uses of surface waters, including aquatic life habitat and fishing. The public health issues that are determined by these standards affect everyone in Washington who eats fish. However, because tribal health and well-being rely on traditional lifeways that include the harvest and consumption of large quantities of local fish and shellfish across a lifetime, the failure to adopt protective criteria disproportionately and involuntarily harms tribal communities.

We have been working with the state of Washington and the US Environmental Protection Agency for many years to develop and adopt revised water quality standards that will protect the health of tribal people and respect our treaty-reserved rights. This process has spanned two governors and three directors of the Washington Department of Ecology. Throughout this long process, the Suquamish Tribe and other treaty tribes have consistently supported the adoption of protective standards, as well as a reasonable pathway for compliance for businesses and municipalities.

The Department of Ecology has now proposed a second draft rule for human health criteria (hhc) and implementation tools. While this new proposal incorporates a more reasonable fish consumption rate (fcr) of 175 g/day and maintains the current cancer risk rate of 1×10^{-6}, other parameters that do not incorporate best available science and fail to account for other sources of toxic chemicals have been carried forward. Additionally, the criterion for mercury is not updated and the criteria for several other highly toxic chemicals including PCBs, arsenic, and dioxin remain at status quo or become even less protective. The state's proposed implementation tools should also be adjusted so that they are directed towards accountability and attainment of water quality standards, and not a set of tools to help dischargers avoid compliance.

As a co-manager of natural resources with the State of Washington, the Suquamish Tribe urges the State to revise the proposed human health water quality criteria and implementation tools to meet the intent of the CWA for all designated uses, to respect and uphold treaty-reserved rights and resources, and to protect the health of tribal members and all Washington citizens who eat fish.

The Tribe supports the comments submitted by the Northwest Indian Fish Commission (NWIFC) related to the proposed criteria and compliance tools. NWIFC's comments are incorporated herein by this reference. Key concerns have also been summarized on the following pages.

The Tribe will continue to engage with Ecology on a government-to-government basis to provide additional input as this rule is finalized. It is the Tribe's expectation that Ecology will give meaningful consideration to these concerns, as well as to comments submitted by NWIFC and other tribes.

Respectfully,

Leonard Forsman
Chairman, Suquamish Tribe

Human Health Parameters

The Suquamish Tribe agrees that human health criteria should reflect data demonstrating that a significant number of Washington residents consume fish and shellfish at higher rates than those currently used for regulatory purposes. The State's current fcr of 6.5 g/day is grossly under representative for most Washington residents. The proposed criteria are based on a fish consumption rate (fcr) of 175 g/day.

Given that tribal U&A areas encompass the majority of waters within the State, tribes are included in the general target population that must be protected under the CWA. As recognized by both EPA and Ecology, the comprehensive tribal surveys that have been regionally available since 1994 are technically defensible studies representing actual tribal consumption patterns. Contemporary and historical rates of fish consumption in excess of 500 g/day have been documented and described at length in many of the surveys, including the Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, published in August 2000.

The Suquamish survey was conducted with the expectation that the reported rates would be used to support environmental programs and rules that would protective of tribal health and would benefit the natural resources upon with tribal members continue to depend. The reported mean fcr for Suquamish tribal members is 214 g/day; the 95th percentile fcr is 797g/day. As with many of the tribal surveys, the Suquamish survey also documents that the reported consumption rates are suppressed. According to the survey, about 50% of respondents said that they already eat less seafood now due to various sources of pollution and related restrictions concerning harvesting. As efforts to improve water quality and habitat continue, the Tribe expects that consumption rates will increase.

The State's proposed fcr of 175 g/day is less than most tribal subsistence rates, and is less than the mean fcr for Suquamish tribal members. The Suquamish Tribe and many of the other treaty tribes, agreed, however, that an fcr of 175 g/day (inclusive of anadromous fish) would be a step in the right direction, significantly reducing the potential for toxic chemicals to be discharged to state water bodies and allowing the State's rulemaking to proceed expeditiously. The tribes were clear that this was a compromise position that would benefit public health state-wide. The tribes were also clear that this compromise was based on the assumption that the State would not alter other exposure parameters to be less protective.

While the current proposal incorporates a more reasonable fcr, and maintains the current cancer risk rate of 1×10^{-6}, the State has unfortunately chosen to carry forward several other parameter values that do not reflect EPA's revised national 304(a) criteria to account for bioaccumulation and cumulative exposure across multiple pathways. These choices effectively diminish the protectiveness of the proposed hhc.

The Tribe requests that Ecology follow the most recent EPA guidance in updating all parameters related to hhc.

Human Health Criterion for Arsenic

Under the State's proposed rule, the hhc for arsenic would become significantly less protective than the current standard. The Tribe does not believe that the use of the arsenic drinking water standard is appropriate as it does not meet the intent of the CWA to protect designated uses for surface water.

The Tribe requests that Ecology adopt EPA's proposed criterion for arsenic.

Human Health Criterion for Mercury

The Tribe does not support Ecology's proposal to delay updating the hhc for mercury, a contaminant that is continually identified as a leading concern in fish health advisories.

The Tribe requests that the State utilize EPA guidance and update the hhc for mercury as required by the CWA.

Human Health Criteria for PCBs and Dioxins

The Tribe does not agree with Ecology's approach for developing hhc for PCBs and dioxins, based only on non-carcinogenic health effects. Both PCBs and dioxins are also carcinogenic and bioaccumulative. Ecology's failure to develop criteria that fully account for all human health impacts of these highly toxic contaminants is a failure to protect the health of tribal members as well as a failure to protect treaty resources.

The Tribe requests that Ecology revise the hhc for PCBs and dioxins to incorporate health protective variables and apply best available science.

Implementation Tools, General Comments

Through participation in Governor Inslee's advisory group and recommendations submitted by the NWIFC, the Suquamish Tribe has provided input regarding the development of compliance and implementation tools. The Tribe has repeatedly expressed support for reasonable and responsible tools as the key to providing businesses and municipalities the flexibility needed to meet the economic and technical challenges of achieving water quality criteria. The Tribe, however, has also been clear that compliance or implementation tools do not take precedence, and cannot be used in lieu of, protective human health criteria.

<u>Implementation Tools, General Comments</u>

The Tribe's previously submitted comments regarding compliance schedules, variances, and intake credits are generally reiterated below. Compliance tools, specifically compliance schedules and variances, which provide dischargers with enhanced flexibility in meeting federal regulations need to incorporate the following elements:

- Application is limited to an individual discharge or permit as opposed to entire waterbodies or classes of dischargers.

- Documentation that the action(s) will not degrade or change an existing designated use; will not contribute to a lowering of water quality; will protect downstream tribal resources; and will not pose an increased risk to human health or the environment.

- A specified time frame for achieving water quality standards or compliance as soon as possible. Extensions beyond the 5 year NPDES permit cycle must be justified, explicitly time limited, subject to full and appropriate review, and should not be used to avoid meeting criteria.

- An enforceable sequence of actions or operations that lead to compliance with water quality criteria or effluent limitations.

- Clear and enforceable benchmarks and metrics for monitoring progress, including interim numeric limits where possible.

- Consultation with and review by tribes whose U&A may be impacted by the action.

Regarding intake credits, the State has expanded the definition and use of intake credits in a manner that is overly broad and has the potential to be misused. Intake credits should apply only to intake water that comes from the same surface body of water in the immediate vicinity of the discharge. Intake credits should be limited to facilities that do not add the intake pollutant of concern and do not alter the intake pollutant chemically or physically. Intake credits should not be used when intake water is taken from groundwater and discharged to surface water, when intake water is mixed with waters other than those from the same body of water, or when intake water supplied by a municipality is treated to remove an intake water pollutant prior to distribution.

The Tribe believes that it is possible to improve water quality by establishing protective human health criteria and to assist dischargers in maintaining economic health by establishing responsible compliance tools. We support revising the compliance tool language to clearly define their use and application, to define time frames, and to ensure measurable progress in achieving the highest level of water quality as soon as possible.

CSO Treatment Facility Provision

The State has proposed allowing CSO treatment facilities to primarily use narrative effluent limits as opposed to having to meet numeric hhc. The Tribe does not believe that this approach complies with either state or federal CSO policies and regulations. Although CSO dischargers such as King County have made significant improvements in treating CSO discharges and in reducing the frequency and magnitude of CSO events, there is ample evidence that even intermittent discharges of contaminants may result in environmental degradation. The Tribe believes that, like any other discharger, CSO treatment facilities must ultimately comply with water quality standards, including numeric hhc, that protect designated uses.

The Tribe requests that this section of the proposed rule be revised to include measures for monitoring and demonstrating compliance with all applicable criteria.

Commenter ID: 14

Commenter Name: Merry Fougere

Commenter Association: Spokane Riverkeepers

Comment received via online comment form

Comment:

Please tighten rules for no exceptions to pollute, tighter limits on mercury and arsenic, and monitoring compliance to current restrictions. Please save our rivers. And our people.

Commenter ID: 15

Commenter Name: Brandy Frick

Commenter Association: Eastern Washington University

Comment received via online comment form

Comment:

Please tighten rules for no exceptions to pollute, tighter limits on mercury and arsenic, and monitoring compliance to current restrictions. Please save our rivers. And our people.

MIC Executive Committee

Marc Doan
GM Nameplate
Co-chair

Mike Harford
JA Jack & Sons
Co-chair

Warren Aakervik
Ballard Oil
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Scott Anderson
CSR Marine

Johnny Bianchi
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Johan Hellman
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Kathleen Goodman
AMEC Geomatrix

David Huchthausen
Somerset Properties

Mike Kelly
ASKO Processing

Matt Lyons
NUCOR Steel

John Odland
MacMillan-Piper

Lindsay Pulsifer
Port of Seattle

Jordan Royer
Pacific Merchant
Shipping Association

Larry Ward
Pacific
Fishermen Shipyard

April 22, 2016

Becca Conklin
Department of Ecology
Water Quality Program
P.O. Box 47600
Olympia, WA 98503-7600

RE: Proposed Amendments to Surface Water Standards
Chapter 173-201A WAC

Dear Ms. Conklin:

The Manufacturing Industrial Council is comprised of companies located primarily in the City of Seattle, with a large concentration of members operating in or near the site of the Duwamish River Superfund. Our input on the Department of Ecology proposal for changes to water quality rules is based on our collective experiences with the Superfund and other activities involving stormwater and water quality issues. We are concerned that the proposed rule will impose unattainable goals for water quality permits and in-water cleanup projects that will result in a significant loss of family wage jobs in an area that routinely ranks among the top five export production centers in the nation.

The Duwamish Superfund model demonstrates the practical progress that can be achieved through a local collaboration adapted to local conditions. Real cleanup is occurring through these efforts, producing environmental and health benefits for all who work, live or fish in the Duwamish watershed.

We urge Ecology and the Environmental Protection Agency to take the time necessary to develop a similar, more collaborative approach to water quality rules and fish consumption. In our view, the present DOE and EPA proposals will result in a top-down, one-size fits-all effort that is highly likely to result in the type of prolonged disputes that hamstring the Portland Harbor superfund in Oregon. In contrast, the Duwamish model is literally producing cleaner fish sooner.

Washington state is home to a wide variety of marine environments. We urge you to pursue water quality rules that can be adapted to local conditions.

Sincerely,

Dave Gering

Dave Gering, Executive Director
Manufacturing Industrial Council

City of Seattle
Seattle Public Utilities

April 22, 2016

Becca Conklin
Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600

Re: Seattle Public Utilities (SPU) Comments for Water Quality Standards for Protecting Human Health (Fish consumption rates)

Thank you for the opportunity to provide comments on the proposed revisions to Washington's Surface Water Quality Standards: Human Health Criteria and Implementation Tools (WAC 173-201A). SPU supports Ecology's efforts to develop protective water quality standards and provide regulatory tools to implement the standards.

Schedules of compliance also apply to general permits. Ecology's proposed rule states that schedules of compliance shall meet requirements in WAC 173-220-140, a rule which only applies to individual NPDES permits. For general permits, the proposed compliance schedule rule must refer to WAC 173-226-180. At WAC 173-201A-510(4)(d), after "WAC 173-220-140" please add ", or in WAC 173-226-180 for general permits," or language to the same effect. Reference: Pollution Control Hearing Board municipal stormwater Phase I and Phase II general permit ruling at http://www.eluho.wa.gov/Global/RenderPDF?source=casedocument&id=327 (Findings of Fact, Conclusions of Law and Order – Condition S4, at CL 12, August 07, 2008, in PSA, et al. v. Ecology, PCHB Nos. 07-021, 07-026, 07-027, 07-028, 07-029, 0-030, 07-037 (Phase I), and PCHB Nos. 07-022, 07-023 (Phase II)). See also WAC 173-226-040.

> WAC 173-201A-510 Means of implementation.
> (4) General allowance for compliance schedules.
> ((~~(c)~~)) (d) Prior to establishing a schedule of compliance, the department shall require the discharger to evaluate the possibility of achieving water quality ((~~criteria~~)) standards via nonconstruction changes (e.g., facility operation, pollution prevention). Schedules of compliance ((~~may in no case exceed ten years, and~~)) shall meet requirements in WAC 173-220-140, **or in WAC 173-226-180 for general permits,** and shall require compliance with the specified requirements as soon as practicable. Compliance schedules shall generally not exceed the term of any permit unless the department determines that a longer time period is needed to come into compliance with the applicable water quality standards.

Ray Hoffman, Director
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Please feel free to contact Kate Rhoads, of my staff, if you have any questions regarding this letter. Kate can be reached at (206) 684-8298 or at kate.rhoads@seattle.gov.

Sincerely,

Madeline Fong Goddard, PE
Deputy Director
Drainage & Wastewater Line of Business
Seattle Public Utilities

cc: Ben Marre, SPU
Kevin Buckley, SPU
Kate Rhoads, SPU
Susan Saffery, SPU
Judi Gladstone, SPU
Dave Schuchardt, SPU
Pete Rude, SPU
Theresa Wagner, Seattle City Attorney's Office

Commenter ID: 19

Commenter Name: Marilyn Hair

Commenter Association: University of Washington

Comment received via online comment form

Comment:

Very glad to see the FCR increased to 175 gr/day and the cancer risk maintained at 1 in 1 million. I support Washington approving the FCR for our state and not leaving it to EPA.

Commenter ID: 20

Commenter Name: Elizabeth Hartsoch

Commenter Association: Citizen

Comment received via online comment form

Comment:

State water quality standards should be MORE protective than federal standards, not less. Let's move this forward!

LUMMI INDIAN BUSINESS COUNCIL
2665 KWINA ROAD BELLINGHAM, WASHINGTON 98226 (360) 312-2000

April 22, 2016

Ms. Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

SUBJECT: Washington State's Water Quality Standards: 2016 Draft Rule for Human Health Criteria and Implementation Tools

Dear Director Bellon,

Although I appreciate the efforts of your agency and the associated difficulties in adopting water quality standards that are protective of public health of all citizens in the state, the Washington state water quality standards update process has gone on far too long. I urge you to be guided by the best available science, ensure that the adopted water quality standards are protective of the designated uses of each water body under your jurisdiction, and move rapidly toward adopting updated standards. As you know, the Clean Water Act mandates that public health must be the overriding consideration in the establishment of water quality standards – not the profits of private companies.

As the Lummi Nation has noted in previous comments or correspondence during this multi-year process:

1. We agree with the Washington state position that adopting a more protective fish consumption rate for water quality standards is not a panacea and that Ecology needs to do much more to address the discharges of non-point pollutant sources in Washington State.
2. The proposed 175 g/day fish consumption rate is too low to adequately protect Lummi tribal members from toxic chemicals discharged into the environment.
3. The Lummi people have a treaty right to harvest finfish and shellfish – this right is diminished if the harvested fish cannot be consumed due to contamination or the fish cannot be harvested at all.
4. Contamination of finfish and shellfish habitat, just like reduced instream flows due to out-of-stream diversions, fish passage barriers, elimination of functioning riparian areas, and other factors have put our treaty rights and our *Schelangen* ("way of life") at risk.
5. It is morally and legally wrong for the state to allow large private companies to profit at the expense of the environment and the citizens of the state.

Washington State should as soon as practicable:

1. Use the most current best available science provided by the U.S. Environmental Protection Agency (EPA) to analyze how pollutants accumulate in the food chain. Washington State should adopt the most updated revised national 304(a) criteria or at a minimum be consistent with the national guidance, including relative source contribution and bioaccumulation criteria.
2. Ecology should adopt the EPA proposal for arsenic in the EPA's 2015 proposed rule for human health criteria applicable to Washington state.
3. Ecology should use the updated EPA guidance to develop an updated methyl mercury standard.
4. Ecology should update its water quality standards for polychlorinated biphenyls (PCBs) consistent with the EPA 304(a) guidance.
5. Ecology should align its dioxins criteria, in particular 2,3,7,8-Tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD), with the EPA's 2015 proposed rule for Washington.
6. Ecology should modify its rule related to variances, compliance schedules, and other implementation provisions so that any such implementation provisions that could affect the amount of time that permittees would be allowed to continue to violate the water quality standards will only be authorized after consultation with the EPA and affected tribal governments and concurrence in writing from these partners.

The Lummi Nation has been working on a triennial review of our water quality standards and anticipates that revised water quality standards will be issued for public comment during 2017. We are relying on the best available science in the revisions to our water quality standards and if the state does the same, it will be easier to both ensure consistency among the two sets of water quality standards and ensure the Washington standards will be protective of our downstream designated uses.

As you know, the EPA issued a draft rule for human health criteria applicable to Washington State on September 14, 2015. The Lummi Nation can support these more protective criteria as they are based on the best available science and are more closely aligned to the water quality standards that the Lummi Nation expects to seek adoption of during 2017. Hopefully, Washington State can prioritize the protection of public health and the environment over the interests of private companies and conclude this prolonged adoption process in the near future.

Sincerely,

Merle Jefferson

Merle Jefferson, Executive Director,
Lummi Natural Resources Department

Cc: Elden Hillaire, Lummi Fisheries and Natural Resources Commission Chair
Dennis McLerran, EPA Region 10 Administrator
Dan Opalski, EPA Region 10 Director for the Office of Water and Watersheds

New Water Quality Standards, Impacts on Cities

Presentation to the Governor's Informal Advisory Group - 12/5/13

Kelli Linville
Mayor, City of Bellingham

Why do cities care about this issue?

- Cities have a duty to provide clean and healthy water for their residents
- Municipal wastewater plants have about one billion gallons a day of capacity. We process a lot of wastewater.
- Cities and towns operate over 200 wastewater facilities around the state.
- Towns as small as Wilkeson (population - 485)
- Cities as large as Spokane, Tacoma, Vancouver, Everett, Bellingham
- Any of these facilities that discharge into surface waters are potentially affected.

The potential for requiring end of pipe technological solutions:

- Water quality standards apply to surface waters, not to the end of the pipe but dischargers must meet water quality standards at edge of mixing zone.

- But, if receiving waters do not meet water quality standards, then there is nothing to mix with. This is a potential result of ultra-low standards.

- If that happens, dischargers would then have to meet water quality standards without any dilution benefit (at the "end of the pipe").

What would this mean for Bellingham if forced to go to a technology solution?

40 MGD Membrane Reactor plant (this new technology likely wouldn't work added on to our existing facility):	$400- $600 million
Add a reverse osmosis plant:	$400- $800 million
Add 30 years of operational costs	$200-$400 million
Total	**$1 billion to $1.8 billion**

What does this mean for ratepayers?

- Current Bellingham sewer rates are approximately $35 / month
- Sewer customers in areas with new state of the art membrane reactor plants are paying upwards of $100-$120/month for sewer (Blaine, Carnation)
- Double the cost for adding reverse osmosis after high levels of treatment and sewer bills start to approach $200-$250/month.
- Would we achieve our desired human health outcomes?
- Is there a better investment beyond “end of pipe” solutions?

What is the larger picture?

Twenty five year totals for PCB loading into Puget Sound- based on Ecology Phase 3 Toxic Loading Study:	
Source:	**Pounds over twenty five years**
Current Municipal Dischargers	29
Runoff from the built environment (residential, commercial, industrial land)	35
Runoff from the resource environment (agriculture and forest land)	254
Air deposition directly to Puget Sound	73
Salmon returning from the Pacific Ocean	15
Total	**406**

Why we need a holistic approach:

- The top of the line technology, if put on all municipal sources into Puget Sound, could cost at least $7.4 Billion just to address wastewater costs, leaving aside stormwater costs.
- That figure is probably substantially low considering site-specific costs associated with larger facilities in already developed urban areas.
- This technology could potentially remove less than 6% of the total PCB loading into Puget Sound (26 pounds of PCBs over the 25 year period).
- The technology would still not meet water quality standards and therefore this process could introduce significant legal exposure to ratepayers.
- We believe that collectively we can find an approach that will have a more significant and timely impact on human health outcomes.

Weyerhaeuser

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April 20, 2016

Cheryl Niemi
Water Quality Program
Washington Department of Ecology

Sent by Electronic Mail to: swqs@ecy.wa.gov

The Weyerhaeuser Company comments on proposed revisions to WAC 173-201A *Water Quality Standards for Surface Waters* are provided below.

At the outset, the Water Quality Program should again be complimented for a sustained, highly professional and transparent public involvement process on this regulation development activity. The quality of the agency work and commitment to engage willing stakeholders over these last five years has been exceptional.

Weyerhaeuser fully endorses the comment package submitted by the Northwest Pulp and Paper Association and other co-signers[1] . The NWPPA and Weyerhaeuser comment packages are extensive and, taken together, provide legal and science analysis on the key decision criteria framing the proposed rule. Many suggested changes/improvements to the proposed rule text are offered and supported in these comments.

General Comments on Proposed WAC 173-201A *Water Quality Standards for Surface Water*

1. Adopting this rule revision package would represent a mediocre public policy outcome for the state of Washington.
   Five years of regulation development activity now has the state of Washington proposing unnecessarily conservative human health based water quality criteria (HHWQC). The Department of Ecology's own evaluation of these numeric criteria strains to show any benefit to human health protection.

   Comments submitted by the Northwest Pulp and Paper Association offer details on the state of Washington's leap to unnecessarily stringent HHWQC. With a few important exceptions, Ecology's proposed criteria give only secondary consideration to accepted risk management principles, cost/benefit assessments, and relevant court decisions.

[1] "Northwest Pulp and Paper Association Comments on Draft Human Health Water Quality Criteria for the State of Washington," submitted by Chris McCabe, April 2016.

While the headline at time of rule adoption this autumn will make claims about cleaner water and improved public health, the near certain effect of this rule package in coming years will be incrementally higher cost to NPDES permittees (and thus the public), incrementally higher management and program delivery costs for the Department of Ecology, adverse secondary effects on state economic growth, stigmatization of Washington waters, more litigation; all of this for no practical benefit to the health of state residents (including high fish consuming population groups).

2. Ecology's static 2016 analysis on the implications of these proposed numeric criteria in the delivery of Clean Water Act programs is woefully and intentionally short-sighted.

   Water quality numeric criteria serve as the regulatory foundation on which most Clean Water Act programs are based. With the pending adoption of criteria that are generally more stringent, Ecology can certainly anticipate the effect they will have on CWA program delivery. The *"Preliminary Cost-Benefit and Least Burdensome Alternative Analysis*[2]," makes only a token effort at a "best information" 20-year look-forward on the implementation realities of the proposed HHWQC.

   The impact of more stringent HHWQC, coupled with enhanced analytical methodologies, and a growing body of ambient water quality and NPDES permittee discharge data, will ripple across CWA program implementation. In a 5-10 year timeframe Ecology can expect:

   - Many thousands of new waterbody/pollutant Category 5 listings,
   - A parallel demand for TMDLs. Each TMDL must necessarily spawn NPDES re-permitting transactions, non-point source reductions, or "other pollution control" program development to reduce trace toxic pollutant discharges. Experience indicates the combination of extraordinarily low HHWQC and societal/legacy/non-point/undefined pollutant sources will lead to TMDL "black holes" attainment of water quality standards is not likely.
   - NPDES permittees will fail "reasonable potential analyses" with the need for customized WQBELs and ultimately a demand for tertiary wastewater treatment,
   - Requests for variances of all types (individual, multi-discharger, waterbody). Requests for intake credit consideration. Both will represent enormous resource drains on the Water Quality Program,
   - Litigation challenges seem probable when a Clean Water Act transaction fails to satisfy somebody.

   It is easy to imagine credible scenarios in which aspects of the Water Quality Program service delivery becomes grid-locked and to the detriment of the state.

   The state of Washington's lack of inquisitiveness in examining the likely broader effect of the proposed HHWQC over the next 20 years represents a major deficiency of this rule package.

[2] WDOE Publication no. 16-10-009, February 2016

3. Ecology must be commended for the practical and good science-based proposals for the setting of numeric criteria for total PCBs and total arsenic, and for choosing to retain the current National Toxic Rule numeric criterion for mercury. Similarly, agency decisions to retain a Relative Source Contribution value of 1.0 and to rely on a Bioconcentration Factor-based approach in criteria calculations, are reasonable and supported by the best available science.

4. The state of Washington should be committed to a legal defense of an adopted state water quality standards revision should the EPA chose to disapprove any aspect of the state rule per 40 CFR 131.21.

   Washington will certainly characterize its submittal of water quality standards to EPA as fully achieving the regulatory criteria in 40 CFR 131.5, 40 CFR 131.6 and 40 CFR 131.11(a), and assert per 40 CFR 131.5(b) that EPA must therefore approve the standards.[3] That said, a side-by-side comparison of EPA's September 2015 *Revision of Certain Water Quality Standards Applicable to Washington*[4], and the Department of Ecology's current HHWQC proposal, reveals many differences. It is not premature for Washington's Governor and the Department of Ecology to acknowledge the possibility of a partial EPA disapproval of state adopted standards (per 40 CFR 131.21). Should disapproval occur the Governor should be resolved to provide a vigorous legal (and political and public relations defense) of state adopted HHWQC revisions. Further, the state of Washington should make clear to EPA that any series of events that leaves the EPA September 2015 water quality standards proposal being promulgated and serving as Washington water quality standards is simply unacceptable.

5. Adoption of the proposed numeric criteria will exacerbate the already difficult management challenges facing Ecology's Water Quality Program. We encourage the agency to be especially pragmatic in creating implementation measures that will support efficient, timely, confident and realistic delivery of Clean Water Act programs.

   The coming promulgation of more stringent HHWQC will stress Ecology's ability to implement CWA programs. These impacts can be somewhat mitigated with thoughtful revisions to the Water Quality Program Policy 1-11 and Permit Writers Manual. The NPDES Permittee Coalition has identified technical/science and regulatory policy issues embedded in the current Policy 1-11 which should be reconsidered. A more robust and data-driven process should help reveal where Ecology's limited resources can best be applied for early and important water quality improvement. The Permit Writers Manual should include clear direction on what it will take to obtain a variance or intake credit.

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[3] We suggest the EPA Region X ideas on "endorsed" FCR, demand for 10e-6 incremental excess cancer risk, other agency guidance, environmental justice, federal trust responsibilities, tribal treaty rights, and probably other considerations, as presented in the Dennis McLerran December 18, 2014 letter to Maia Bellon, and other EPA communications through 2014, are advisory only and not prerequisites for judging achievement of regulatory criteria in 40 CFR 131.

[4] 80 FR 177, Pages 55063-55077, September 14, 2015

Specific Comments on proposed WAC 173-201A *Water Quality Standards for Surface Water*

1) WAC 173-201A-240(5)(a) – Text in this subsection could be repositioned to more accurately reflect Ecology's obligation and commitment with future aquatic life and human health criteria revisions.

   Discussion – Text in (5)(a) addresses aquatic life protection criteria and reads

   > "The department shall formally adopt any appropriate revised criteria as part of this chapter in accordance with the provisions established in chapter 34.05 RCW, the Administrative Procedures Act. The department shall ensure there are early opportunities for public review and comment on proposals to develop revised criteria."

   This commitment is not exclusive to aquatic life protection criteria discussion. It applies equally to human health protection criteria. Ecology should relocate this text to the parent (5) section to make this clear.

   If Ecology chooses not to accept this suggestion, then please include in the Response to Comment an explanation on whether revised human health protection criteria must be adopted in accordance with provisions established in chapter 34.05 RCW.

2) WAC 173-201A-240(5)(b) and Table 240 footnotes "C" and "F" – The inclusion of the specific fish consumption rate, exposure duration, and incremental excess cancer risk level used for deriving HHWQC, should all be removed from the rule text. There is no inherent value in presenting just these three parameters and point data values used in deriving the HHWQC, to the exclusion of many other parameters/values used in the deterministic algorithm. What is obviously important is the listing of actual numeric criteria in WAC 173-201A-240.

   Discussion – Ecology should be content to rely on the "*Washington State Water Quality Standards: Human Health Criteria and Implementation Tools – Overview of Key Decisions*"[5], to reveal details on the HHWQC derivation methodology and choice of parameter input values. The Key Decisions document could be included as part of the water quality standards submission to EPA to demonstrate the sufficiency and approvability of water quality standards.[6] To list just the FCR, exposure duration and excess cancer risk parameters and data values will encourage comments on those values, or the HHWQC derived from the parameter values, or to question why other important parameter/input values were not presented in regulation text. For example, EPA might

[5] "*Washington State Water Quality Standards: Human Health Criteria and Implementation Tools – Overview of Key Decisions,*" WDOE Publication No. 16-10-006, January 2016

[6] 40 CFR 131.5, 40 CFR 131.6, 40 CFR 131.11(a) broadly define the necessary technical and scientific elements of an approvable water quality standards submittal.

consider each parameter and data value worthy of a separate approval/disapproval decision. A disapproval determination on any aspect of the derivation process would compromise the integrity of the HHWQC package.

3) Table 240 Toxics Substances Criteria – The "Category" column could be deleted.

   Discussion - There is no compelling regulatory reason to present a qualitative identification of a Compound/Chemical by pollutant category. For example, there is scant value in identifying that Antimony is in the "Metals, cyanide and total phenols" Category.

4) Table 240 Toxics Substances Criteria – A column should be added to Table 240 which specifies the "Approved Analytical Protocol(s)," and identifies the expectations for Detection and Quantitation Levels, and instructions and qualifications, as appropriate. Consistent with WAC 173-201A-260(3)(h) these analytical methods would reference to the 40 CFR 136 methods in effect on the date of WAC 173-201A adoption.

   Discussion – The regulatory effect of water quality standards depends on the numeric criterion concentration and the ability of an analytical method to assess the presence of the pollutant in an ambient water sample, at or below the criterion concentration. As proposed in the current rulemaking, there are 51 freshwater toxic pollutants where the numeric criterion proposed by Ecology are below the 40 CFR 136 method detection levels or quantification levels. The inability to detect these pollutants at the concentration of the water quality criterion means they have no practical regulatory significance. But if (or when) pollutant analytical methods are improved and adopted into 40 CFR 136, the real regulatory implications of these 2016 HHWQC will come into focus. The state of Washington will have silently "backed-into" possibly very significant regulatory requirements that may or may not be in the public interest.[7] [8] Ecology certainly understands the significance of this issue. Transparency and fairness should compel a notice and public involvement process.

   To summarize this very important comment, it is the HHWQC and accompanying 40 CFR 136 approved analytical method(s) which together work to define the regulatory effect of any water quality criterion. Ecology should specify in regulation the approved or recommended methodology(ies) to evaluate pollutant concentrations in ambient waters and, as 40 CFR 136 methods change, commit to a formal regulation amendment of Table 240.

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[7] The example we have come to appreciate over the last five years is for Polychlorinated Biphenyls. The 40 CFR 136 approved method is EPA Method 608 (Arochlors). Ecology has been selectively comfortable using the unapproved 40 CFR 136 Method 1668 for assessing PCB (congeners) in ambient water. Should Method 1668 ever be adopted in 40 CFR 136 it would have multi-billion dollar cost implications to the residents of Washington as Clean Water Act programs are implemented in the state.

[8] Note that a pairing of toxic pollutant evaluation and specification of 40 CFR 136 methods is embedded in the agency's NPDES permit program. Ecology-issued NPDES permits include an appendix titled "List of pollutants with analytical methods, detection limits and quantitation levels," with the "Recommended Analytical Protocol," "Detection and Quantitation Levels" specified, and other explanations and qualifications.

As an alternative to adding a column in Table 240 delineating HHWQC/methodologies, the agency could address the same need with an amendment to WAC 173-201A-260(3)(h) (see next comment).

5) WAC 173-201A-260(3) (h) – This subsection should be amended to establish an unambiguous regulatory process requiring amendment of WAC 173-201A to announce revisions to 40 CFR 136 analytical methodologies.

Discussion - Existing WAC 173-201A-260(3) (h) announces agency intentions on the use of approved analytical methodologies to evaluate ambient water quality. An important amendment should be adopted (see underlined text).

> (h) The analytical testing methods for these numeric criteria must be in accordance with the "*Guidelines Establishing Test Procedures for the Analysis of Pollutants*" (40 CFR 136) ~~or superseding methods published~~ in effect on (*date of rule adoption*). The department may also approve other methods following consultation with adjacent states and with the approval of the USEPA. Any superseding methods or other methods not published in 40 CFR 136, will become effective when adopted into WAC 173-201A.

The effect of this suggested amendment would be to require a regulatory action to announce the incorporation of federal regulation changes into state regulation ("in effect on (*date*)" or "when adopted into WAC 173-201A"), in contrast to the passive/silent process existing in the current rule ("or superseding methods published"). This change would provide a reasonable "fair warning of a due process requirement" to the public. This is not an unfamiliar process for the Department of Ecology. Agency regulatory programs that have been delegated implementation authority from the EPA routinely update state rules through an "adoption by reference" process or equivalent.[9]

Finally, this requirement to provide notice of changed federal regulation requirements is demanded by Washington case law. Three Washington Supreme Court decisions have held that the adoption of future federal rules, regulations or statutes would be an unconstitutional delegation of legislative power. (State of Washington, Kirschner v. Urquhart, 50 Wash.2d 131. April 1957; Yelle v. Bishop, 55 Wash.2d 131. December 1959;

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[9] This obligation to periodically update Washington environmental regulations to stay current with changing EPA rules is routine in other programs implemented by Ecology. For example, WAC 173-400 *General Regulation for Air Pollution Sources* is currently going through a rule revision to incorporate amended federal NESHAP and NSPS regulation provisions. The amendatory language in that rule reads as:

> **(New Section) WAC 173-400-025 Adoption of federal rules.** Federal rules mentioned in this rule are adopted as they exist on January 1, 2016, except for WAC 173-400-050(7). Adopted or adopted by reference means the federal rule applies as if it was copied into this rule.

Another recent example is WAC 173-351 *Criteria for Municipal Waste Landfills* in which the adopted regulation amendments were predominantly driven by the obligation to incorporate changing federal requirements in 40 CFR Part 258, Subtitle D of the Resource Conservation and Recovery Act.

State of Washington v. Readers Digest Association, 81 Wash.2d 259. Sep 1972.) 40 CFR 136 is an adopted federal regulation. As that federal regulation is revised a companion revision to WAC 173-201A must

Note that EPA's 40 CFR 136 was last amended in 2012. There is a regulation amendment proposal pending (described at 80 FR 8956 – 9075, February 19, 2015). In either the addition of a column in Table 240 or amendment of WAC 173-201A-260(3)(h), Ecology could simply add language to indicate the date of last revision of 40 CFR 136, and then update and adopt future federal rule changes by reference.

6) WAC 173-201A-420 Variance – Weyerhaeuser appreciates the inclusion of broader regulatory languages providing for variances. A variance offers a mechanism for NPDES permittees to maintain Clean Water Act compliance while working toward ultimate achievement of more stringent HHWAC. However, the sheer complexity of the regulatory process raises questions on whether the "on-paper" benefits of a variance could ever actually be realized.

Discussion – The proposed regulatory language is an expansion of WAC 173-201A-420 *Variances* and necessarily references 40 CFR 131.14. As proposed, the pathway to issuance of a variance includes extensive information development on science and technology questions, multiple favorable regulatory determinations by Ecology, targeted amendment of WAC 173-201A, modification of an NPDES permit(s), a formal review procedure with EPA and interested tribes, perhaps an ESA review, and then approval by EPA. This will be a formidable, resource-intensive, multi-year process.

Ecology has never issued a WQS variance and the "*Rule Implementation Plan: Water Quality Standards for Surface Waters of the State of Washington*" offers minimal commentary on the success elements for issuing a variance or sense of commitment on how the agency would ever turn the concept into reality[10]. The *Preliminary Cost-Benefit and Least Burdensome Alternative Analyses* seems not to recognize the certain Ecology and permittee resource demands associated with a variance issuance process, nor the implications to an NPDES permittee should the decision-making on a variance application stretch out for years or ultimately be unsuccessful[11]. Given the CWA realities mentioned in Comment #2 above, there is an under-appreciation of the likely reliance on variances as the practical implementation tool to accommodate more stringent HHWQC in NPDES permitting transactions.

7) WAC 173-201A-020 *Intake Credit* definition and WAC 173-201A-460 *Intake Credits*

Discussion – The proposed regulatory language is much improved over the January 2015 version. Although this administrative mechanism will not likely be relied on in many NPDES permitting transactions, it is nevertheless an important and reasonable regulatory concept.

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[10] WDOE Publication no. 16-10-005, January 2016

[11] WDOE Publication no. 16-10-009, February 2016

Weyerhaeuser appreciates Ecology's efforts to develop and include the Intake Credit concept in the water quality standards regulation.

Preliminary Benefit-Cost and Least Burdensome Alternative Analyses[12]

It is an admittedly difficult challenge to perform the RCW 34.05.328 cost/benefit assessment on the effects of the proposed regulation. While the format and topic areas addressed in the analysis seem comprehensive, the C/B conclusions in Chapter 8 are simply not credible. The reason stems from Ecology's insistence on a static analysis based on 2016 information. Surely the agency does not believe a look-back in 2036 (reflecting the presumed 20-year life of this regulation) will come close to matching the meager summary of costs and benefits presented in this immediate evaluation. The draft presentation opens the agency to justifiable criticism along the lines of "The State of Washington's revised toxic pollutant water quality standards are not expected to result in any higher level of wastewater treatment on NPDES permittees; no reduction of toxic pollutants into state waters; no ambient water quality improvement; no incremental cost for private or public entities; no meaningful human health benefits; etc."

We would encourage the agency to supplement Chapter 8 with a C/B assessment based on Ecology experience with CWA program implementation and the likely/probable/possible outcomes linked to more stringent HHWQC.

Here are a few comments (which are aligned with the numbering system in the Ecology document):

- Paragraphs 2.2.3 and 2.2.4 – It is appropriate that Ecology recognizes the Permit Writers Manual and Water Quality Program Policy 1-11 as elements of the "Baseline" for Clean Water Act program delivery. As mentioned in General Comment #5, agency discretion and policy choices presented in those guidance documents will have significant influence on program success. Ecology should always be open to meritorious and pragmatic changes in those documents.

- Paragraph 3.2.2 – A fish consumption rate of 175 gr/d is not representative of "average" fish and shellfish consumption of highly-exposed Puget Sound population groups. It is much closer to 90^{th} percentile and, as pointed out in agency documents, includes all fish and shellfish, irrespective of source. This is a highly conservative policy (really a political) choice.

- Paragraph 4.2 and Chapter 5 – The analysis overlooks the costs the "public" will bear in the form of increased sewer rates if/when POTWs are required to install tertiary treatment to achieve a water quality-based effluent limit. A presentation by Bellingham

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[12] "Preliminary Cost-Benefit and Least Burdensome Alternative Analyses," WDOE Publication No. 16-10-009 , February 2016

Mayor Kelli Linville to Governor Inslee (December 2013) articulates this reality (attached). The residents in the Spokane River watershed are certainly experiencing higher sewer bills as the wastewater treatment jurisdictions and other local governments chase PCBs entering the environment. The residents of the City of Vader will soon be paying for expensive wastewater treatment system upgrades driven by a 303(d) Category 5 impairment listing based on Fish Tissue results (newspaper article and Ecology letter enclosed). While these three examples are not directly connected to the proposed HHWQC revisions, they do offer advance notice on the progression of CWA program implementation leading to sewer rate increases. Ecology would be hard pressed to deny that adoption of more stringent HHWQC would not ultimately lead to this result.

- Chapter 5 – Likely Costs of the Proposed Rule – Here are a few costs areas that Ecology probably could estimate and mention.

  - The document identifies there will be 307 new Category 5 CWA 303(d) listings. These will each require development of a TMDL and then Ecology efforts to impose the Wasteload and Load Allocations, and more. Ecology's range of costs to produce and implement a TMDL should be known. Category 5 listings for toxics will surely increase in time as monitoring effort and more refined analytical methodologies combine to reveal impaired waterbodies.

  - Ecology's adoption of revised HHWQC will almost certainly generate legal appeals. The state will incur costs to defend the adopted HHWQC.

  - NPDES permittees unable to immediately comply with WQBELs driven by more stringent criteria will likely seek an extended compliance schedule or a variance. These will require resource intensive responses by Ecology. Some costs could be estimated.

  - The Spokane River Watershed effort to reduce PCBs represents a case-study that should not be overlooked. Could Ecology imagine another watershed, citizen concern with another HHWQC, the use of litigation and legal precedent, etc., in an effort to affect CWA program implementation?

- Chapter 6 – Likely Benefits of the Proposed Rule Amendments - Here are a few observations on benefits that Ecology could be more forthcoming about.

  - This Chapter alludes to qualitative human health benefits arising from adoption/implementation of the proposed HHWQS. But given the earlier acknowledgement that no toxic pollutant reductions from NPDES permittees will result from implementation of the proposed rule, and that TMDL work for the additional 307 impaired waterbodies "is not likely in the 20-year timeframe of this analysis" (paragraph 5.6.2), what is the mechanism to accomplish improved health benefits (qualitative or quantitative)?

- The reduced incremental cancer rate attributable to the proposed HHWQC can be computed for any defined population group and for the general population. These population level analyses should be developed and presented so that state residents can understand the human health benefit expected from this rule proposal[13]. To provide a proper context, any claim of cost savings due to reduced cancer rates (mortality or pecuniary or non-pecuniary cost of illness) being assigned to the adoption of more stringent HHWQC can and should be based on Washington population demographics and survey fish/shellfish consumption information.

- Finally, given Ecology's own conclusion that water quality benefits arising from this proposed rule are not quantifiable, the discussion in sections 6.2 *Potentially affected entities and benefits* and 7.5 *Non-use benefits under future improvements in sampling and testing* simply lacks relevance and credibility.

- Chapter 9 - The Least Burdensome Alternative Analysis lacks rigor. The agency asserts the "elements of the proposed rule" result in the least burdensome regulation that meets the goals and objectives of the statute. This analysis is too narrow and a number of credible and CWA compliant HHWQC alternatives could be developed. As a single example, Ecology presented a compelling HHWQC rule package in January 2015 that included a choice of 10e-5 as a fully protective incremental excess cancer risk level. How is it then in the current rule proposal that an excess cancer risk level of 10e-6, resulting in more stringent HHWQC, is the better choice? In what sense would it lead to a less burdensome result for those obligated to comply with it?

Thank you for the opportunities provided to Weyerhaeuser to participate in the many public involvement activities over the last several years.

Sincerely,

Ken Johnson

Ken Johnson
Corporate Environmental Manager

[13] As an example, the primary target population group these revised HHWQC seek to protect are "American Indian and Alaska natives." This population group numbers about 104,000. Tribal survey data indicate a fish consumption rate of 175 gr/day corresponds to about the 90th percentile consumption rate for that population group (see pages 18 and 75, "Final Fish Consumption Rates Technical Support Document," WDOE, Publication no. 12-09-058). Thus, 10,400 tribal members consume fish at or above 175 gr/day. At an incremental lifetime cancer risk rate of 1 x 10e-6, the estimated lifetime total additional cancers among the Washington tribal population consuming maximally contaminated fish at more than 175 gr/day would be much less than 1 (actually 0.01). At a population level, the one additional cancer incident theoretically arising from Ecology's HHWQC exposure scenario will present itself sometime in the next one hundred 70-year generations of tribal members (7,000 years). Any assertion of cost impacts from mortality or illness for this high consuming population group should be spread out over the next few thousand years.

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711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

February 9, 2016

The Honorable Ken Smith, Mayor,
City of Vader Washington
PO Box 189
Vader, WA 98593

RE: City of Vader 2015 Wastewater Facility Plan Amendment

Dear Mayor Smith:

We are writing to offer additional comments on the City of Vader's (City) 2015 Wastewater Facility Plan Amendment. These comments address the proposed discharge location in the Cowlitz River and the existing discharge location in Olequa Creek.

Cowlitz River Discharge

The Facility Plan needs to consider an expected change to our Water Quality Assessment Report, under which we are placing the Cowlitz River in the area of the proposed discharge, on our list of impaired water bodies (Clean Water Act 303d list). We expect EPA will approve this change in the next few months when it considers our revised Assessment Report.

This change is part of a larger, state-wide policy change regarding how we define a river reach for purposes of our biennial Assessment. Previously we had defined a reach based upon section, township and range. Under that definition, we had divided the Cowlitz River between Lacamas Creek and Olequa Creek into three reaches. We had listed the upstream reach and the downstream reach as impaired in our previous Water Quality Assessment Report, but not the middle reach, the location of the proposed discharge. We are now listing the entire area of river between Lacamas Creek and Olequa Creek as impaired. The pollutants of concern are mercury, PCBs and 2,3,7,8-TCDD (Dioxin). We have found these pollutants at elevated concentrations in fish taken from the river.

The revised listing will have a practical effect for any permit we issue for a discharge to the Cowlitz River. Any permit we issue will prohibit the discharge of these chemicals and (probably) require the City to periodically test its treated effluent for them, to show that these pollutants are not present in the discharge. If those chemicals are present, the City would need to provide additional treatment to remove them. Our experience is that these chemicals may be present in very small amounts at some time in all wastewater treatment plant discharges, even a community as small as Vader with no industrial inflows.

The City can request that the Department of Ecology (Ecology) reconsider this listing. We have recently issued a call for data to update the Assessment Report, which we do every two years. This path would essentially put the City's project on hold for two years or longer and does not guarantee success. We would expect the City to continue making progress during this period of time. In particular the City should consider any additional planning work needed to support an increased discharge to Olequa Creek or seasonal land application; and continue to adjust its sewer rates to better prepare for the future.

Olequa Creek Discharge

The City may want to re-consider the option of discharging to Olequa Creek. We appreciate that this alternative has higher life-cycle costs than the Cowlitz River alternative. The City may be able to reduce that cost through use of a constructed treatment wetland in lieu of some chemical addition, filtration and cooling. A constructed wetland would have a capital cost but few maintenance costs.

One downside of a constructed wetland is that, while it is certain to help reduce pollutants, it is difficult to predict by what amount it will do so. As a result, we would likely need to authorize a larger mixing zone than we normally do in Olequa Creek. That may not be a sustainable solution given the presence of endangered salmon species in the creek, or if new information suggests the creek's pollutant assimilative capacity is lower than expected.

If the City wants to consider the Olequa Creek discharge point further, we would re-engage the National Marine Fisheries Services as a next step. Please let us know if you would like us to arrange that meeting.

Sewer Hook-ups

We issued an Administrative Order to the City in January 2009, and modified the Order in 2011. The modified order requires that the City report quarterly on the sewer applications it receives and any action the City takes to impose a ban on new sewer connections. We are not aware of any applications since we modified the order, or of any ban that the City has adopted. We understand that should Ecology require the City to institute a moratorium after the City has approved sewer connections, the City might have some legal exposure.

We do not object to the City approving limited sewer connections (2-3 per year from within city limits) while it continues to work through its planning process. If the City reports these applications and approvals in the quarterly report you submit to us, we will exempt these approvals from any order we issue requiring the City to institute a moratorium on hook-ups.

Although we are concerned that the City's treatment plant has limited if any capacity to accept additional wastewater, we recognize the City has been working diligently to address this issue but additional time may be necessary before a new treatment plant is on line. We understand that the City feels allowing some connections in the near future may be important.

If you have any questions regarding this matter, please contact Al Bolinger, Senior Environmental Engineer, at (360) 407-6318, or myself at (360) 407-6368.

Sincerely,

Gregory Zentner, Supervisor
Municipal Operations Unit
Southwest Regional Office
Water Quality Program

cc: Tim Elsie, Director, Lewis County Department of Public Works

Commenter ID: 23

Commenter Name: Mary Lou Johnson

Commenter Association: Spokane Riverkeeper

Comment received via online comment form

Comment:

I do not believe the rules will adequately protect our water for the following reasons:

1. Compliance schedules are too long.

Polluters need to meet standards sooner than the windows in this rule.

2. Ignores PCB, mercury and arsenic.

The proposed rule is not strong enough with regards to these toxins. The Spokane River has issues with all of these toxins and the rule should update and tighten the standards on these pollutants.

3. Increased availability of variances. Variances are temporary waivers of water quality standards.

The proposed rule allows polluters to receive "free passes" to meet water quality standards.

Sauk-Suiattle Indian Tribe

5318 Chief Brown Lane
Darrington, Washington 98241-9420

(360) 436-0131
Fax (360) 436-1511

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments on the State's 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

April 19, 2016

Dear Director Bellon,

The Sauk-Suiattle Indian Tribe has been working with the state of Washington and the U.S. Environmental Protection Agency for many years to develop and adopt revised water quality standards that will protect the health of Tribal people and respect our treaty-reserved rights to the harvest of fish and shellfish. The Department of Ecology has now proposed a second draft rule for human health criteria and implementation tools, and we offer the following comments on the state's proposed rule, issued in February 2016. First, the proposed state rule once again falls short of the stated goal of protecting people who consume fish and shellfish. Additionally, the Sauk-Suiattle Indian Tribe hereby supports, adopts, and incorporates by reference the complete Northwest Indian Fisheries Commission comments submitted to Ecology in April 2016. Finally, the Sauk-Suiattle Indian Tribe would like to express our support for the more protective draft rule for human health criteria applicable to Washington State, issued by the U.S. Environmental Protection Agency on September 14, 2015.

Tribes entered this discussion many years ago with their concerns that the existing fish consumption rate of 6.5 grams per day grossly under-represents Tribal fish consumption. The harvest and consumption of fish and shellfish remains at the heart of Tribal communities, and is a cultural, nutritional, and economic necessity as well as a treaty right. The proposed FCR of 175 g/day is low compared to fish consumption rates at many Tribes. Additionally, in reviewing the impact on public health from toxic chemicals in the food chain, we have learned that many other provisions of the rule proposed by the Department of Ecology may greatly diminish the protective benefit of a higher fish consumption rate.

Ecology proposes other human health criteria that do not incorporate best available science and fail to account for other sources of toxic chemicals, and we recommend adoption of the criteria proposed by the EPA. Additionally, the state's proposal will allow the criteria for several highly toxic chemicals including PCBs, arsenic, and dioxin to remain at status quo or to get substantially worse. The state's proposed implementation tools should be adjusted so that they are directed toward accountability and attainment of water quality standards, not a set of tools to help dischargers avoid compliance.

Washington State is required to meet the provisions of the Clean Water Act to preserve the beneficial uses of water, including fishing. The public health issues that are determined by these standards affect everyone in Washington who eats fish. On top of this concern, the state must not impair the Tribe's treaty-reserved rights to take and consume fish at all their usual and accustomed fishing grounds and stations. The proposed rules by the state of Washington do not meet these requirements.

Sincerely,

Jason L. Joseph
Sauk-Suiattle Natural Resources Director, and
Northwest Indian Fisheries Commissioner

CC:
Lorraine Loomis, Chair, Northwest Indian Fisheries Commission
Dennis McLerran, EPA Region 10 Administrator
Dan Opalski, EPA Region 10 Director for the Office of Water and Watersheds

Commenter ID: 25

Commenter Name: Valarie Kaser

Commenter Association: Enrolled Makah Tribal member

Comment received via online comment form

Comment:

It seems as the water is tested, but not the many varieties of clams? We get frustrated when it's closed, then reopened without the shellfish being actually tested. So please do us a favor and test the shellfish. We live on this stuff. It's very important to so many.

Spokane Tribal Natural Resources

P.O. Box 480 ● Wellpinit, WA 99040 ● (509) 626 - 4400 ● fax 258 - 9600

April 20, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

RE: Comments on the Washington State's 2016 Revisions to its Water Quality Standards (sent via email to: swqs@ecy.wa.gov**)**

Director Bellon:

On behalf of the Spokane Tribal Natural Resources Department ("Department"), please accept these comments on the Washington State Department of Ecology's ("Ecology") draft revisions to Washington State's Water Quality Standards, Human Health Criteria, and Implementation Tools ("draft revisions").

As Ecology is aware the Spokane Tribe of Indians ("Tribe") gained treatment in the same manner as a state in 2002 for purposes under the Clean Water Act, and EPA approved its first water quality standards in 2003. EPA approved the Tribe's latest WQS revisions in December of 2013. Those revisions were based on a human health criterion that included a fish consumption rate of 865 grams per day and a cancer risk rate of 10 to the minus 6. The Tribe adopted these revisions with the goal of better protection for its subsistence fishing rights within its waters, and to prepare and protect its waters for the return of anadromous fish. In reviewing Ecology's draft revisions, the Department is seeking to ensure that fish that migrate to and from the Tribe's waters are protected, and that the Tribe's reserved rights are protected from pollution originating in other jurisdictions.

First, the Department with these comments does not support, and the comments should not be construed as supporting any NPDES permits that do not meet the downstream water quality standard requirements of 40 C.F.R. Section 122.4(d). Second, the Department hereby, supports, adopts, and incorporates by reference the complete Northwest Indian Fisheries Commission comments regarding the draft Washington water quality standards revisions, which were prepared on behalf and at the behest of its member tribes, including all materials, references and records, submitted to the Washington Department of Ecology. With that said, the Department will briefly outline three specific concerns and comments on the draft revisions.

Implementation Tools

In 2009, Washington State passed Substitute Senate Bill 6036. The legislation outlined very specific instances when compliance schedules would be allowed to exceed ten-(10) years. The implementation tools as drafted by Ecology would far exceed what the legislature outlined in 2009. Accordingly, the Department strongly opposes the implementation tools as written in the draft revisions.

PCBs

Elevated levels of PCBs in fish tissue cause many fish consumption advisories within the State, and are also the cause of many 303d listings. Given this it is unacceptable that Ecology proposes to readopt its current PCB surface water quality criteria of 170pg/L. This standard is currently failing to protect for the designated use of harvest in the state waters and readopting it will not assist in protecting fish and the people that consume those fish. Currently, the Tribe's fish are heavily impacted by pollution that originates in Washington State, and they do not meet the Tribe's standards. Sadly the fish do not even come close to meeting the State's inadequate standards.[1]

PCB Testing

Ecology must require the use of EPA Method 1668C for all PCB monitoring and enforcement purposes in these revisions. The continued use of method 608 is absurd in light of its inability to detect PCB's even remotely close to the levels required by the State's current inadequate WQS.

Conclusion

Overall, Ecology should redraft its revisions to work towards one of the overarching purposes of the Clean Water Act, which is "that the discharge of pollutants into the navigable waters be eliminated."[2] If you have any questions, feel free to contact me at 509-626-4427.

Sincerely,

B.J. Kieffer
Director
Spokane Tribal Natural Resources Department

Cc: Carol Evans, Chairwoman, Spokane Tribe Business Council
Brian Crossley, Water and Fish Program Manager, Spokane Tribe of Indians
Ted Knight, Special Legal Counsel, Spokane Tribe of Indians

[1] Attached Declaration by Brian Crossley.
[2] *See* 33 U.S.C. Section 1251(a)(1).

Honorable Robert S. Lasnik

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

SIERRA CLUB; and CENTER FOR ENVIRONMENTAL LAW AND POLICY, Plaintiffs, and SPOKANE TRIBE OF INDIANS, Plaintiff-Intervenor, v. DENNIS MCLERRAN; LISA JACKSON; and UNITED STATES ENVIRONMENTAL PROTECTION AGENCY Defendants, and SPOKANE COUNTY: KAISER ALUMINUM WASHINGTON LLC; and STATE OF WASHINGTON DEPARTMENT OF ECOLOGY, Intervenors.	No. 2: 11-cv-01759-RSL DECLARATION OF BRIAN CROSSLEY IN SUPPORT OF THE SPOKANE TRIBE OF INDIANS' MOTION FOR SUMMARY JUDGMENT

I, Brian Crossley, declare under the penalty of perjury under the laws of the United States of America:

OFFICE OF THE SPOKANE TRIBAL ATTORNEY
P.O. Box 100
Wellpinit, WA 98840
(509) 953-1908

1. I am a resident of Stevens County, Washington, over the age of eighteen years, and am competent to make this declaration based on my personal knowledge and experience.

2. I am the Spokane Tribe's Water and Fish Program Manager, a division of the Spokane Tribe of Indians' Natural Resources Department.

3. As part of my position, I have reviewed PCB testing results from recent data collected within the Spokane River that flows through the Spokane Indian Reservation.

4. Seventy-four fish were grouped into seventeen fish tissue composites that were taken from the Spokane River within and near the border of the Spokane Tribe of Indians Reservation in the fall of 2012.

5. For those seventeen composites, the average PCB level in the tissue was 34.85 ng/g.

6. The National Toxic Rule tissue standard is 5.3 ng/g which is Washington State's standard for PCBs in fish tissue, EPA's recommended screening value for subsistence users in fish tissue is .245 ng/g, and the Spokane Tribe's current standard for fish tissue is .04 ng/g.

7. This data indicates that the average fish sampled within the Tribe's waters has levels of PCBs 6.6 times higher than the State standard, 142.24 times higher than EPA's subsistence screening level standard, and 871.25 times higher than the Tribe's standard for fish tissue.

EXECUTED this 11th day of March, 2014 in Wellpinit, Washington.

Brian Crossley

OFFICE OF THE SPOKANE TRIBAL ATTORNEY
P.O. Box 100
Wellpinit, WA 98840
(509) 953-1908

Commenter ID: 27

Commenter Name: Claude Kistlet

Commenter Association: Citizen

Comment received via online comment form

Comment:

Please adopt the EPA proposed rules on the Spokane River. The Washington Ecology rules do not do enough to clean up and protect this incredible community resource.

Commenter ID: 28

Commenter Name: Janet Knox

Commenter Association: Pacific Groundwater Group

Comment received via online comment form

Comment:

Ecology note: No comment text or attachments were submitted by Ms. Knox.

Commenter ID: 29

Commenter Name: Lincoln Loehr

Commenter Association: Citizen

Comment received via email

Comment:

In October 2015, the World Health Organization's IARC came out with a report evaluating the cancer risks associated with consumption of red meat and processed meat. I am attaching to this email the following: WHO IARC Mongraphs evaluate consumption of red meat and processed meat, WHO IARC Q&A on the carcinogenicity of the consumption of red meat and processed meat, UK Cancer Research. Processed meat and cancer - what you need to know, American Cancer Society. World Health Organization Says Processed Meat Causes Cancer. The very short summary is that consumption of 50 grams a day of processed meat results in a 1% increased life time cancer risk (10-2). The reports recommend reducing the amount of red meat consumed, and avoiding processed meat all together. The studies address only the cancer risks, not the cardiovascular risks that also result form a high red meat diet. The information is relevant to Ecology's proposed revisions of human health surface water quality criteria, which for most parameters are intended to produce cancer risks of less than 1 in a million (10-6) for people consuming 175 grams/day of fish for a 70 year life time. The program has the potential to scare people away from fish consumption without givng them good information on the risks of other food and protein sources. As such, it may do more harm than good. I have made a rather disturbing calculation. 50 grams a day is the equivalent of eating one quarter pound hot dog every 2.27 days. Since 50 grams a day results in a 10-2 additional lifetime cancer risk, I computed what the hot dog consumption rate would be that would result in a 10-6 additional lifetime cancer risk. That is 0.005 grams a day, which is equal to one quarter pound hot dog every 62 years. I have in earlier correspondence noted that smoke curing methods for salmon adds substantial carcinogen risks, and I simply raise that concern again as another perspective on understanding dietary risks. I am attaching the following article that pertains. Forsberg, et al, 2012. Effect of Native American fish smoking methods on dietary exposure to polycyclic aromatic hydrocarbons and possible risks to human health. I recognize that Ecology has been under a lot of pressure from EPA Region X and from the Tribes to go with 10-6 risk level, and a high fish consumption rate, and I also recognize that the Water Quality Program with its standards program, is constrained as to what it can address. However, from a public health perspective, the narrow focus on fish consumption really puts blinders on us as to where the really significant risks lie, and can even drive us away from fish consumption and towards riskier dietary choices. The public needs to become better informed in order to make better choices.

Lincoln

Processed meat and cancer – what you need to know

You've probably seen today's headlines, about the fact that processed meat has been classified as a 'definite' cause of cancer. And red meat is a 'probable' cause.

The decision – coordinated by a respected international body – has been so highly anticipated by the media that speculation about the announcement has been building since last week.

But a link between certain types of meat and some forms of cancer – notably bowel cancer – isn't 'new' news – the evidence has been building for decades, and is supported by a lot of careful research.

Nevertheless, today's announcement is significant. It comes from the International Agency for Research on Cancer (IARC) – a group of international experts who scrutinise the overall evidence – in this case more than 800 studies – on how likely certain things are to cause cancer. Their decisions carry a lot of clout, especially with governments and regulators.

But what does the finding – published here in the *Lancet Oncology* – mean in practice? How much meat is it sensible to eat? And how many cases of cancer are linked to meat consumption?

In this post, we'll look at what IARC's classification actually means, how red and processed meat affect cancer risk, and the likely size of this effect.

But before we move on, let's be clear: yes, a prolonged high-meat diet isn't terribly good for you. But a steak, bacon sandwich or sausage bap a few times a week probably isn't much to worry about. And overall the risks are much lower than for other things linked to cancer – such as smoking.

What *are* 'red' and 'processed' meat?
First, let's clear up some definitions.

'Red' meat is (as you might expect), any meat that's a dark red colour before it's cooked – this obviously means meats like beef and lamb, but also includes pork.

'Processed' meat is meat that's not sold fresh, but instead has been cured, salted, smoked, or otherwise preserved in some way (so things like bacon, sausages, hot dogs, ham, salami, and pepperoni). But this doesn't include fresh burgers or mince.

Both of these types of meat are distinct from 'white' meats, like fresh chicken or turkey, and fish (neither of which appear to increase your risk of cancer).

The evidence so far…

There's now a large body of evidence that **bowel cancer** is more common among people who eat the most red and processed meat. As this evidence has steadily built up, we've blogged about it several times – and it's covered on the NHS Choices website and by the World Cancer Research Fund (WCRF).

(There's also growing evidence for a possible link to both stomach and pancreatic cancers, but this seems to be less clear cut than the link to bowel cancer.)

The most convincing overview of the evidence of a link to bowel cancer comes from a 2011 analysis by researchers at the WCRF, who combined the results of a number of previous studies, to try to get a clear sense of the overall picture.

They were able to group the data according to those who ate the most red and processed meat and those who ate the least. A key finding from the WCRF analysis is that red meat and processed meat aren't equally harmful: processed meat is more strongly linked to bowel cancer than red meat.

The results showed that those who ate the most processed meat had **around a 17 per cent higher** risk of developing bowel cancer, compared to those who ate the least.

'17 per cent' sounds like a fairly big number – but this is a 'relative' risk, so let's put it into perspective, and convert it to absolute numbers. Remember these are all ball-park figures – everyone's risk will be different as there are many different factors at play.

We know that, out of every 1000 people in the UK, about 61 will develop bowel cancer at some point in their lives. Those who eat the lowest amount of processed meat are likely to have a lower lifetime risk than the rest of the population (about 56 cases per 1000 low meat-eaters).

If this is correct, the WCRF's analysis suggests that, among 1000 people who eat the most processed meat, you'd expect 66 to develop bowel cancer at some point in their lives – 10 more than the group who eat the least processed meat.

How does red and processed meat cause cancer?

Researchers are still trying to pin down exactly *how* red and processed meat cause cells to become cancerous, but the main culprits seem to be certain chemicals found in the meat itself.

In red meat, the problems seem to start when a chemical called haem – part of the red pigment in the blood, haemoglobin – is broken down in our gut to form a family of chemicals called N-nitroso compounds. These have been found to damage the cells that line the bowel, so other cells in the bowel lining have to replicate more in order to heal. And it's this 'extra' replication that can increase the chance of errors developing in the cells' DNA – the first step on the road to cancer.

On top of this, processed red meats contain chemicals that generate N-nitroso compounds in the gut, such as nitrite preservatives.

Cooking meat at high temperatures, such as grilling or barbequing, can also create chemicals in the meat that may increase the risk of cancer. These chemicals are generally produced in higher levels in red and processed meat compared to other meats.

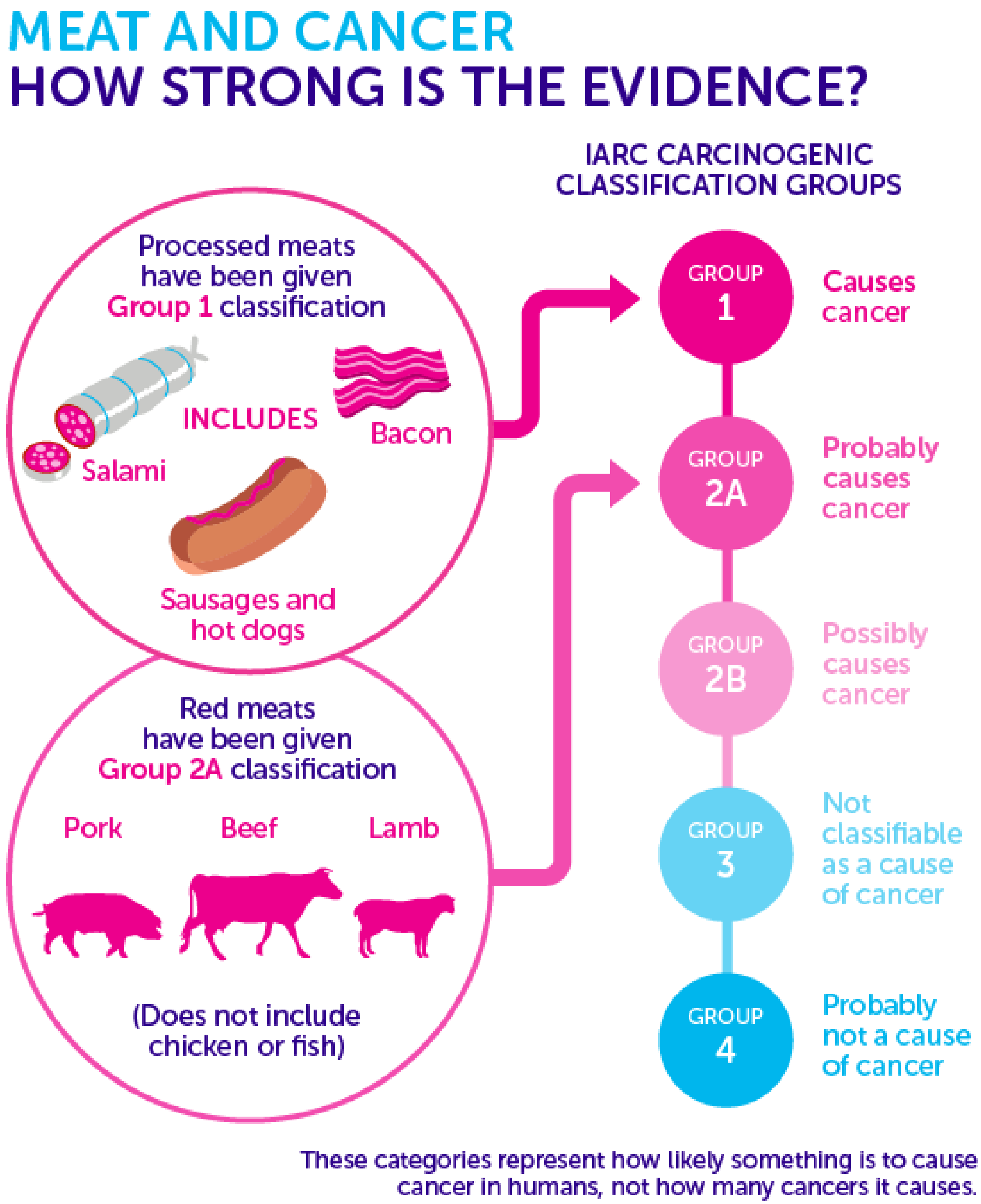
But there are other theories too – some research has suggested that the iron in red meat could play a role, while others suggest the bacteria in the gut might play a supporting role too.

So despite what you may hear, it isn't about the quality of the meat, or whether it's from the local butcher or your supermarket. The evidence so far suggests that it's probably the processing of the meat, or chemicals naturally present within it, that increases cancer risk.

What does this decision from IARC mean?

Whatever the underlying mechanism, there's now sufficient evidence for IARC to rule that processed meat 'definitely' causes cancer, and that red meat 'probably' causes cancer. But to really understand what this means (and doesn't mean), you need to know a bit about IARC's categories.

When IARC assesses the evidence on a particular cancer risk, it assigns it to one of several groups, which – as the graphic below shows – represent **how confident** they are that it causes cancer in people.

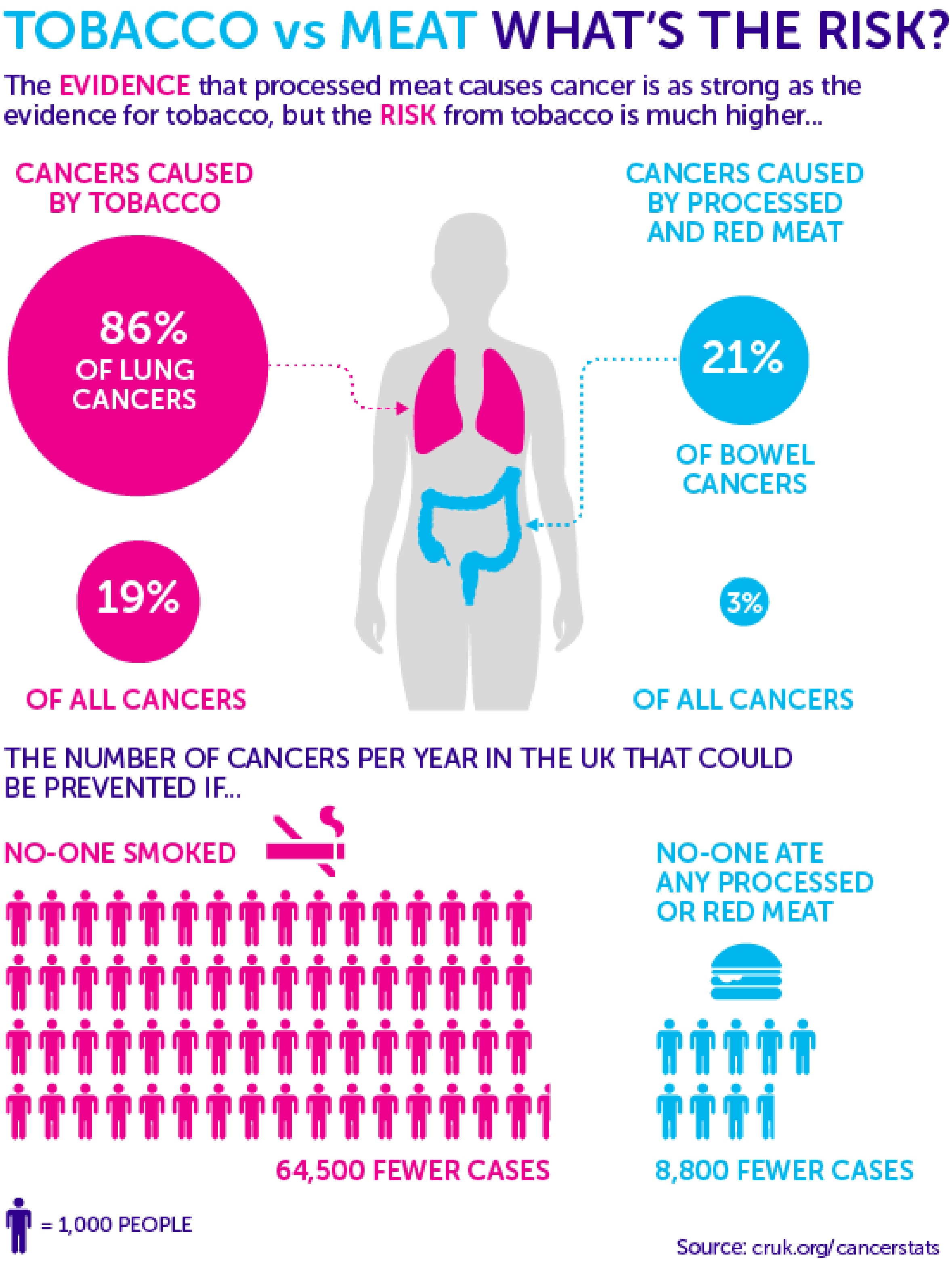


Processed meat has been classified as a ‘definite’ cause of cancer (or Group 1 carcinogen) – the same group that includes smoking and alcohol. And red meat is a ‘probable’ cause of cancer (or a Group 2a carcinogen) – the same group as shift work. While this may sound alarming, it’s important to remember that these groups show **how confident IARC is** that red and processed meat cause cancer**, not how much cancer they cause.**

As we wrote when we covered a previous IARC decision on diesel emissions, and interviewed one of our experts in the causes of cancer:

> As Professor Phillips explains, “IARC does ‘hazard identification’, not ‘risk assessment’.
>
> “That sounds quite technical, but what it means is that IARC isn’t in the business of telling us *how potent* something is in causing cancer – only *whether it does so or not*”, he says.
>
> To take an analogy, think of banana skins. They definitely *can* cause accidents, explains Phillips, but in practice this doesn’t happen very often (unless you work in a banana factory). And the sort of harm you can come to from slipping on a banana skin isn’t generally as severe as, say, being in a car accident.
>
> But under a hazard identification system like IARC’s, ‘banana skins’ and ‘cars’ would come under the same category – they both definitely do cause accidents.

To put things in perspective, let’s look at how red and processed meat stack up against smoking:



In 2011, scientists estimated that around 3 in every hundred cancers in the UK were due to eating too much red and processed meat (that's around 8,800 cases every year). This compares against 64,500 cases every year caused by smoking (or 19 per cent of all cancers).

So what does this mean for mealtimes?

Does red and processed meat still have a place in a healthy diet?

None of this means that a single meat-based meal is 'bad for you'. What it does mean is that regularly eating large amounts of red and processed meat, over a long period of time, is probably not the best approach if you're aiming to live a long and healthy life. Meat is fine in moderation – it's a good source of some nutrients such as protein, iron and zinc. It's just about being sensible, and not eating too much, too often.

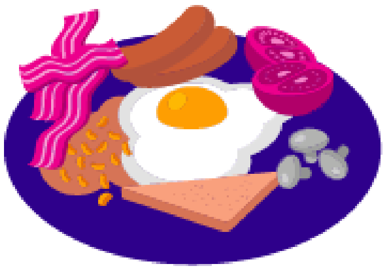
So how much is a 'sensible' amount of meat? This is a much trickier question to answer. The evidence so far doesn't point to a particular amount that's, in terms of cancer risk, likely to be 'too much'. All we can say is that on the whole, the risk is lower the less you eat. Based on a range of health considerations, the Government advises people who eat more than 90g (cooked weight) of red and/or processed meat a day should cut down to 70g or less.

But what do these portions actually look like?

HOW MUCH MEAT DO YOU EAT A DAY?

HOW YOUR PROCESSED AND RED MEAT CONSUMPTION CAN ADD UP OVER A DAY...

ENGLISH BREAKFAST

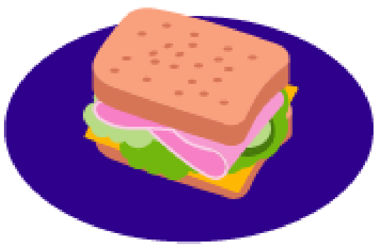


Two sausages...60g
Three rashers of bacon.............75g

CUT IT DOWN

One sausage........30g
One rasher of bacon................25g

HAM SANDWICH

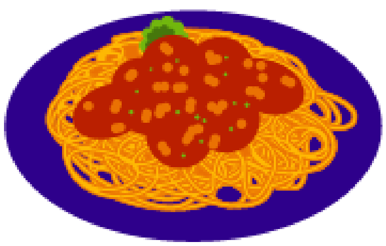


Two slices of ham................ 50g

SWAP IT

Substitute ham for chicken or tuna......................0g

SPAGHETTI BOLOGNESE



Minced beef in a regular portion.............100g

BULK IT OUT

Use less meat and add beans or extra veggies...15g

285g TOTAL EATEN

70g RECOMMENDED DAILY LIMIT OF CONSUMPTION

So if you're someone who has a very meaty diet, and you're worried about cancer, you may want to think about cutting down. That doesn't mean you need to start stocking up on tofu, unless you want to, it just means trying to eat smaller and fewer portions (by adding in more vegetables, beans and pulses – remember the eatwell plate?), or choosing chicken or fish instead. As we said above, there's no strong evidence linking fresh white meats such as chicken, turkey, or fish to any types of cancer.

So our advice on diet stays the same: eat plenty of fibre, fruit and vegetables; cut back on red and processed meat, and salt; and limit your alcohol intake. It might sound boring but it's true: healthy living is all about moderation.

Except for smoking: that's *always* bad for you.

Casey Dunlop is a health information officer at Cancer Research UK
*this post was edited at 6pm on 26th October to correct an error in the way Professor Phillips was attributed in the quote box.

647
57

World Health Organization Says Processed Meat Causes Cancer

Article date: October 26, 2015

By Stacy Simon

The International Agency for Research on Cancer (IARC) has classified processed meat as a carcinogen, something that causes cancer. And it has classified red meat as a probable carcinogen, something that probably causes cancer. IARC is the cancer agency of the World Health Organization.

Processed meat includes hot dogs, ham, bacon, sausage, and some deli meats. It refers to meat that has been treated in some way to preserve or flavor it. Processes include salting, curing, fermenting, and smoking. Red meat includes beef, pork, lamb, and goat.

Twenty-two experts from 10 countries reviewed more than 800 studies to reach their conclusions. They found that eating 50 grams of processed meat every day increased the risk of colorectal cancer by 18%. That's the equivalent of about 4 strips of bacon or 1 hot dog. For red meat, there was evidence of increased risk of colorectal, pancreatic, and prostate cancer.

Overall, the lifetime risk of someone developing colon cancer is 5%. To put the numbers into perspective, the increased risk from eating the amount of processed meat in the study would raise average lifetime risk to almost 6%.

Colleen Doyle, MS, RD, American Cancer Society managing director of nutrition and physical activity, says, "We should be limiting red and processed meat to help reduce colon cancer risk, and possibly, the risk of other cancers. The occasional hot dog or hamburger is okay."

The American Cancer Society has long recommended a diet that limits processed meat and red meat, and that is high in vegetables, fruits, and whole grains. The American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention recommend choosing fish, poultry, or beans instead of red meat and processed meat.

IARC published its report online October 26, 2015 in *The Lancet Oncology*.

Citation: Carcinogenicity of consumption of red and processed meat. Published early online October 26, 2015 in *The Lancet Oncology*. First author Veronique Bouvard, International Agency for Research on Cancer Monograph Working Group, Lyon, France.

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Was this article helpful? Yes No

IARC Monographs evaluate consumption of red meat and processed meat

Lyon, France, 26 October 2015 – The International Agency for Research on Cancer (IARC), the cancer agency of the World Health Organization, has evaluated the carcinogenicity of the consumption of red meat and processed meat.

Red meat

After thoroughly reviewing the accumulated scientific literature, a Working Group of 22 experts from 10 countries convened by the IARC Monographs Programme classified the consumption of red meat as *probably carcinogenic to humans* (Group 2A), based on *limited evidence* that the consumption of red meat causes cancer in humans and *strong* mechanistic evidence supporting a carcinogenic effect.

This association was observed mainly for colorectal cancer, but associations were also seen for pancreatic cancer and prostate cancer.

Processed meat

Processed meat was classified as *carcinogenic to humans* (Group 1), based on *sufficient evidence* in humans that the consumption of processed meat causes colorectal cancer.

Meat consumption and its effects

The consumption of meat varies greatly between countries, with from a few percent up to 100% of people eating red meat, depending on the country, and somewhat lower proportions eating processed meat.

The experts concluded that each 50 gram portion of processed meat eaten daily increases the risk of colorectal cancer by 18%.

"For an individual, the risk of developing colorectal cancer because of their consumption of processed meat remains small, but this risk increases with the amount of meat consumed," says Dr Kurt Straif, Head of the IARC Monographs Programme. "In view of the large number of people who consume processed meat, the global impact on cancer incidence is of public health importance."

The IARC Working Group considered more than 800 studies that investigated associations of more than a dozen types of cancer with the consumption of red meat or processed meat in many countries and populations with diverse diets. The most influential evidence came from large prospective cohort studies conducted over the past 20 years.

Public health

"These findings further support current public health recommendations to limit intake of meat," says Dr Christopher Wild, Director of IARC. "At the same time, red meat has nutritional value. Therefore, these results are important in enabling governments and international regulatory agencies to conduct risk assessments, in order to balance the risks and benefits of eating red meat and processed meat and to provide the best possible dietary recommendations."

Note to the Editor:

Red meat refers to all types of mammalian muscle meat, such as beef, veal, pork, lamb, mutton, horse, and goat.

Processed meat refers to meat that has been transformed through salting, curing, fermentation, smoking, or other processes to enhance flavour or improve preservation. Most processed meats contain pork or beef, but processed meats may also contain other red meats, poultry, offal, or meat by-products such as blood.

Examples of processed meat include hot dogs (frankfurters), ham, sausages, corned beef, and biltong or beef jerky as well as canned meat and meat-based preparations and sauces.

A summary of the final evaluations is available online in *The Lancet Oncology*, and the detailed assessments will be published as Volume 114 of the IARC Monographs.

Read the IARC Monographs Q&A

http://www.iarc.fr/en/media-centre/iarcnews/pdf/Monographs-Q&A.pdf

Read the IARC Monographs Q&A on the carcinogenicity of the consumption of red meat and processed meat.

http://www.iarc.fr/en/media-centre/iarcnews/pdf/Monographs-Q&A_Vol114.pdf

For more information, please contact

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or Dr Nicolas Gaudin, IARC Communications, at com@iarc.fr

The International Agency for Research on Cancer (IARC) is part of the World Health Organization. Its mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The Agency is involved in both epidemiological and laboratory research and disseminates scientific information through publications, meetings, courses, and fellowships. If you wish your name to be removed from our press release e-mailing list, please write to com@iarc.fr.

Q&A on the carcinogenicity of the consumption of red meat and processed meat

Q. What do you consider as red meat?

A. Red meat refers to all mammalian muscle meat, including, beef, veal, pork, lamb, mutton, horse, and goat.

Q. What do you consider as processed meat?

A. Processed meat refers to meat that has been transformed through salting, curing, fermentation, smoking, or other processes to enhance flavour or improve preservation. Most processed meats contain pork or beef, but processed meats may also contain other red meats, poultry, offal, or meat by-products such as blood.

Examples of processed meat include hot dogs (frankfurters), ham, sausages, corned beef, and biltong or beef jerky as well as canned meat and meat-based preparations and sauces.

Q. Why did IARC choose to evaluate red meat and processed meat?

A. An international advisory committee that met in 2014 recommended red meat and processed meat as high priorities for evaluation by the IARC Monographs Programme. This recommendation was based on epidemiological studies suggesting that small increases in the risk of several cancers may be associated with high consumption of red meat or processed meat. Although these risks are small, they could be important for public health because many people worldwide eat meat and meat consumption is increasing in low- and middle-income countries. Although some health agencies already recommend limiting intake of meat, these recommendations are aimed mostly at reducing the risk of other diseases. With this in mind, it was important for IARC to provide authoritative scientific evidence on the cancer risks associated with eating red meat and processed meat.

Q. Do methods of cooking meat change the risk?

A. High-temperature cooking methods generate compounds that may contribute to carcinogenic risk, but their role is not yet fully understood.

Q. What are the safest methods of cooking meat (e.g. sautéing, boiling, broiling, or barbecuing)?

A. Cooking at high temperatures or with the food in direct contact with a flame or a hot surface, as in barbecuing or pan-frying, produces more of certain types of carcinogenic chemicals (such as polycyclic aromatic hydrocarbons and heterocyclic aromatic amines). However, there were not enough data for the IARC Working Group to reach a conclusion about whether the way meat is cooked affects the risk of cancer.

Q. Is eating raw meat safer?

A. There were no data to address this question in relation to cancer risk. However, the separate question of risk of infection from consumption of raw meat needs to be kept in mind.

Q. Red meat was classified as Group 2A, *probably carcinogenic to humans*. What does this mean exactly?

A. In the case of red meat, the classification is based on *limited evidence* from epidemiological studies showing positive associations between eating red meat and developing colorectal cancer as well as *strong* mechanistic evidence.

Limited evidence means that a positive association has been observed between exposure to the agent and cancer but that other explanations for the observations (technically termed chance, bias, or confounding) could not be ruled out.

Q. Processed meat was classified as Group 1, *carcinogenic to humans*. What does this mean?

A. This category is used when there is *sufficient evidence* of carcinogenicity in humans. In other words, there is convincing evidence that the agent causes cancer. The evaluation is usually based on epidemiological studies showing the development of cancer in exposed humans.

In the case of processed meat, this classification is based on *sufficient evidence* from epidemiological studies that eating processed meat causes colorectal cancer.

Q. Processed meat was classified as carcinogenic to humans (Group 1). Tobacco smoking and asbestos are also both classified as carcinogenic to humans (Group 1). Does it mean that consumption of processed meat is as carcinogenic as tobacco smoking and asbestos?

A. No, processed meat has been classified in the same category as causes of cancer such as tobacco smoking and asbestos (IARC Group 1, *carcinogenic to humans*), but this does **NOT** mean that they are all equally dangerous. The IARC classifications describe the strength of the scientific evidence about an agent being a cause of cancer, rather than assessing the level of risk.

Q. What types of cancers are linked or associated with eating red meat?

A. The strongest, but still *limited*, evidence for an association with eating red meat is for colorectal cancer. There is also evidence of links with pancreatic cancer and prostate cancer.

Q. What types of cancers are linked or associated with eating processed meat?

A. The IARC Working Group concluded that eating processed meat causes colorectal cancer. An association with stomach cancer was also seen, but the evidence is not conclusive.

Q. How many cancer cases every year can be attributed to consumption of processed meat and red meat?

A. According to the most recent estimates by the Global Burden of Disease Project, an independent academic research organization, about 34 000 cancer deaths per year worldwide are attributable to diets high in processed meat.

Eating red meat has not yet been established as a cause of cancer. However, if the reported associations were proven to be causal, the Global Burden of Disease Project has estimated that diets high in red meat could be responsible for 50 000 cancer deaths per year worldwide.

These numbers contrast with about 1 million cancer deaths per year globally due to tobacco smoking, 600 000 per year due to alcohol consumption, and more than 200 000 per year due to air pollution.

Q. Could you quantify the risk of eating red meat and processed meat?

A. The consumption of processed meat was associated with small increases in the risk of cancer in the studies reviewed. In those studies, the risk generally increased with the amount of meat consumed. An analysis of data from 10 studies estimated that every 50 gram portion of processed meat eaten daily increases the risk of colorectal cancer by about 18%.

The cancer risk related to the consumption of red meat is more difficult to estimate because the evidence that red meat causes cancer is not as strong. However, if the association of red meat and colorectal cancer were proven to be causal, data from the same studies suggest that the risk of colorectal cancer could increase by 17% for every 100 gram portion of red meat eaten daily.

Q. Is the risk higher in children, in elderly people, in women, or in men? Are some people more at risk?

A. The available data did not allow conclusions about whether the risks differ in different groups of people.

Q. What about people who have had colon cancer? Should they stop eating red meat?

A. The available data did not allow conclusions about risks to people who have already had cancer.

Q. Should I stop eating meat?

A. Eating meat has known health benefits. Many national health recommendations advise people to limit intake of processed meat and red meat, which are linked to increased risks of death from heart disease, diabetes, and other illnesses.

Q. How much meat is it safe to eat?

A. The risk increases with the amount of meat consumed, but the data available for evaluation did not permit a conclusion about whether a safe level exists.

Q. What makes red meat and processed meat increase the risk of cancer?

A. Meat consists of multiple components, such as haem iron. Meat can also contain chemicals that form during meat processing or cooking. For instance, carcinogenic chemicals that form during meat processing include *N*-nitroso compounds and polycyclic aromatic hydrocarbons. Cooking of red meat or processed meat also produces heterocyclic aromatic amines as well as other chemicals including polycyclic aromatic hydrocarbons, which are also found in other foods and in air pollution. Some of these chemicals are known or suspected carcinogens, but despite this knowledge it is not yet fully understood how cancer risk is increased by red meat or processed meat.

Q. Can you compare the risk of eating red meat with the risk of eating processed meat?

A. Similar risks have been estimated for a typical portion, which is smaller on average for processed meat than for red meat. However, consumption of red meat has not been established as a cause of cancer.

Q. What is WHO's health recommendation to prevent cancer risk associated with eating red meat and processed meat?

A. IARC is a research organization that evaluates the evidence available on the causes of cancer but does not make health recommendations as such. National governments and WHO are responsible for developing nutritional guidelines. This evaluation by IARC reinforces a 2002 recommendation from WHO that people who eat meat should moderate the consumption of processed meat to reduce the risk of colorectal cancer. Some other dietary guidelines also recommend limiting consumption of red meat or processed meat, but these are focused mainly on reducing the intake of fat and sodium, which are risk factors for cardiovascular disease and obesity. Individuals who are concerned about cancer could consider reducing their consumption of red meat or processed meat until updated guidelines related specifically to cancer have been developed.

Q. Should we eat only poultry and fish?

A. The cancer risks associated with consumption of poultry and fish were not evaluated.

Q. Should we be vegetarians?

A. Vegetarian diets and diets that include meat have different advantages and disadvantages for health. However, this evaluation did not directly compare health risks in vegetarians and people who eat meat. That type of comparison is difficult because these groups can be different in other ways besides their consumption of meat.

Q. Is there a type of red meat that is safer?

A. A few studies have investigated the cancer risks associated with different types of red meat, such as beef and pork, and with different kinds of processed meats, like ham and hot dogs. However, there is not enough information to say whether higher or lower cancer risks are related to eating any particular type of red meat or processed meat.

Q. Could the preservation method influence the risk (e.g. salting, deep-freezing, or irradiation)?

A. Different preservation methods could result in the formation of carcinogens (e.g. *N*-nitroso compounds), but whether and how much this contributes to the cancer risk is unknown.

Q. How many studies were evaluated?

A. The IARC Working Group considered more than 800 different studies on cancer in humans (some studies provided data on both types of meat; in total more than 700 epidemiological studies provided data on red meat and more than 400 epidemiological studies provided data on processed meat).

Q. How many experts were involved in the evaluation?

A. The IARC Working Group consisted of 22 experts from 10 countries (List of Participants).

Q. What actions do you think governments should take based on your results?

A. IARC is a research organization that evaluates the evidence on the causes of cancer but does not make health recommendations as such. The IARC Monographs are, however, often used as a basis for making national and international policies, guidelines and recommendations to minimize cancer risks. Governments may decide to include this new information on the cancer hazards of processed meat in the context of other health risks and benefits in updating dietary recommendations.

Northwest Indian Fisheries Commission
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April 20, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments on the Washington Department of Ecology 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon:

Please find enclosed comments regarding the Department of Ecology's (Ecology) Draft Rule for Human Health Criteria (HHC) and Implementation Tools in Washington State's Water Quality Standards. The attached comments are submitted on behalf, and at the behest of the 20 member tribes of the Northwest Indian Fisheries Commission (NWIFC).[1] The member tribes of the NWIFC have constitutionally protected, treaty-reserved rights to harvest, consume, and manage fish and shellfish in their usual and accustomed areas. The attached comments are submitted to ensure protection of those reserved rights and the health of tribal members.

Tribes strongly agree with the US Environmental Protection Agency's formal determination that the "existing criteria are not protective of the designated uses," and therefore "new or revised WQS [water quality standards] for the protection of human health are necessary to meet the requirements of the CWA [Clean Water Act] for Washington."[2] The EPA published this determination as part of the proposed rule to amend the National Toxics Rule for water quality criteria applicable to Washington in September, 2015. Tribes support the EPA proposed rule as it protects designated uses of water, including public health and treaty-reserved rights, while the state proposal fails to meet this delegated responsibility. The state proposal adopts the

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[1] Hoh Tribe, Jamestown S'Klallam, Lower Elwha Klalam Tribe, Lummi Nation, Makah Tribe, Muckleshoot Indian Tribe, Nisqually Indian Tribe, Nooksack Indian Tribe, Port Gamble S'Klallam Tribe, Puyallup Tribe of Indians, Sauk-Suiattle Indian Tribe, Skokomish Indian Tribe, Squaxin Island Tribe, Stillaguamish Tribe of Indians, Suquamish Tribe, Swinomish Tribal Community, Tulalip Tribe, Upper Skagit Tribe, Quinault Nation, Quileute Nation.

[2] 80 F.R. 550066 (Sept. 14, 2015)

EPA proposal for a fish consumption rate of 175 grams per day and a cancer risk rate of one-per-million (10^{-6}), but the state continues to diminish these protections through other provisions of the proposed rule.

The attached comments[3] and all materials referenced demonstrate that the state of Washington's proposed rule fails to protect designated uses of water in several important ways. We call your attention to three of the major deficiencies. First, the state has selectively adopted the revised national 304(a) criteria, excluding relative source contribution and bioaccumulation criteria. The state fails to account for all sources of pollution, and does not use updated scientific information to analyze how pollutants accumulate in the food chain. Second, the state sets aside several highly toxic chemicals for special treatment to exempt them from tighter standards, leaving these chemicals at status quo, or even allowing discharge levels to increase. These exemptions are clearly directed toward alleviating the impact of tighter chemical criteria on specific industries, yet the Clean Water Act mandates that public health must be the overriding consideration in the establishment of standards. Third, variances, compliance schedules, and other implementation provisions will allow permittees to violate water quality standards for potentially long and unspecified amounts of time.

The Clean Water Act also creates a legal duty upon EPA to act promptly to develop water quality standards after a determination of necessity is made. The Department of Ecology has asserted that the EPA's proposed rule imposes on the state's ongoing process to establish water quality standards.[4] Given that the state is already under federal rule, and has delayed adoption of state standards for years, Ecology's assertion that the EPA is imposing on the state is inappropriate. The state has knowingly delayed revising an under-protective fish consumption rate for Washington for many years, has delayed adoption of new standards at the requests of regulated industry, and has repeatedly failed to meet its own deadlines for rule-making. Immediate action by EPA is clearly justified and legally mandated regardless of state action on a draft rule for water quality standards.

Tribes concur that water quality discharge standards are only a part of the toxic chemical problem in the state of Washington, and that more efforts toward source control and toxic cleanup are needed. However, the standards are an essential anchor for determining where and how to deploy toxic reduction efforts, and monitor improvement.

Tribes look forward to working with you on an overall effort to reduce existing and future pollution in Washington. Setting protective water quality standards will be an essential step in that process, and it is our hope that the enclosed comments will help the Department of

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[3] All materials cited in the attached comments are hereby incorporated into the rulemaking docket by reference. All materials can be provided to the Department of Ecology by request, and/or will be made available via hand delivered digital file submitted to Ecology on March 23rd, 2015.

[4] Letter from Maia Bellon, Director of the Department of Ecology, to EPA Administrator Gina McCarthy. December 21, 2015

Ecology to improve on the proposed rule, protect tribes and their treaty-reserved rights, and ensure protection of the designated uses of water.

Sincerely,

Lorraine Loomis,
Chairperson

cc: NWIFC Commissioners
Columbia River Intertribal Fish Commission
Gina McCarthy, EPA Headquarters, Administrator
Dennis McLerran, EPA Region 10, Administrator
Daniel Opalski, EPA Region 10, Director of the Office of Water and Watersheds

Comments on the State's Proposed 2016 Rule for Human Health Criteria and Implementation Tools in WA State Water Quality Standards

TO: **Washington Department of Ecology, Water Quality Program**

ATTN: swqs@ecy.wa.gov
Becca Conklin
Washington State Department of Ecology
Water Quality Program
P.O. Box 47600, Olympia, WA 98504-7600

RE: Proposed Amendments to Water Quality Standards for Surface Waters of the State of Washington – Chapter 173-201A WAC

SUBM: April 20, 2016

Northwest Indian Fisheries Commission

6730 Martin Way E. Olympia, WA 98516-5540

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I. INTRODUCTION AND GENERAL COMMENTS

The attached comments to the State's Draft 2016 Rule for Human Health Criteria and Implementation Tools in WA State Water Quality Standards were prepared on behalf and at the behest of the 20 member treaty tribes of the Northwest Indian Fisheries Commission, with contributions from other tribes in Washington and Oregon. The submission of this set of comments was approved at the March 22, 2016 meeting of the Northwest Indian Fisheries Commission. All materials cited in this document are hereby incorporated in the rulemaking document by reference. These materials can be made available upon request. Additionally, a digital file will be hand delivered to the Department of Ecology prior to the closure of the public comment period, which includes references cited and additional materials that support the statements and positions herein. These additional materials are provided for Ecology's further consideration in the course of rulemaking decisions. A copy of this file will be stored at the Northwest Indian Fisheries Commission and can be made available for duplication should the original become unavailable. These comments do not supercede the input or recommendations submitted by our individual member tribes to the rule docket.

The enclosed comments pertain to the Washington Department of Ecology's proposed rule for state water quality standards filed in February, 2016 and associated supporting documents. The comments and all materials referenced and/or attached constitute a record demonstrating that the state of Washington's proposed rule fails to protect beneficial uses of water under the Clean Water Act, a responsibility delegated to the state from the US Environmental Protection Agency (EPA). Moreover, the state's proposal fails to respect the state's obligation to honor the treaty rights of Pacific Northwest tribes.

A. Relationship to Federal Rule Promulgation

The EPA issued a Proposed Rule for "Revision of Certain Water Quality Criteria Applicable to the State of Washington," Docket ID No. EPA-HQ-OW-2015-0174 on September 14, 2015. [1] Tribes continue to advocate for the promulgation of the proposed federal rule without delay. Federal action was taken because of the unnecessary delay by the state of Washington and EPA's

[1] 80 F.R. 550066 (Sept. 14, 2015). Unless otherwise noted, the terms "EPA proposed rule" or "proposed federal rule" refers to this citation.

determination, published as part of the proposed federal rule, that existing human health criteria applicable to Washington are not protective of designated uses of waters in the state of Washington.

NWIFC and member tribes commented extensively on the proposed federal rule in December, 2015.[2] EPA has appropriately included the safe harvest of treaty-reserved resources as designated uses in the regulation of water quality. Contamination of fisheries resources precludes tribal citizens from the exercise of treaty-reserved rights to harvest and consume fish, and creates disproportionate loss to tribal communities that are excluded from the nutritional, cultural, and economic uses of these resources. Tribes concur with EPA's approach for deriving regional fish consumption rates using data from tribal studies in the Pacific Northwest, while noting that contemporary fish consumption has been suppressed by loss of resource, pollution, and other factors. Tribes further note that studies of contemporary fish consumption are not representative of heritage levels of fish consumption reserved by treaty, as was acknowledged by EPA.

Along with the use of a regional fish consumption rate derived from tribal studies, tribes support the EPA's decision to update human health criteria for Washington using revised national recommended 304(a) criteria, adopted in 2015.[3] These recommendations reflect current best available science and rigorously vetted technical information. In contrast, Washington State has chosen to adopt only some of the revised national criteria, generally to the detriment of the protectiveness of the water quality standards. As a result, the proposed EPA rule is more protective of the designated uses, while Washington's rule falls short of adequately reflecting likely exposure and toxicity of the chemical parameters, and therefore sets standards that are under-protective.

[2] Northwest Indian Fisheries Commission; December 21, 2015. Comments on the Proposed Federal Rule, Docket ID No. EPA-HQ-OW-2015-0174, Revision of Certain Water Quality Criteria Applicable to Washington. NWIFC comments on the proposed federal rule and associated references are hereby attached and incorporated into the current subject comments on the Washington Department of Ecology 2016 proposed rule for human health criteria and implementation tools.

[3] U.S. Environmental Protection Agency, Final Updated Ambient Water Quality Criteria for the Protection of Human Health. FR Doc. 2015-15912 (June 29, 2015), EPA-HQ-OW-2014-0135-0155

B. Undue Delay by the State of Washington in Protecting Designated Uses

Tribes and tribal consortiums have provided information to the state for over 20 years documenting that the fish consumption rate (FCR) used in state standards is grossly under-representative of consumption rates in tribal communities. Tribes raised the issue repeatedly in Triennial Reviews of state water quality standards over the last decade, and the state acknowledged and committed to addressing the deficiency in the 2010 review. Since 2011, the state has repeatedly delayed or changed course in the development of a FCR in state standards, largely at the behest of industry. The Department of Ecology has pivoted the rule-making process back and forth between the Water Quality Program and the Toxics Cleanup Program. Following the abandonment of a numerical FCR in draft Sediment Management Standards in July 2012, the state breached their commitment to develop the FCR and other human health criteria in water quality standards numerous times. Ecology published an inadequate rule in January, 2015 and subsequently withdrew the proposal in August. The state's failure to discharge their delegated duties under the Clean Water Act has made it necessary for the EPA to promulgate revised criteria under the National Toxics Rule (NTR) for Washington (proposed federal rule).

The enclosed Appendix A details the long history of undue delay by the state of Washington in adopting revised human health criteria. These delays have subjected tribal communities to continued harm from exposure to toxic chemicals.

C. Environmental Justice and Tribal Exposure to Toxic Chemicals

The National Environmental Justice Advisory Council issued a report in 2002 on Fish Consumption and Environmental Justice describing the issues related to national pollutant standards and fish consumption by tribes, low-income groups, and people of color. Key findings in the report were: testimonials that tribal identity and fish consumption are culturally inseparable for many tribal communities; evidence that tribes face multiple health risks from both economic disadvantage and the loss or contamination of fisheries resources; and "where human health criteria are established based upon consumption of toxic chemicals that bioaccumulate in fish, regulators should employ appropriate human fish consumption rates and bioaccumulation factors, including cultural practices (*e.g.*, species, fish parts used, and manner of cooking and preparation) of tribes and other indigenous and environmental justice communities using the waterbody.” [4]

The elevated health risk to tribal members from exposure to pollutants is considered to be an unacceptable impairment of treaty reserved rights by tribes. The state of Washington must utilize exposure parameters in the calculation of human health criteria that fully protect tribal members’ health, continued cultural, spiritual, and economic practices, and the treaty-reserved rights to exercise them safely.

D. Treaty-Reserved Rights and Washington’s Designated Uses

When the United States entered into treaties with the tribes, [5] it bound itself to permanently protect the tribes' right to take fish.[6] At treaty times, "fish was the great staple of [Indians'] diet and livelihood,"[7] and fishing rights "were not much less necessary to the existence of the Indians than the atmosphere they breathed."[8] Thus, "the Indians viewed a guarantee of permanent fishing rights as an absolute predicate to entering into a treaty,"[9] and in providing those guarantees "[i]t never could have been the intention of Congress that Indians should be excluded from their ancient fisheries . . .. "[10]

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[4] National Environmental Justice Advisory Council, 2002. Fish Consumption and Environmental Justice: A Report Developed from the National Environmental Justice Advisory Committee Meeting of December 3-6, 2001

[5] *See, e.g,* Treaty of Medicine Creek, 10 Stat. 1132-37, December 26, 1854, proclaimed April 10, 1855; Treaty of Point Elliott, 12 Stat. 927-32, January 22, 1855; proclaimed April 11, 1859; Treaty of Point No Point, 12 Stat. 933-37, January 26, 1855, proclaimed April 29, 1859; Treaty of Makah, 12 Stat. 939-43, January 31, 1855, proclaimed April 18, 1859; Treaty of Yakama, 12 Stat. 951-56; June 9, 1855; proclaimed April 18, 1859; Treaty of Olympia, 12 Stat. 971-74, July 1, 1855 and January 25, 1856; proclaimed April 11, 1859.

[6] *See,e.g.,* Treaty of Point Elliott, 12 Stat. 927, Art. 5 ("The right of taking fish at usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the Territory .... "); *see also* Treaty of Point No Point, 12 Stat. 933, Art. 4; Treaty of Medicine Creek, 10 Stat 1132, Art. 3.

[7] *Washington v Washington State Commercial Passenger Fishing Vessel Ass’n*, 443 U.S. 658 at 665 n.6 (citations and internal quotation marks omitted).

[8] *United States* v. *Winans,* 198 U.S. 371, 381 (1905); *United States* v. *Michigan ("Michigan f'),* 471 F. Supp. 192,213,224,256-57 (W.D. Mich. 1979), *aff'd as modified,* 653 F.2d 277 (6th Cir. 1981).

[9] *United States* v. *Washington, 873 F.Supp. 1422* at 1437 (W.D. Wash. 1994).

[10] *Fishing Vessel,* 443 U.S. at 666-67 n.9, 700 (citation and internal quotation marks omitted).

While the precise language of the fishing rights provisions varies among treaties, federal courts have interpreted those provisions commensurately, as securing to the tribes permanent, enforceable rights to take fish throughout their fishing areas for subsistence, ceremonial, and commercial purposes.[11]

These rights have been recognized because they are essential to fulfill the treaties' purpose to "protect that source of food and commerce [which] were crucial in obtaining the Indians' assent."[12] It was the United States' intent, "and the Tribes' understanding, that they would be able to meet their own subsistence needs forever."[13] "I want that you shall not have simply food and drink now but that you may have them forever."[14] "It was thus the right to take fish, not just the right to fish, that was secured by the treaties."[15]

In the context of the Clean Water Act, this translates into obligations to ensure that water quality standards are set to levels that allow the continued safe harvest as promised in the treaties, and that such standards are implemented in a manner that will not render treaty rights inconsequential. Therefore, in deriving human health criteria, perpetuation of the safe take of treaty-reserved fish and shellfish is part and parcel with protecting the designated and the beneficial uses of fishable, drinkable waters, and the protection of human health. This approach harmonizes the CWA with EPA's fiduciary obligations, thus allowing both water quality standards and CWA implementation to support treaty right protection and not undermine it.

Treaty-reserved rights must be considered in the derivation of human health criteria and implementation tools in Washington State. The state retains a delegated responsibility under the Federal Clean Water Act to protect designated uses, which coincide with treaty-reserved rights, and includes downstream uses in Tribal waters and in the state of Oregon.

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11 *See, e.g., Fishing Vessel,* 443 U.S. at 678-79; *see also Muckleshoot* v. *Hall,* 698 F. Supp 1504, 1513-14 (W.D. Wash. 1988); *United States* v. *Oregon,* 718 F.2d 299,305 (9th Cir. 1983) (holding that "the court must accord primacy to the geographical aspect of the treaty rights"); *Confederated Tribes of the Umatilla Indian Reservation* v. *Alexander,* 440 F. Supp. 553, 555-56 (D. Or. 1977) (declaring proposed - construction of a federal dam to be unlawful where the dam would have inundated traditional fishing areas of the Umatilla Tribe. Such areas may even include usual and accustomed sites outside of ceded territories. *See Seufert Bros. Co.* v. United States, 249 U.S. 194, 198-99 (1919).

12 *United States v. Washington*, 20 F. Supp. 3d. 828, 889 citing State of Washington, et al., v. Washington State Commercial Passenger Fishing Vessel Association, et al., 443 U.S. 658 (1979) (emphasis added by Judge Martinez)

13 *United States v. Washington*, 20 F.Supp.3d,889 Subproceedings No 01-1 (Culverts)(W.D. Wash 2007).

14 20 F. Supp.3d 889, 898 citing Decl. of Richard White, DKT. #296, ¶¶13, 14,which quotes Governor Stevens (emphasis added by Judge Martinez).

15 Id at 898

E. Fish Consumption and Tribal Lifeways

Fish consumption is a cultural, nutritional, and economic necessity, as well as a treaty right for the tribes of the Pacific Northwest. Toxic contamination of fisheries resources works in contravention of the right of tribal people to harvest fish that they may safely consume, a right that has been nationally and internationally recognized.

1. The contamination of fisheries resources harms tribal communities.

Tribal members live compounded risk scenarios since they face lifetime exposure to pollutants through the ingestion of drinking water and consumption of local fish and shellfish. These fisheries resources are harvested from usual and accustomed fishing areas in Washington's inland and nearshore waters as part of tribal cultural, spiritual, and economic lifeways. Many tribal members consume fish/shellfish daily, often at multiple meals, throughout their lives—beginning with *in utero* exposure from the mother all the way through their elder years.[16] Tribes also exercise traditional practices for processing and consuming fish that are not typically included in exposure risk studies; such studies thereby under-represent potential exposure.[17]

For additional discussion on the harm to tribal communities, please refer to the comments submitted previously to the state of Washington on the 2015 proposed rule and the EPA on the federal rule promulgated in September. [18],[19]

a. **Tribal lifeways of the Pacific Northwest are culturally synonymous with fish consumption. When fisheries are limited or closed due to toxic contamination[20], tribes lose access to a resource that is their lifeway and livelihood.** Tribes have documented the preference of many tribal members to consume contaminated fish and shellfish, rather than lose the opportunity to consume their traditional food. The toxic contamination of fisheries puts tribal treaty rights at risk. Numerous

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[16] O'Neill, Catherine, 2007. Protecting the Tribal Harvest: The Right to Catch and Consume Fish, 22 *J. ENVTL. L. & LITIG.* 131 (2007). http://digitalcommons.law.seattleu.edu/faculty/542
[17] NEJAC 2002. Id.
[18] Northwest Indian Fisheries Commission; March 23, 2015. Comments on the State's Draft Rule for Human Health Criteria and Implementation Tools in Water Quality Standards.
[19] Northwest Indian Fisheries Commission; December 21, 2015. Comments on the Proposed Federal Rule, Docket ID No. EPA-HQ-OW-2015-0174, Revision of Certain Water Quality Criteria Applicable to Washington.
[20] WA Department of Health. 2015. Fish Consumption Advisories. http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories

articles describe the reliance of tribes on fishing and fish consumption for tribal lifeways, and the potential harm from exposure to toxic chemicals via the fish consumption pathway. [21] [22] [23] [24] [25]

b. **Tribal communities and people are highly reliant on the nutritional benefits of abundant and healthful fisheries resources.** The University of Washington School of Public Health has analyzed many of the relative health benefits and risks of eating fish.[26] Although the nutritional benefits are high, health risks are more pronounced for children, infants, developing embryos, and women of child bearing age, particularly in high fish-consuming communities.[27] [28] [29] In at least one tribal dietary study in Puget Sound, tribal children have been shown to consume fish at over three times the rate of adults, relative to body weight.[30] Many of these studies were

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[21] Harris, S.G. and B.L. Harper, 1997. A Native American Exposure Scenario. Risk Analysis 17:6, 789-795. December, 1997.

[22] Donatuto, J. and B.L. Harper, 2008. Issues in Evaluating Fish Consumption Rates in Native American Tribes. Risk Analysis 28:6, 1497-1506. December, 2008.

[23] O'Neill, C.A. 2000. Variable Justice: Environmental Standards, Contaminated Fish, and "Acceptable" Risk to Native Peoples, Stan. Envtl, L.J. 3,37,46-51 (2000)

[24] O'Neill, C.A. 2007. Protecting the Tribal Harvest: the Right to Catch and Consume Fish. J Environmental Law Litigation 22:131-151 (2007)

[25] O'Neill, C.A. 2013. Fishable Waters. American Indian Law Journal Vol 1, Issue 2

[26] Faustman, E.M. 2011. What's the Public Health Issue and Why Is It Important? Presentation at the Washington Department of Ecology Technical Workshop on Fish Consumption in Washingon, December 12, 2011. http://www.ecy.wa.gov/toxics/docs/20111212_fishworkshop_faustman.pdf

[27] Hoover, 2013. Cultural and health implications of fish consumption advisories in a Native American community. Ecological Processes 2013, 2:4

[28] Tsuchiya, Hardy, Burbacher, Faustman and Marien, 2008. Fish intake guidelines: incorporating n-3 fatty acid intake and contaminant exposure in the Korean and Japanese communities. Am Jrnl Clinical Nutrition 2008;87: 1867-75. American Society for Nutrition

[29] US Environmental Protection Agency, 2008. Child-Specific Exposure Factors Handbook; Chapter 10, Intake of Fish and Shellfish. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=199243

[30] U.S. Environmental Protection Agency (EPA). (2013) Reanalysis of fish and shellfish consumption data for the Tulalip and Squaxin Island Tribes of the Puget Sound Region: Consumption Rates for Consumers Only. National Center for Environmental Assessment, Washington, DC; EPA/600/R-06/080F

described in the Department of Ecology's technical workshop on fish consumption, held at the University of WA campus in December, 2011. [31]

c. **The loss of consumable fisheries resources due to toxic contamination affects tribes economically**. The seafood industry in Washington is a major economic sector in the state of Washington.[32] [33] Toxic contamination of fisheries resources generates economic losses to tribes in several ways: First, tribes may be precluded from harvesting fish for their personal use, necessitating a cost to purchase fish or other food as substitution for what they could have caught. Second, tribes may not be able to sell fish that they have lawfully harvested in accord with treaty rights and fishing management plans because of closed areas, contaminated product, or even the perceived potential for contaminated product by consumers. Fishing closures and the inability to market product precludes tribes from their livelihood. Third, tribal fishers experience secondary economic impacts from being forced to travel to alternative sites in order to exercise fishing rights. A fourth economic impact come from the potential costs of health impacts from prolonged exposure to toxic chemicals.

The loss of revenue from product contaminated with toxic chemicals was illustrated in late 2013 when China banned all imports of shellfish from the West Coast due to arsenic contamination.[34]

> *"China has suspended imports of shellfish from the West Coast of the United States – an unprecedented move that cuts off a $270 million Northwest industry from its biggest export market. China said it decided to impose the ban after recent shipments of geoduck clams from Northwest waters were found by its own government inspectors to have high levels of arsenic… (Campbell/KCTS9, 2013)*[35]

[31] Washington Department of Ecology, December 2011. Technical Workshop on Fish Consumption in Washington, Summary. http://www.ecy.wa.gov/toxics/docs/20111212_fishworkshop_summary.pdf http://www.ecy.wa.gov/toxics/fish_publicinvolvement.html

[32] WA Department of Fish and Wildlife, 2010. Fish, Wildlife, and Washington's Economy. Olympia, WA. http://wdfw.wa.gov/publications/01145/wdfw_01145.pdf

[33] National Marine Fisheries Service, NOAA Office of Science and Technology. 2011. Fisheries Economics of the United States 2011, Pacific Region Summary. http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2011/FEUS2011%20-%20Pacific.pdf

[34] Garnick, Coral. December 20, 2013. State closes geoduck harvest after China ban. Seattle Times. http://seattletimes.com/html/businesstechnology/2022497142_geoduckarsenicxml.html

[35] Campbell, Katie. December 12, 2013. China imposes first-ever West Coast shellfish ban. KCTS9

d. **Fish consumption has been regionally, nationally, and internationally recognized as part of the basic right for indigenous people to be secure in their means of sustenance.** [**36,** 37,38] The cultural value of fish consumption in Asian and Pacific Islander communities has also been recognized in the Pacific Northwest region. Tribes of the Pacific Northwest have been united in their support of water quality standards that will protect the health of tribal people in the exercise of fishing rights.[39]

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[36] FAO, 2014. Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines): http://www.fao.org/3/a-i4356e.pdf

[37]Puget Sound Partnership; August 9, 2012. Resolution 2012-04 Fish Consumption Rates

[38] Seattle Human Rights Commission. March 12, 2014. Resolution 14-01: Calling on Washington State Department of Ecology to Raise the Statewide Fish Consumption Rate

[39] Affiliated Tribes of Northwest Indians (ATNI). Resolutions 12-19, 12-54, 13-44, 14-56 related to FCR and cancer risk levels in water quality rules.

II. HUMAN HEALTH CRITERIA (HHC)

Introduction

Washington Department of Ecology issued a draft rule in 2015 with proposed Human Health Criteria, including a fish consumption rate of 175 g/day and a cancer risk level of one-per-100,000. NWIFC and member tribes commented extensively on the state's proposed HHC and implementation tools.[40] Many of NWIFC's previous comments to the state's 2015 proposal are still relevant, and are hereby incorporated into these comments on the Washington Department of Ecology 2016 proposed rule.

A major change since the state's 2015 proposed rule is that the state has retained the existing cancer risk level in applicable state law at one-per-million, a decision which is supported by NWIFC. In the year since the state issued the 2015 proposal, the EPA has adopted revised national criteria for water quality standards[41], and has issued a draft rule to amend the NTR for water quality criteria applicable to Washington specifically.[42] Both EPA and the state have now proposed a fish consumption rate of 175 g/day and a cancer risk rate of 1 per million (10^{-6}) in Washington. However, Washington State's 2016 proposal selectively adopts federal guidance from EPA's revised 2015 national criteria. The state proposal appears to adopt national recommendations for input values that result in less protection (i.e. body weight), but retains other factors at older values (relative source contribution and bio-concentration) that do not reflect best available science or updated national standards.

A comparison of the chemical criteria under the proposed federal and state rules for Washington indicates that the EPA version is more protective for approximately 80% of the regulated chemicals. Appendix B contains a spreadsheet comparing the proposed state rule, federal rule, and Oregon's water quality standards.[43] The tally, also in Appendix B, shows that the EPA rule is more protective of designated uses for a greater number of chemicals, and to a

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[40] Northwest Indian Fisheries Commission; March 23, 2015. Comments on the State's Draft Rule for Human Health Criteria and Implementation Tools in Water Quality Standards.

[41] U.S. Environmental Protection Agency, Final Updated Ambient Water Quality Criteria for the Protection of Human Health. FR Doc. 2015-15912 (June 29, 2015), EPA-HQ-OW-2014-0135-0155

[42] 80 Fed.Reg. 550066 (Sept. 14, 2015).

[43] Ridolfi Environmental, March 1, 2016. Spreadsheet of chemical comparisons: NTR, EPA 2015 WA, WA 2016 Proposed, OR Approved. See Appendix B for document. Also see Excel version in electronic attachments.

greater extent. Tribes remain concerned about the special treatment given to several challenging chemicals, including PCBs, arsenic, methylmercury, and 2,3,7,8-TCDD (dioxin) which would be vastly less protective in the state version of the rule. These differences have the potential for adding to the legacy of toxic chemicals in Washington waters, and increasing the risk to tribes and highly exposed populations.

A. Fish Consumption Rates

Overview and Definitions

The state of Washington currently utilizes a fish consumption rate of 6.5 g/day in their water quality standards – a rate established in 1992 by the US EPA in the National Toxics Rule. The existing rate is grossly under-representative of fish consumption in Washington, especially for tribal communities, thereby exposing tribal people to ongoing harm. The Washington Department of Ecology characterizes the selection of a FCR as a "risk management decision" at the discretion of the state.[44] Tribes do not willingly incur the risk to the health, cultural, and economic well-being of their citizens which results from the chemical contamination of freshwater and marine waters of Washington.

The proposed fish consumption rate of 175 g/day is lower than documented contemporary or heritage rates in regional tribal communities, and does not account for the suppression of fish consumption resulting from the availability of fish and shellfish, habitat degradation, biological and chemical contamination, or access to fishing grounds. The exercise of treaty-reserved fishing rights and the subsequent safe consumption of those resources must also be protected concomitantly with the designated uses of water in Washington State. The proposed rate of 175 g/day does not reflect the heritage rates that are relevant to the establishment of a FCR for Washington.

Tribes concur with the Washington Department of Ecology and the EPA that tribes must be considered as a highly exposed population and that tribal consumption rates be used as the basis for establishing a FCR in Washington. However, tribes disagree with the state's contention that the proposed rate should be established based on "average" consumption values. The state has also mischaracterized 175 g/day as an "endorsed" value by tribes. Tribes have commented repeatedly that 175 g/day represents a minimum value that must be used in conjunction with other revised values used in the derivation of human health criteria that

[44] WA Department of Ecology; January, 2016. Washington State Water Quality Standards: Human health criteria and implementation tools – Overview of key decisions in rule amendment. Ecology Publication no. 16-10-006.

would more accurately reflect likely exposure and toxicity. The state has failed to follow EPA's 2015 recommendations for the calculation of relative source contribution and bioaccumulation, and has singled out several chemicals for special treatment—effectively exempting them from the application of human health criteria.

Tribes concur with the state's decision to include all fish, including salmon, in the fish consumption rate since data demonstrate elevated levels of toxic contaminants in fish that originate, reside in, or transit, state freshwater and marine water bodies within Washington's jurisdiction. Numerous studies by NOAA/National Marine Fisheries Service, Washington Department of Fish and Wildlife, Environment Canada, and the Puget Sound Ambient Monitoring Program have documented uptake of toxic chemicals in fish, shellfish, and marine mammal species in Puget Sound, the Columbia River, and other nearshore/marine areas of Washington. Tribes are highly reliant on local/regional fisheries resources for both personal consumption and commercial harvest.

Definition of terms:
As used herein, the following terms are applied:

> **Heritage Rates** "refer to the rates of fish intake consonant with traditional tribal practices, prior to contact with European settlers"[45] and assume rates that were "uncontaminated and available" and not subject to suppression.[46]
> **Contemporary** rates of tribal fish consumption, as used in this document, refers to fish consumption that has occurred in recent history, i.e. since the early 1990s when tribes began conducting dietary surveys to document modern consumption.
> **Traditional** refers to harvest and consumption practices, similar to ancestral use of fisheries resources, and is not a rate.
> **Subsistence** is used in two ways in this document: 1) as used by EPA and the Department of Ecology in reference to water quality criteria, and 2) as used in treaty tribal fisheries management. The intent must be inferred from context.

For further discussion of terms, please see the Appendix C on Fish Consumption Rates.
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[45] Donatuto, J., B. Harper and C. O'Neill; February 14, 2014. "Heritage, Subsistence, and Aspirational Fish Consumption Rates: Comments on Usage. Submitted to the Idaho Department of Environmental Quality.

[46] Catherine O'Neill, Professor of Law, Seattle University School of Law, Comments to IDEQ, *Risk, Human Health, and Water Quality Standards* (Jan. 20, 2015).

1. ***The state has correctly identified tribes as a "highly exposed population" in the establishment of a fish consumption rate for Washington.***

Tribes concur with Ecology's decision to base the FCR on "highly exposed populations" and that tribal fish consumption rates be used as the basis for a rate in the human health criteria used to set state water quality standards. Tribes note that Ecology must consider other highly exposed populations on the basis of environmental justice. As discussed previously, tribes must also be considered for the establishment of the HHC due to treaty-reserved fishing rights, a designated use under the Federal Clean Water Act.

2. ***The proposed fish consumption rate of 175 g/day is lower than the rates of contemporary tribal fish consumption, unsuppressed fish consumption rates, or heritage rates.***

The proposed fish consumption rate of 175 grams per day in the Washington Department of Ecology's proposed human health criteria is a step forward from the existing FCR of 6.5 g/day currently in effect in water quality standards applicable to Washington. However, 175 g/day is lower than contemporary consumption rates for tribal consumers, does not account for the suppression of fish consumption through habitat loss and lack of access to fisheries, and falls far short of heritage fish consumption values.

The following discussion is a summary of tribal fish consumption studies in the Pacific Northwest, the publication of technical documents related to fish consumption rates by the Washington Department of Ecology, and associated comments from the Washington Department of Health. Also see Appendix C for additional description of Pacific Northwest tribal fish consumption studies.

a. **Tribal Fish Consumption Studies**
Comprehensive tribal fish consumption studies have been regionally available to the public since 1994. A summary of tribal fish consumption rates is listed in the following table.

Table of fish consumption rate surveys from Tribal and selected FCR studies: [47]

Tribal Survey and year published	Type of Fish	Mean	Median	75th percentile	90th percentile	95th percentile	99th percentile
Columbia River Tribes 1994	Finfish (A, F)	63	40	60	113	176	389
Tulalip Tribe 1996	Finfish (A, E) Shellfish	72	45	85	186	244	312
Squaxin Island Tribe 1996 (upper value) and EPA 2013 reanalysis (lower value)	Finfish (A, E) Shellfish	73	43	-	193	247	-
		95			283	318	
Suquamish Tribe 2000	All seafood	214	132	284	489	797	
Lummi Nation 2013	Finfish (A, E) Shellfish	383	314	-	800	918	-
Nez Perce Tribe (Polissar, et al. 2015)		123.4	70.5	-	270.1	437.4	
Asian/Pacific Islanders 1999	Finfish (A, E) Shellfish	117	78	139	236	306	-

[47] Values in this table may differ slightly from Table 3 in the WAC 173-201A (2016) Decision document. Ecology uses fish consumption data from Polissar et al., 2012, a study commissioned by Ecology following the release of the first Technical Support Document on Fish Consumption Rates in 2011. The Polissar study analyzed fish consumption data for consumers only, and data are therefore slightly higher than the results expressed in the tribal studies for CRITFC, Tulalip, Squaxin Island, and Suquamish. Polissar et al. released a final version of the study in 2014, attached as an electronic file. Polissar et al. also prepared an analysis of the Nez Perce Tribe FCR in 2015. See Appendix C for details and references.

b. In 2011-2012, the Washington Department of Ecology published a Technical Support Document that recommended a proposed range for a default FCR of 157 to 267 g/day. Tribes and others commented that this range is low.

The Washington Department of Ecology Toxics Cleanup Program prepared a comprehensive review of fish consumption studies, which was initially issued in September, 2011 as a Technical Support Document.[48] Ecology had indicated to tribes and EPA in 2010 that they intended to complete an analysis of fish consumption rates in the context of setting Sediment Management Standards—information which would subsequently be transferrable to the development of Water Quality Standards. Ecology personnel from the Toxics Cleanup Program undertook the analysis of regional fish consumption data and published the Technical Support Document in September 2011, which included the following preliminary recommendation:

> *"Ecology has concluded that available scientific studies support the use of a default fish consumption rate in the range of 157 to 267 grams per day (g/day). The preliminary recommendation of this report is that default fish consumption rates should be within this range for state regulatory purposes."*

As described in Appendix C, numerous tribes submitted comments on the Ecology Technical Support Document indicating that the proposed range did not represent unsuppressed or heritage fish consumption rates. Some tribes also expressed concern that the upper bound of the recommended range was established at the 95th percentile (instead of a higher percentile). Tribal comments also indicated that a regulatory default fish consumption rate should be at least 175 g/day, that contemporary rates of 400 grams per day or more have been observed in multiple tribal studies, and that heritage rates of 1,000 g/day or more have been identified in studies of historical consumption.

As described in Appendix A covering the history of delay by the state, the Washington Department of Ecology withdrew the Technical Support Document in

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[48] Washington Department of Ecology, Toxics Cleanup Program. September 2011. Fish Consumption Rates Technical Support Document. Publication no. 11-09-050. (Version 1.)

July, 2012, and substituted a second version without the recommended range.[49] Investigative reports cited industry intervention into the process at the time. (See Appendix A for references.) No default fish consumption rate was adopted for state sediment management standards, and the state has distanced itself from the initial Technical Support Document without justification.

Tribes also note that the Washington Department of Health has stated multiple times that a proposed fish consumption rate of 175 g/day is low.

> *I am concerned that the consumption rates cited as recommendations in the previous draft were removed from the current document. DOH believes that there are ample well conducted, scientifically defensible studies available as described in the TSD to establish a range of consumption rates. DOH has previously commented to Ecology that a fish consumption rate should, at a minimum, be on par with Oregon's adopted value of 175 grams per day. DOH also recommended that a range of rates be considered, with the low end of 175 grams per day, along with higher rates associated with many Puget Sound Tribes as well as ethnic populations as detailed in the document. DOH would also suggest that Ecology determine whether the fish consumption rate of 500 pounds per capita per year (which equates to 620 grams per day) as cited in the 1974 Boldt decision on treaty rights is a legally enforceable rate.*[50]

c. A Fish Consumption Rate of 175 g/day represents a suppressed rate

Researchers have written at length about the many factors that have led to suppressed fish consumption in tribal communities. O'Neill, for example lists suppression factors including: habitat degradation and loss of resource productivity and abundance; bacterial and chemical contamination of fishing grounds; bacterial and chemical contamination of fish; the perception among tribal members that fish may not be safe to eat; blocked access to fishing grounds from roads, dams, structures, fencing of private property, and harassment; and intercepting fisheries from commercial fishermen in Washington, Alaska, and Canada. Suppression among tribal consumers has resulted directly from potential exposure to toxic chemicals in

[49] Washington Department of Ecology; January 2013. Fish Consumption Rates: Technical Support Document—A Review of Data and Information About Fish Consumption in Washington, Version 2.0, Final. Publication no. 12-09-058. Washington Department of Ecology Toxics Cleanup Program. Olympia, WA.

[50] McBride, D. Washington Department of Health comments to M. Hankins, Washington Department of Ecology via email, quoted in internal memo summary August 17, 2012.

closures and health notifications, or indirectly because their consumption rates have been under-estimated due to the lack of access or reduced availability of the resource.[51]

Ecology indicated in the 2011 Technical Support Document that the recommended range of 157-267 grams per day did not account for suppression of fisheries, and that researchers suggested a tribal fish consumption rate above 450 grams per day.

Recently, EPA recognized the significance of contamination in suppressing tribal fisheries. In their 2013 guidance on fish consumption rates EPA provided that:

> *It is also important to avoid any suppression effect that may occur when a fish consumption rate for a given subpopulation reflects an artificially diminished level of consumption from an appropriate baseline level of consumption for that subpopulation because of a perception that fish are contaminated with pollutants.* [52]

Also, EPA provided similar guidance within the specific context of considering the development of HHC protective of Washington's designated uses:

> *EPA also generally recommends, where sufficient data are available, selecting a FCR that reflects consumption that is not suppressed by fish availability or concerns about the safety of available fish. Deriving criteria using an unsuppressed FCR furthers the restoration goals of the CWA, and ensures protection of human health as pollutant levels decrease, fish habitats are restored, and fish availability increases. While EPA encourages doing so in general, where tribal treaty or other reserved fishing rights apply, selecting a FCR that reflects unsuppressed fish consumption could be necessary in order to satisfy such rights.*[53]

[51] O'Neill, C. 2013. Fishable waters. American Law Journal 1:2 (Spring 2013)

[52] USEPA. January 2013. *Human Health Ambient Water Quality Criteria and Fish Consumption Rates: Frequently Asked Questions.* *http://water.epa.gov/scitech/swguidance/standards/criteria/health/methodology/upload/hhfaqs.pdf.*

[53] 80 Fed Reg 55063, 55065 (Sept. 14 2015)

EPA has also disapproved state water quality standards, in part based upon their failure to utilize FCR data that reflected unsuppressed rates. In attachment A of EPA's decision to deny proposed water quality standards for the state of Maine, EPA provided the following:

> *"Second, the data used to determine the fish consumption rate for tribal sustenance consumers must reasonably represent tribal consumers taking fish from tribal waters and fishing practices unsuppressed by concerns about the safety of the fish available to them to consume."* [54]

3. The proposed fish consumption rate is not representative of a heritage rate or rates reflective of treaty-reserved fishing rights.

The EPA has stated that the protection of treaty-reserved fishing rights must be considered when establishing criteria for the protection of designated uses under the Clean Water Act, and "that such the criteria protecting such uses must be consistent with such right [sic]." [55] As the aforementioned comments explain, heritage rates are relevant to the establishment of an FCR and derivation of HHC applicable to Washington. Part III A of the proposed federal rule states that:

> *"In Washington, many tribes hold reserved rights to take fish for subsistence, ceremonial, religious, and commercial purposes, including treaty-reserved rights to fish at all usual and accustomed fishing grounds and stations in waters under state jurisdiction, which cover the majority of waters in the state. Such rights include not only a right to take those fish, but necessarily include an attendant right to not be exposed to unacceptable health risks by consuming those fish."*
>
> *"Many areas where reserved rights are exercised cannot be directly protected or regulated by the tribal governments and, therefore, the responsibility falls to the state and federal governments to ensure their protection. In order to effectuate and harmonize these reserved rights, including treaty rights, with the CWA, EPA determined that such rights appropriately must be considered when determining which criteria are*

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[54] U.S. Department of the Interior, Office of the Solicitor. January 30, 2015. Letter from Hilary C. Tomkins to Avi Garbow, General Counsel, U.S. Environmental Protection Agency. RE: Maine's WQS and Tribal Fishing Rights of Maine Tribes

[55] 80 Fed. Reg. 55067

necessary to adequately protect Washington's fish and shellfish harvesting designated use.[56]

Tribes concur with EPA's logic that it is appropriate under the CWA to set water quality standards that are also consistent with the goal of protecting treaty rights.

Footnote 18 in the proposed federal rule indicates that "historical or heritage FCRs could be of relevance to establishing unsuppressed FCRs for Washington tribes." The proposed state rule for an FCR of 175 g/day does not constitute a heritage rate of fish consumption among treaty tribes. Fish Consumption Rates over 500g/day have been documented in estimates of heritage rates and in contemporary dietary studies. [57, 58] Examples include:

Suquamish Tribe[59]	797g/day, 95th percentile, contemporary Maximum reported: 1,453 g/day (Suquamish Tribe, 2000) Note: In the Suquamish survey, high consumption rates were believed to reflect actual high consumption and were not treated as outliers. The statisticians found that the calculations of percentiles were virtually unaffected by the inclusion of the higher consumption rates.
Lummi Nation	918 g/day, 95th percentile, males, estimated 1985 rate (Lummi Nation, 2012) Note: the Lummi Nation study did not utilize the methods from contemporary dietary studies of fish consumption. In an effort to estimate suppressed fish consumption from the loss of fishing opportunity, the Lummi Nation study estimated 1985 consumption through recall surveys and other data.

[56] Id

[57] O'Neill, C.A. 2007. Protecting the Tribal Harvest: The Right to Catch and Consume Fish. J. Envtl. Law and Litigation. Vol. 22, 131

[58] National Environmental Justice Advisory Council, 1992. Fish Consumption and Environmental Justice: A report developed from the meeting of the National Environmental Justice Advisory Council meeting of December 3-6, 2001.

[59]Suquamish Tribe, 2000. Fish consumption survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation.

Umatilla (CTUIR)	540 g/day, mean Contemporary consumption traditional fishing families (Harris and Harper, 1997)[60]
"Boldt Rate"	620 g/day, mean, salmon consumption US v. Washington 1974
Spokane Tribe	865 g/day FCR Revised Surface Water Quality Standards of the Spokane Tribe of Indians, Submitted April 2010. Approved by EPA December 19, 2013 [61]
Columbia River	1,000 g/day, Pre-dam rate for Columbia River Plateau Tribes[62] [63]
Columbia River	620-725 g/day average heritage rate for Columbia River mainstem.[64]

4. *The Department of Ecology fails to acknowledge the need to address more than an "average" of the highly exposed population.*

a. Ecology appears to advocate a policy of adopting an average statistic in selecting a fish consumption rate for Washington.

Ecology's Decision Document states that they have made a risk management decision to base the FCR on highly exposed populations, and goes on to say "Ecology is continuing use of the average statistic [for the FCR]." (p 18) The FCR of 175 g/day

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[60] Harris, S.G. and B.L. Harper. 1997. A Native American exposure scenario. *Risk Analysis* 17(6):789-795

[61] U.S. Environmental Protection Agency, Region 10. Letter to Spokane Tribal Chairman Rudy Peone, December 19, 2013 and attached Technical Support Document.

[62] Walker, D.E. 1992. Productivity of tribal dipnet fishermen at Celilo Falls: Analysis of the Joe Pinkham fish buying records. *Northwest Anthropological Research Notes* 26:123-135.

[63] Walker, D.E. and L.W. Pritchard. 1999. Estimated radiation doses to Yakama Tribal fishermen. Walker Research Group, Boulder, CO

[64] Harper, B.L. and Walker, D.E. 2015. "Columbia Basin Heritage Fish Consumption Rates." Human Ecology (2015) 43: 237-245.

is less than the mean for the Suquamish Tribe, less than the 90th percentile of any of the Puget Sound Tribes cited by Ecology, and less than the 95th percentile in the 1994 Columbia River tribal study. Ecology has selected a value that Ecology contends is representative of an average rate. Tribes continue to assert that an appropriate fish consumption rate should encompass an upper percentile of the highly exposed population.

b. Tribes agree with EPA's approach to the selection of a FCR that reflects an upper percentile of fish consumption data for tribes, and disagree with Ecology's assertion that an "average" value is appropriate.

The proposed federal rule[65] cites EPA's 2000 recommendation to use an upper percentile of fish consumption data for the target general population, and notes that EPA's current national FCR of 22 g/day represents the 90th percentile national FCR. Public health standards are not typically set on an average or median value when considering risk to a population.[66] Regulatory standards must be based on the goal of protecting the highest possible portion of the population, not just the average (mean) or only half of the population (median). EPA identifies "the tribal population exercising their reserved fishing rights in Washington as the target general population," and indicates that the selected value of 175 g/day for Washington represents the 95th percentile consumption rate from the CRITFC study. [67]

Ecology similarly identifies tribes as a "highly exposed population," but states that that 175 g/day is "representative of the average value/values of these surveys" (referring to Tulalip, Squaxin Island, and Suquamish).[68] Although both EPA and Ecology selected 175 g/day, Ecology's assertion that it is appropriate to use an average value (as opposed to an upper percentile) is wrong.

Additionally, Ecology's assertion that 175 g/day is representative of an average value of fish consumption reinforces the tribes' contention that 175 g/day is low. Using

[65] 80 F.R. 550066 (Sept. 14, 2015).

[66] See comments in (c) below for examples of regulatory standards utilizing upper percentiles as opposed mean or median values.

[67] 80 F.R. 550066 (Sept. 14, 2015).

[68] WA Department of Ecology; January, 2016. Washington State Water Quality Standards: Human health criteria and implementation tools – Overview of key decisions in rule amendment. Ecology Publication no. 16-10-006.

Ecology's table on page 19 of the Key Decisions document, Tribes note that the average of the 90th percentile values for the same three tribal studies (Tulalip, Squaxin Island, and Suquamish) is 296 g/day, and for the 95th percentile the FCR would be 448 g/day.[69]

c. **Regulatory standards commonly utilize upper percentiles of data when estimating exposure, and setting subsequent standards or thresholds for toxicity.** Some examples include:

- In the development of standards for toxic cleanup in Washington, the Department of Ecology indicated that the selection of a value for Reasonable Maximum Exposure under the Model Toxics Cleanup Act is typically set at 90 to 95 percent of the exposure distribution. (Ecology Technical Support Document 2011)
- During preparation of the revised Oregon water quality standards, the Oregon Department of Environmental Quality indicated that fish consumption rates in the 90th to 95th percentile are considered appropriate. Oregon tribes advocated for a value approximating the 99th percentile. After extensive discussion with regional tribes, Oregon adopted a compromised rate at the 95th percentile of the fish consumption values identified in the Columbia River Inter-tribal Fish Commission study (1994).
- The EPA Exposure Factors Handbook recommends a level of reasonable maximum exposure for a population at risk at the 90th to 98th percentile.[70]

These examples illustrate that it is not common in establishing public health standards to use values that reflect median or average levels of exposure to toxic chemicals that may result in death and impairment of human health. The use of percentile values that protect over 90 percent of the population at risk are recommended.

5. ***The proposed fish consumption rate of 175 g/day is a minimum value that has not been endorsed by tribes as a stand-alonevalue. Several tribes have repeatedly stated that a fish consumption rate of <u>at least</u> 175 g/day is part of a package with other protective values used to derive human health criteria.***

[69] Ibid.

[70] US Environmental Protection Agency, 2011. Exposure Factors Handbook: 2011 Edition. National Center for Environmental Assessment. Washington D.C. EPA/600/R-09/052F. Glossary P G-8

Ecology publication no. 16-10-006, the Overview of Key Decisions in Rule Amendment, states that the FCR of 175 g/day has been endorsed by several tribes. Tribes reiterate that a fish consumption rate of at least 175 g/day represents an improvement from the existing criterion of 6.5 g/day, but it cannot be viewed as an endorsement in isolation from other HHC. Tribes also reiterate that the value of 175 g/day is low, based on technically defensible data.

Ecology has improved the proposed rule from the 2015 version by retaining the cancer risk rate at one-per-million, but Ecology declines to adopt other EPA recommended values used in the derivation ofnational recommended human health criteria. No formal compromise, endorsement, or negotiated value presently exists between tribes and the state as a stand-alone value independent from other HHC.

6. Tribes support Ecology's decision to include all fish in the fish consumption rate.

Heritage and contemporary studies of Pacific Northwest tribes show that tribal communities eat a variety of freshwater, marine, and estuarine fish and shellfish year-round. Tribes harvest fish and shellfish that originate, rear, migrate, or reproduce in Washington's freshwater, estuarine and marine waters. Tribal treaty harvest is geographically defined by usual and accustomed fishing areas; tribes thus do not have the legal flexibility to relocate harvest patterns and practices if fisheries resources in a given area become contaminated.

a. Tribes support the Department of Ecology's decision to include all species of salmon.

Salmon are a "first food" for tribal people and a nutritional, cultural, and economic mainstay for tribal communities as well as a treaty-reserved resource for many tribes. Fish health advisories throughout Washington include harvest closures and consumption limits on salmon due to toxic chemicals. [71],[72]

The 2006 evaluation of toxic chemicals in Puget Sound by WADOH indicated that,

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[71] Washington Department of Health; March 22, 2015. Fish Consumption Advisories. Accessed from http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories

[72] Washington Department of Health; October, 2006. Puget Sound Fish Consumption Advice. Accessed from http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-098.pdf on March 22, 2015.

"High end, Native American consumers of in-river and marine Chinook salmon exceed a PCB HQ [Health Quotient] of 1. This includes estimates based on consumption rates of the Suquamish, Tulalip, and Squaxin Island Tribes. High-end API consumers and average recreational consumers also exceed a PCB HQ of 1. PCB hazard quotients from consumption of Puget Sound coho salmon are less than one for all consumers except high-end Suquamish consumers of coho from "marine" stocks….. Although average PCB levels in Puget Sound coho are below levels of concern, some individual station averages may be slightly above levels of concern, as evidenced by station-specific hazard quotients."[73]

Clearly tribal consumers have already been eating salmon from multiple species at levels above recommended exposure for several years, and chemical criteria must account for salmon in human health criteria.

b. Numerous studies document chemical update of persistent pollutants in fish. In particular, salmonids have been shown to accumulate toxic chemicals in freshwater, estuarine, and coastal marine areas of Washington.

i. Technical Support Document and Supplement

Versions 1 and 2 of Ecology's Technical Support Document on Fish Consumption Rates included references related to chemical contaminants in fish (see for example, Appendix H in Version 1). In response to public comments on the TSD Version 1, the WA Department of Ecology prepared a supplement document[74] to evaluate the inclusion of fish and shellfish in the default FCR, particularly salmon, and associated health benefits and risks of fish consumption. The supplemental information includes sections that are directly relevant to the discussion of the draft rule for Human Health Criteria as follows:

- Health Benefits and Risks of Consuming Fish and Shellfish
- Chemical Contaminants in Dietary Protein Sources
- Salmon Life History and Contaminant Body Burdens

[73] Washington Department of Health, Division of Environmental Health; October, 2006. Human Health Evaluation of Contaminants in Puget Sound Fish. DOH-334-104. Olympia, WA.

[74] Washington Department of Ecology, Toxics Cleanup Program; July 20, 2012. Supplemental Information to Support the Fish Consumption Rates Technical Support Document. Olympia, WA.

The supplement also cites numerous studies (hereby incorporated by reference) that document the uptake of toxic chemicals among salmon at various life stages in Washington freshwater, estuarine, and marine waters. In particular, studies by the WA Department of Fish and Wildlife document higher levels of persistent organic pollutants in Puget Sound resident Chinook compared to Chinook in other areas of the Pacific Northwest, indicating higher exposure in the inland waters of Puget Sound.[75] Ecology's overview description in the supplement (Section C, "Salmonid Body Burdens") has been confirmed as correct by the researcher from Washington Department of Fish and Wildlife.[76] Some commenters on the Technical Support Document (1.0) had stated that salmon pick up the body burden of toxic chemicals in marine waters, implying that they should be excluded from the fish consumption rate, without accounting for the fact that marine waters include estuarine and nearshore areas such as Puget Sound. A synopsis of the issue addressing the importance of including salmon in the Fish Consumption Rate is included in the blog article by C.A. O'Neill, 2012.[77]

ii. Additional references

Documents and presentations prepared by NOAA/National Marine Fisheries Service, the WA Department of Ecology, WA Department of Health, WA Department of Fish and Wildlife, Environment Canada, and the Puget Sound Ambient Monitoring Program describe chemical contamination in a wide range of fish, shellfish, and marine mammal species in Washington freshwater, estuarine, nearshore and coastal waters including Puget Sound and the Columbia River basin (examples listed, more attached but not cited individually).[78], [79],[80]

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[75] O'Neill, S.M. and J. E. West, 2009. Marine Distribution, Life History Traits, and the Accumulation of Polychlorinated Biphynols in Chinook Salmon from Puget Sound, WA. Transactions of the American Fisheries Society 138:616-632,2009. DOI: 10.1577/TO8-003.1

[76] West, James; March 9, 2015. Email re: Puget Sound toxic chemical uptake in salmon.

[77] O'Neill, C.A. (Puget) Sound Science. November 8, 2012. Center for Progressive Reform blog. http://progressivereform.org/CPRBlog.cfm?idBlog=E072AEC3-A728-A0BD-32965A41D8C66EBB

[78] West, James E. 2011. PCBs in Puget Sound's Food Web. Presentation to the Washington Department of Ecology Technical Fish Consumption Workshop on December 12, 2011 at the University of Washington, Seattle, WA. Accessed at: http://www.ecy.wa.gov/toxics/docs/20111212_fishworkshop_west.pdf http://www.ecy.wa.gov/toxics/fish_publicinvolvement.html

[79] O'Neill, S.M., G.M. Ylitalo, J.E. West, J. Bolton, C.A. Sloan and M.M. Krahn. April, 2006. Regional patterns of persistent organic pollutants in five Pacific salmon species (*Onchorhychus spp)* and their contribution to contamination levels in northern and southern resident killer whales *(Orcinus orca).* Extended abstract presented to the 2006 Southern Resident Killer Whale Symposium. Seattle, WA.

Some of these references are included in the Ecology supplement and others have been identified or are more recent. West's March 9, 2015 email also states that,

> *"Sandie reported at the 2014 Salish Sea Ecosystem Conference on a recent PSEMP study where we measured PBT burdens in juvenile Chinook salmon during their first year of life in Puget Sound in 2013. Results from this effort documented high exposures of outmigrating Chinook to PBTs in contaminated river mouths and nearshore habitats, and in Puget Sound marine waters."* [81]

Additional studies of pollutants in juvenile Chinook salmon in the Columbia River basin have also been published since the completion of the Technical Support Document supplement.[82]

c. Water quality monitoring continues to yield additional information about the uptake of pollutants in Washington waters by salmonids and other fish species.

Monitoring is an essential tool in the implementation of the Clean Water Act to identify impaired waters, assess improvement or degradation, and identify differences in specific areas of Washington. In order to protect tribal communities and other high fish consumers from greater risk of exposure, additional monitoring, including fish tissue sampling and updated detection methodology, should continue.. For example, Washington Departments of Fish and Wildlife and Ecology initiated an interagency agreement for fish tissue sampling of outmigrating juvenile Chinook salmon (initial findings cited above). These efforts will continue to yield data demonstrating the uptake of HHC pollutants by salmonids, and therefore provide further evidence that all fish are necessarily included in FCR. The importance of monitoring activities is summarized in the statement in the introduction of the interagency agreement:

> *"Results from this work will be used to provide a measure of the effectiveness of current toxic reduction strategies and actions, inform*

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[80] Presentations at the 2014 Toxics Reduction Conference; Seattle, WA. November 17, 2014.

[81] West, James; March 9, 2015. Email re: Puget Sound toxic chemical uptake in salmon.

[82] Johnson,L., B. Anulacion, M. Arkoosh, O.P. Olson, C. Sloan, S.Y. Sol, J. Spromberg, D.J. Teel, G. Yanagida and G. Ylitalo. 2013. Persistent organic pollutants in juvenile Chinook salmon in the Columbia River basin: Implications for stock recovery, transactions of the American Fisheries Society, 142:1, 21-40.

future pollution reduction efforts, and enhance recovery of Chinook Salmon." [83]

In addition to this data, which supports inclusion of all fish in an FCR, Tribes also add that monitoring is also an essential component of the implementation of water quality standards to measure both performance and effectiveness.

d. Western Washington tribal studies indicate high levels of shellfish consumption. The FCR studies for Tulalip, Squaxin Island, and the Suquamish Tribes have fish consumption rates of 244, 318, and 797 grams per day, respectively, at the 95th percentile. The Columbia River study, completed earlier, indicated a FCR of 175 g/day at the 95th percentile, comprised primary of finfish species.

Tribal treaty rights include the right to harvest and consume shellfish, much the same as finfish in their usual and accustomed grounds. The Ninth Circuit Court of Appeals held that "usual and accustomed grounds and stations" are the same for shellfish as they are for fish, noting that establishing grounds for each species of fish would be unduly burdensome.[84]

The importance of shellfish in determining a fish consumption rate has been recognized by the Washington Department of Health. During the review of Ecology's Technical Support Document in 2011-2012, the Washington Department of Health stated that:

"Washington State Department of Health's Position is that 175 grams / day is the ***minimum*** *in Washington State's fish consuming populations because the 175 grams / day estimate in the Columbia River Inter-tribal Fish Commission Survey does not fully account for the range of shellfish harvested and consumed by Washington State's fish consuming populations. (McBride, December 2012) [emphasis in original]* [85]

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[83] O'Neill, S., J.E. West, L.L. Johnson, J. Lanksbury, L. Niewolny and A. Carey. July, 2013. Quality Assurance Project Plan: Toxic contamination in outmigrating juvenile Chinook Salmon (*Oncorhyrchus tshawytscha*) from river mouths and nearshore saltwater habitats of Puget Sound. WDFW-Ecology Interagency Agreement #G1200486.

[84] *Shellfish III,* 157 F.3d 630, 645 (9th Cir. 1998), *cert. denied,* 119 **S.** Ct. 1376 (1999).

[85] McBride, D.. December 20, 2012. Memo to C. McCormack re: Fish Consumption.

In areas where toxic cleanup sites and contaminated sediments are present, such as Port Gamble Bay, regional health entities have issued specific guidelines for subsistence shellfish harvesters. [86]

Finfish and shellfish are an important cultural, economic and subsistence food, which the tribes consume regularly. A failure to include all species of fish and shellfish in the calculation of human health criteria, could result in under estimating tribes' exposure to any given toxic parameter, and therefore fail to adequately protect the target population

[86] Washington Department of Health, 2014. DOH 334-361. Is Port Gamble Bay shellfish in your diet? Information for subsistence harvesters.

B. Cancer Risk Level

In order to protect public health for the citizens of Washington and designated uses that depend on water quality, it is essential that the state of Washington maintain the cancer risk level used in the calculation of water quality criteria at a level of one-per-million (10^{-6}), retain the current water quality standard, WAC 173-201a-240(6), and resist political pressure to raise the cancer risk level as an offset for higher fish consumption rates.

Tribes concur with the state's decision to reverse the proposed change to a risk level of one per 100,000 (10^{-5}) that was advanced in the 2015 version of the state's rule.

- A reduction in the protective level of cancer risk fails to protect designated uses under the Federal Clean Water Act, which is the sole basis for authorization of standards.
- Maintaining a cancer risk level of 10^{-6} corresponds to longstanding state policy, reflected initially in the Department of Ecology's comments on the 1992 NTR, and maintained in the standards at WAC 173-201A-240(6).
- Manipulating the cancer risk level has a profound and direct effect on the protective level of standards, to the detriment of highly exposed populations.
- Increasing the cancer risk level would decrease protection of tribal treaty-reserved rights to safely harvest and consume fish in the Pacific Northwest.
- An increase in the cancer risk level used to calculate human health criteria would have a disproportionate impact to tribes and other highly exposed populations, in violation of environmental justice mandates.

Ecology states that the proposed rule applies the existing risk level of 10^{-6} to a FCR of 175 g/day that is representative of the arithmetic means (averages) of highly exposed populations.[87] If the state of Washington adopts standards in the future that reduce the cancer risk level to 10^{-5}, such action should not be approved by EPA without consideration of the need to use a higher percentile for the FCR and the need for public notice and comment. For additional discussion

[87] Ecology, 2016. Decisions document, p 23.

on the state's previous proposal to use a cancer risk level of 10^{-5}, please refer to the NWIFC comments on the state's 2015 proposed rule.[88]

1. **Tribes concur with Ecology's decision to retain the cancer risk level of one-per-million (10^{-6}) currently in effect in the NTR criteria and adopted in Washington State Water Quality Standards.**

   It is current Washington State law that, "Risk-based criteria for carcinogenic substances shall be selected such that the upper-bound excess cancer risk is less than or equal to one in one million."[89] Tribes and environmental and human health organizations have clearly requested, and advocated for, maintaining a cancer risk rate of 10^{-6} in Washington as necessary for the protection of human health and the designated uses of water in the Clean Water Act. In numerous correspondences, Tribes,[90] EPA,[91] environmental and human health organizations[92], and the Department of Ecology[93] have advocated that 10^{-6} is an appropriate cancer risk level for use in developing Human Health Criteria (HHC) to ensure protection of designated uses.

   During the state rule-making process in 2012-2015, industry advocates argued for a ten-fold increase in the cancer risk level, based on their assertion that the EPA's year 2000 methodology for deriving ambient water quality criteria (AWQC guidance)

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[88] Northwest Indian Fisheries Commission; March 23, 2015. Comments on the State's Draft Rule for Human Health Criteria and Implementation Tools in Water Quality Standards.

[89] WAC 173-201A-240(6)

[90] See section I.C and section I generally in this document correspondence to DOE imploring the state to maintain the current cancer risk rate.

[91] See Letter from Dennis McLerran, EPA Region 10 Regional Administrator to Senator Doug Eriksen. April 24, 2014. See Also Letter from Dennis McLerran, EPA Region 10 Regional Administrator to Senator Doug Eriksen. July 1, 2014

[92] See E.g. www.keepourseafoodclean.org; see also Letter from Nina Bell executie Director of NWEA to EPA Administrator McCarthy, re: Petition for Rulemaking on Water Quality Criteria for Toxics in the State of Washington, October 28, 2013; and Attached Petition for Rulemaking From NWEA to EPA submitted by Nina Bell, Executive Director, Northwest Environmental Advocates 28th of October, 2013.

[93] See 57 FR 60848

allows states to set an increased cancer risk level.[94] Under the industry interpretation, the EPA's 2000 guidance would allow for an increase of the cancer risk level as long as the risk levels are set no higher than 10^{-4} for so-called sensitive subpopulations. However, nothing in EPA guidance explicates that Washington tribes are in fact "subpopulations," or suggests that states have the discretion to minimize water quality standard protections for tribes. What the AWQC does is to require the justification of setting of a cancer risk level, by in part, ensuring the protection of the highly exposed. The Washington State Department of Ecology provided no justification during rule-making in 2015 for changing the cancer risk level, other than to consider it a state-specific "risk management" decision.[95]

2. **A cancer risk level of one-per-million is necessary to address the risk of additive toxicity from multiple chemical contaminants.**

As EPA's rule proposal in the Federal Register notes, previous comments from the Washington Department of Ecology in 1991, clearly support 10^{-6} due in part to concerns over additive toxicity—concerns which are shared by many tribes. When multiple chemicals induce the same effect by similar modes of action, EPA guidance is to assume that the chemicals contribute additively to risk.[96] Evaluating cumulative risks from exposures to multiple chemicals "is especially important in cases where the resulting toxic effect from the mixture has been demonstrated to be greater than the sum of the individual effects".[97] EPA has stated previously that "[c]ertain categories of contaminants, in particular, persistent organic pollutants that share a common mode of action and/or target tissue, are of elevated concern when they co-occur in the fish and drinking water."[98] Tribes also note that anadromous fish, such as salmon, may transit multiple inland, nearshore, and marine waters through their migratory life cycle, potentially exposing them to numerous chemical contaminants.

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[94] Association of Washington Business, January 18, 2013. ""Water Quality Risk Policy for the Protection of Human Health". Posted on Washington Department of Ecology: Feedback on Current Rulemaking. http://www.ecy.wa.gov/programs/wq/swqs/whatpeoplesay.html

[95] WA Dept. of Ecology; January 2015. "Overview of Key Decisions in Rule Amendment" Ecology Publication no. 14-10-058.

[96] U.S. Environmental Protection Agency (EPA). 2000c *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health, Technical Support Document Volume I: Risk Assessment*. Office of Water, Office of Science and Technology. EPA-822-B-00-005. October.

[97] Id

[98] Id

In order to protect humans from exposure to carcinogens, a risk level of 10^{-6} is appropriate for calculating individual chemical criteria, and to address the likely additive and synergistic effects of toxic pollutants.

3. **A risk that is not zero is still a risk.**

Although tribes have advocated for Washington to retain their existing cancer risk level of 10^{-6} for the criteria applicable to Washington in the context of CWA regulation, tribes have not universally supported one-per-million as representative of an adequate *de minimus* risk to protect treaty-reserved rights in all cases. Some tribes have stated that any elevated health risk to tribal members from fish consumption is unacceptable—in other words recommending that the pollutant concentrations be set to zero to protect human health. There is no recognized safe concentration for a human carcinogen.

C. Relative Source Contribution (RSC)

1. *Ecology Must Utilize Default Relative Source Contribution Values as Recommended By EPA in Order to Accurately Account for Toxic Exposures and Set Criteria that Protect the Designated Uses*

When deriving human health water quality criteria for non-carcinogens, a relative source contribution (RSC) factor is included to account for non-water sources of exposure to pollutants. The RSC designates a percentage of an individual's acceptable daily intake (or "reference dose") that accounts for exposures from water and fish when there are other possible exposure routes, including non-fish food consumption, dermal exposure, and respiratory exposure. The use of RSC ensures that an individual's total exposure from all sources of a pollutant does not exceed a maximum acceptable daily intake.[99]

EPA's *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000), provides guidance for determining the appropriate RSC to be used for a particular chemical. **In the absence of data, the EPA recommends the use of 20 percent as the default RSC in calculating criteria for State or Tribal water quality standards**.

In 2013, EPA published "*Human Health Ambient Water Quality Criteria and Fish Consumption Rates Frequently Asked Questions*" to clarify agency policy and the guidance included in its 2000 Human Health Methodology. Discussing the RSC factor, EPA states:

> *In the absence of scientific data, the application of the EPA's default value of 20 percent RSC in calculating 304(a) criteria or establishing State or Tribal water quality standards under Section 303(c) will ensure that the designated use for a water body is protected. This 20 percent default for RSC can only be replaced where sufficient data are available to develop a scientifically defensible alternative value. If appropriate scientific data demonstrating that other sources and routes of exposure besides water and freshwater/estuarine fish are not anticipated for the pollutant in question, then the RSC may be raised to the appropriate level, based on the data, but not to exceed 80 percent. The 80 percent ceiling accounts for the fact that some sources of exposure may be unknown.*

[99] EPA. 2000.supra; EPA. 2014. supra

EPA adopted final updated national water quality criteria for the protection of human health on June 29, 2015. EPA's regulations provide that states and authorized tribes should adopt numeric water quality criteria based on:

> (1) EPA's recommended section 304(a) criteria; or
> (2) EPA's recommended section 304(a) criteria modified to reflect site-specific conditions; or
> (3) Other scientifically defensible methods. (40 CFR 131.11(b)).

EPA's proposed water quality standards applicable to Washington, followed the path in (2) primarily using the values in the recommended 304(a) criteria, but included a modified FCR to reflect Washington's specific consumption patterns. Conversely, the Department of Ecology's proposal for RSC deviates from national guidance (304(a)), but provides neither defensible nor site-specific information to justify their deviation from updated 304(a) criteria as required by federal regulations. Instead, Ecology is proposing that the draft rule uses a relative source contribution value of one, or 100 percent, not because this is the site-specific exposure scenario for Washington, but because Ecology "believes" this is a prudent policy decision.

The rationale for this decision is included in Ecology's "*Overview of key decisions in rule amendment."* (2016) Specifically, the decision for the draft rule states that:

> *Because the geographic and regulatory scope of the CWA addresses contaminant discharge directly to waters of the state (not other sources or areas), Ecology is making a risk management decision that this draft rule continue to use a relative source contribution of one (RSC = 1). Given the limited ability of the Clean Water Act to control sources outside its jurisdiction, Ecology strongly believes that this is a prudent decision.*

It is important to note, however, nothing in the EPA's guidance suggests that the RSC should be modified based upon the level of control a state has over a particular pollutant. By proposing to use a RSC of 100 percent, it appears that Ecology has misconstrued the existing EPA guidance. The guidance does not suggest, as Ecology proposes, that the Clean Water Act is intended to **control** sources outside its jurisdiction, only that it **accounts** for them when assessing "safe" levels of exposure. Ecology has taken the position that because regulation of other exposures is beyond the scope of the Clean Water Act jurisdiction, it is therefore prudent to allot **all** of an individual's acceptable daily intake to drinking water and fish consumption (or, in the case of marine criteria, only to fish consumption) when establishing safe levels of exposure. However, if an individual's entire daily intake comes from surface water exposures, then any additional exposure would exceed the acceptable daily intake, and would increase the likelihood of a variety of non-cancer health effects. In other words, Ecology cannot ignore that humans are exposed to other pathways of contaminants and have preexisting body burdens when attempting to establish thresholds of safe exposure. To do so, would wrongly assume much higher levels of safe levels of exposure through fish and water intake, and subsequently set pollutant allowances too high.

Regardless of what the CWA does and does not have jurisdiction over, Ecology must set water quality standards that will result in protection of the designated uses. This means Ecology must accurately assess the likely affects of exposure from water and fish intake, and assume that affects from pollutant burdened fish and water are not interacting with unadulterated or pristine human health conditions, especially considering criteria are based on a lifetime exposure of 70 years. EPA guidance states that "[w]hen other sources or routes of exposure are anticipated, but data are not adequate, there is an even greater need to make sure that public health protection is achieved".[100] Not only has the State not provided data regarding other sources or routes of exposure for non-carcinogens, but there is ample evidence that a variety of non-water sources of exposure exist for most chemicals.

In the *PAH Chemical Action Plan*,[101] Ecology notes the following regarding sources of PAH exposures:

- Everyone is exposed to PAHs, which are present in food and found throughout the environment in air, water, soil, and dust. The importance of various sources of exposure to PAHs is expected to differ from person to person due to factors such as diet, the use of wood stoves in the neighborhood, occupation, and personal habits like smoking.

- Food accounts for 80 to 95% of PAH exposure for people who do not smoke and who do not have significant exposure on the job. For the average consumer, the three food groups that contribute most to dietary exposure appear to be cereals, vegetables/nuts, and meat. For people who regularly eat shellfish, PAH exposure from seafood may contribute 25% or more of dietary exposure.

- For smokers, PAH exposure from tobacco smoke can equal or exceed that from food. People who live or work with smokers can have greater than normal exposure to PAHs.

- Inhalation of PAHs in air is estimated account for about 10% of exposure.

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[100] EPA. 2000. Supra

[101] Washington Department of Ecology (Ecology). 2012. *PAH Chemical Action Plan*. Publication no. 12-07-048. December. Available at https://fortress.wa.gov/ecy/publications/publications/1207048.pdf

- Two major contributors of airborne PAHs in the Puget Sound region of Washington are exhaust from combustion engines and wood smoke from home heating.

- PAHs in water and soil are estimated to make only a minor contribution to most people's exposure.

Several of the PAHs are non-carcinogens, including fluoranthene, which is included on Ecology's list of Persistent Bioaccumulative Toxins (PBTs) that it considers the "worst of the worst."

Some other examples of non-water exposures to non-carcinogens include:

Toluene
Because toluene is a common solvent and is found in many consumer products, you can be exposed to toluene at home and outdoors while using gasoline, nail polish, cosmetics, rubber cement, paints, paintbrush cleaners, stain removers, fabric dyes, inks, adhesives, carburetor cleaners, and lacquer thinners. Smokers are exposed to small amounts of toluene in cigarette smoke. [102]

Ethylbenzene
The highest exposure to ethylbenzene for the general public is most likely to occur via inhalation associated with the use of self-service gasoline pumps or while driving a gasoline-powered motor vehicles especially in high traffic areas or in tunnels.[103]

Endrin
Because endrin is no longer used in the United States, residues on imported foods are the main source of potential human exposure in food.[104]

By electing to use a RSC value of 100 percent for all non-carcinogens, the criteria proposed by Washington are not consistent with EPA policy and guidance, do not account for non-water sources of exposure, and are therefore not adequately protective of the designated uses.

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[102] Agency for Toxic Substances and Disease Registry (ATSDR). 2000. *Toxicological Profile for Toluene*. U.S. Department of Health and Human Services, Public Health Service. August.
[103] Agency for Toxic Substances and Disease Registry (ATSDR). 2010. *Toxicological Profile for Ethylbenzene*. U.S. Department of Health and Human Services, Public Health Service. November.
[104] Agency for Toxic Substances and Disease Registry (ATSDR). 1996. *Toxicological Profile for Endrin*. U.S. Department of Health and Human Services, Public Health Service. August.

2. ***The RSC is part of Ecology's selective adoption of specific updates to national water quality criteria that tend toward a direction of higher (less protective) chemical criteria.***

Ecology proposes to use values from the updated national recommended human health criteria for body weight, which would change standards toward higher (less protective) chemical criteria. Ecology does not propose to adopt the new values used to calculate national criteria or follow guidance for RSC or Bioaccumulation Factors, which would tend toward lower (more protective) chemical criteria. Ecology would adopt updated national criteria for Reference Dose and Cancer Slope Factor, which have varying direction (higher or lower criteria) on a chemical by chemical basis. However, Ecology exempts some toxicity factors entirely (see discussion on 2,3,7,8-TCDD and arsenic).

These selective choices for water quality criteria, justified largely as risk management decisions at the discretion of the state, appear to be an attempt to offset the increase in the fish consumption rate to reduce the impact to dischargers. The change in the FCR from 6.5 to 175 g/day drives chemical criteria lower (makes them more protective), but as discussed previously, represents actual regional data for highly exposed populations. In combination with the use of Bioconcentration Factors, the use of an RSC of one (100%) results in chemical criteria that are less protective than the EPA proposed rule for approximately 80% of the regulated chemicals.

Ecology is required to adopt the values used to derive national recommended 304 (a) criteria , except where regional data specifically justify the selection of alternative criteria. In this case, Ecology has no such supporting data to suggest that default RSC values are unsupported or that Washington residents are solely exposed to the pollutants parameters via fish intake (at 175 gpd) and drinking water intake. In the face of uncertainty for toxic contaminants, Ecology should make risk management decisions in favor of public health, not dischargers.

3. **An RSC value of less than one is necessary to account for additional fish consumed by tribes, but not accounted for in the FCR.**

Despite Ecology's arguments that RSC should only be employed to account for additional fish and water intake exposures (within CWA jurisdiction) as opposed to other exposures such as recreational contact and inhalation, they fail to utilize a RSC value that would address documented fish intake that is not otherwise accounted for in the fish consumption rate. As mentioned early, numerous tribal fish consumption studies document contemporary consumption rates well in excess of 175 gpd. If Ecology does not plan to increase the FCR to account for these additional exposures, they then must apply a RSC value less than 1 to account for additional exposures of tribes from "other fish." This approach is consistent with EPA guidance on the matter. The tribal fish consumption studies summarized in these comments, provide both scientifically defensible and site-specific justifications to apply an RSC value of less than 1 (100%).

D. Body Weight

1. **Tribes recommend the use of 70 kg for calculating human health criteria.** Earlier analysis of fish consumption data in Washington was based on an assumption of 70 kg as a default body weight. Citing studies of fish consumption in tribal and Asian/Pacific Islander communities, Ecology et al. (1999) recommended a default FCR of 175 g/day but stated specifically that this assumed a body weight of 70 kg and would need to be re-evaluated if the assumptions were changed.[105]

2. **Ecology must consider additional regional data.** Ecology considers tribes as the target general population in Washington and cites tribal data as consistent with an adult body weight of 80 kg. While the tribes agree that tribes are the appropriate population for consideration of risk, tribes continue to urge Ecology and EPA to consider the effect of calculating criteria with an 80 kg input variable for high fish consuming individuals with lower body weights – particularly tribal women and children and the Asian Pacific islander communities. For example, a study of fish consumption in the A/PI community in King County indicated an average body weight of 62 kg for men and women. [106] One of the authors, Lorenzana, has indicated in presentations that the 80 kg figure significantly overestimates bodyweight for Washington's A/PI population, for whom the average body weight for women is just 57 kg. As a result, the chemical criteria calculations would underestimate toxicity and exposure, by over-estimating body weight, and thus develop standards that are under protective for those individuals.

[105] Washington State Department of Ecology, 1999. Draft analysis and selection of fish consumption rates for risk assessments and risk-based standards. Ecology Pub. 99-200. L. Kiell and L. Kissinger and an interagency Risk Assessment Forum. https://fortress.wa.gov/ecy/publications/publications/99200.pdf

[106] Sechena, R., C.Nakano, S.Liao, N.Polissar, R.Lorenzana, S.Truong, and R.Fenske. "Asian and Pacific Islander Seafood Consumption Study in King County, Washington." EPA 910/R-99-003. May 1999.http://www.epa.gov/region10/pdf/asian_pacific_islander_seafood_consumption_1999.pdf

3. **The use of a body weight value of 80 kg may under-report exposure to women and children.**
   Tribal studies indicate differences in body weight between male and female respondents, and higher fish consumption (per body weight) among children. Citations of tribal values as local data may also under-report body weight for women and children. The mean body weight for women in the Tulalip fish consumption study was 68 kg. The mean weight for adult women in the Squaxin Island study was also 68 kg. The Squaxin Island study also found that children consumed fish at a rate approximately three times higher, in g/kg-day, than adults. [107]

   National studies indicate that women, children and developing embryos face higher *risks of health impairment.*

   > *While a very large number of environmental toxicants are potentially harmful to health, the most commonly studied ones can be divided into three major categories: heavy metals, air pollutants, and pesticides. Prenatal exposures to heavy metals, including mercury, lead, and arsenic, are associated with increased risk for brain damage, neurodevelopmental problems, congenital malformations, miscarriage, and low birth weight. Air pollutants and pesticides also are linked to poor pregnancy outcomes…. Exposure to certain pesticides, PCBs and DDT, increases the risk of preterm birth, low birth weight, and miscarriage.* [108]

   Although carcinogenic risk levels are proposed to be set to one-per-million, several of the toxicants have other health risks with particular repercussions to tribal women and children.

4. **Many tribes are emphasizing the importance of access to traditional foods in a healthful diet.**

   Data indicating levels of Type 2 diabetes and obesity at levels substantially higher than national rates have prompted tribal communities to emphasize a return to "First Foods," i.e., traditional sources of food such as fish and shellfish in the Pacific Northwest. The CDC has encouraged programs promoting nutrition and health in

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[107] U.S. Environmental Protection Agency (EPA). (2013) Reanalysis of fish and shellfish consumption data for the Tulalip and Squaxin Island Tribes of the Puget Sound Region: Consumption Rates for Consumers Only. National Center for Environmental Assessment, Washington, DC; EPA/600/R-06/080F

[108] Harrison E, Partelow J, Grason H. 2009. Environmental Toxicants and Maternal and Child Health: An Emerging Public Health Challenge. Baltimore, MD. Women's and Children's Health Policy Center. Johns Hopkins Bloomberg School Public Health.

tribal communities, noting that, "American Indians and Alaska Native communities are reclaiming traditional foods as part of the global indigenous food sovereignty movement that embraces identity, history, and traditional ways and practices to address health." [109]

5. **The change in the body weight does not consider additional chemical concentration effects from the affinity of contaminants to fat tissue.**

   The increase in the national recommendation for input variable for human body weight from 70kg to 80 kg will have a harmful effect on potential exposure scenarios. Persistent Organic Pollutants (POPs) have serious deleterious effects in the human body at very low levels. Most of these chemicals are lipophilic (fat soluble) and many are hydrophobic (water repellant) which increases their affinity to fat molecules.

E. Drinking Water Intake

Tribes concur with Ecology's proposal to use updated national water quality criteria values for Drinking Water Intake as these criteria reflect best available science. As we state throughout these comments, Ecology has an obligation to use EPA recommended values, absent a scientific justifications to prove otherwise.

F. Reference Dose and Cancer Slope Factor

Tribes concur with Ecology's proposal to use RfDs found in the EPA IRIS or NRWQC documents.

Tribes concur with Ecology's proposal to use Cancer Slope Factors from EPA 2015. However, tribes object to the exemptions made for arsenic and 2,3,7,8-TCDD (dioxin). See discussion in the section on challenging chemicals.

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[109] Centers for Disease Control and Prevention, 2015. Traditional Foods Project. http://www.cdc.gov/diabetes/projects/ndwp/traditional-foods.htmhttp://www.cdc.gov/diabetes/projects/ndwp/traditional-foods.htm

G. Bioaccumulation Factors (BAF)

1. *Ecology's selection of older methods of accounting for aquatic organisms' uptake of toxic chemicals (use of BCFs rather than BAFs) and older values for bioconcentration factors (where updated values have been calculated by EPA) lacks valid justification.*

Washington Department of Ecology proposes to continue to use bioconcentration factors (BCF) in the evaluation of chemical accumulation into aquatic organisms instead of updated national guidance to use Bioaccumulation Factors. Tribes are highly reliant on upper trophic level organisms, such as salmon and Dungeness crab, which are known to accumulate toxic chemicals in tissue and organs. By not accounting for bioaccumulation through the food chain, the proposed use of criteria calculated using BCFs may under-represent toxic contamination in aquatic species to the detriment of highly exposed populations of consumers, including tribes.

- In their decision to reject the use of Bioaccumulation Factors at this time, Ecology cites "uncertainty" in the BAF model due to lipid content of various species of fish, site variability (organic carbon concentrations in water bodies), and the history of BAF adoption by other states. None of these arguments provide adequate justification for lowering criteria in the direction of reduced public health protection.

- Ecology argues that there is substantial variability in Washington waters with respect to organic carbon (as well as fish tissue lipid), and use this as a rationale for continuing to use old BCF values. Ecology fails to describe how this variability would affect the criteria compared to EPA's BAF values, nor how they would address the issue of variability. This comparison is particularly important due to the large difference between the old BCF and new BAF in some chemical criteria.

- As additional justification, Ecology states that, "The development of the [EPA's] 2015 304(a) guideline documents appears rushed." Nonetheless, the recommended use of the BAF approach has been part of EPA guidance since 2000. Recent guideline documents from EPA in 2014-2015 added specificity for the calculation of individual chemical criteria via the BAF approach, and should be adopted by Ecology as best available science. Moreover, Ecology does not propose to adopt updated values for BCF's either, citing concerns over site-specific variability.

Ecology states that they will consider new information on BAFs in the development of the final rule. Ecology should provide chemical-by-chemical justification for their choice to reject updated science. In combination with other decisions made by the state as part of the draft rule, including the use of a relative source contribution of 100 percent, the failure to account for bioaccumulation will likely result in criteria that are under-protective of tribal fish consumers and other high fish consuming populations.

2. Consistent With EPA's Updated 304(A) National Recommendations, Ecology Should Utilize Bioaccumulation Factors To More Accurately Represent The Presence of Toxics in Tissue

In order to prevent harmful exposures to waterborne chemicals through the consumption of contaminated fish and shellfish, water quality criteria for the protection of human health "must address the process of chemical bioaccumulation in aquatic organisms"[110]. Accordingly, EPA's *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* recommends "the use of a bioaccumulation factor (BAF) to reflect the uptake of a contaminant from all sources (e.g., ingestion, sediment) by fish and shellfish, rather than just from the water column as reflected by the use of a bioconcentration factor (BCF)."[111]

The use of a BAF better represents the amount of a contaminant accumulating in an organism because it accounts not only for the organism's exposure to the pollutant in the water column, but also from the food chain and surrounding environment, as well as biotransformation of the pollutant in the organism due to metabolic processes.[112] For some chemicals (particularly those that are highly persistent and hydrophobic), the magnitude of bioaccumulation by aquatic organisms can be substantially greater than the magnitude of bioconcentration. Thus, an assessment of bioconcentration alone would underestimate the extent of accumulation in aquatic biota for these chemicals.[113]

To calculate the criteria in its draft rule, Ecology has proposed to continue to use BCFs from the NTR. In addition to claims that the BAF method has uncertainties and that BAF guidelines are too new to incorporate into state rule-making, Ecology also claims that BCFs are "more closely related to the specific environmental media (water) that is regulated under the Clean Water Act,"[114] and therefore are justified. However, nothing in the CWA, suggests that once a

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[110] U.S. Environmental Protection Agency (EPA). 2000. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health*. Office of Water, Office of Science and Technology. EPA-822-B-00-004. October.

[111] Id

[112] U.S. Environmental Protection Agency (EPA). 2014a. *Draft Update of Human Health Ambient Water Quality Criteria: Benzo(a)Pyrene*. EPA 820-D-14-012. Office of Water, Office Science and Technology. May.

[113] EPA. 2000. Supra

[114] Ecology. 2016. Overview of Key Decisions. pg 43

pollutant is discharged and it moves through the *aquatic* environment through bioaccumulation, it is somehow not within the scope of the act's jurisdiction. Quite the contrary, the CWA is specifically intended to protect those designated uses, including aquatic organisms, and does not solely focus on the water column.[115] See recent comments on Washington's proposed 2016 Human Health Criteria from Earthjustice section III.C.2 for additional justification of why selection of BAF is not a CWA jurisdictional issue. Moreover, Ecology appears to defy applicable EPA national guidance, by suggesting that BAFs are not appropriately applied under the CWA or via the development of human health criteria for Washington. This is illogical, considering EPA has applied BAFs in the calculation of criteria for both Washington and Maine.[116]

As Ecology has acknowledged in their *Overview of Key Decisions*, the majority of BCF values used to calculate the State's draft criteria have been carried over from 1980 criteria documents.[117] EPA published, reviewed, and issued final national criteria for water quality for most of the priority pollutants in 2014-2015, and issued supplemental information on BAFs in January, 2016.[118],[119] Ecology should adopt the EPA's proposed values[120] for the BAF/BCF calculations in the proposed state rule. Given the lengthy delay in adopting human health criteria on the part of the state, it is likely to be many years before the state again undertakes a review of adopted HHC.

For many persistent bioaccumulative chemicals, the BAF and updated BCF values published by EPA[121] are significantly higher than the previously used BCF values because they also take into account accumulation in fish and shellfish through the food chain. Because the BCF values used by Ecology are included in the denominator of the equation for calculating human health criteria, the higher the value is, the lower (more stringent) the criteria become.

For a number of bioaccumulative chemicals included on Ecology's Persistent Bioaccumulative Toxins (PBT) List, which Ecology terms the "worst of the worst", and which includes a number of carcinogenic PAHs and chlorinated pesticides, the average BAF value for these chemicals is

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[115] See e.g. *PUD No. 1 of Jefferson Cty. v. Washington Dept. of Ecology*, 511 U.S. 700 (1994)

[116] EPA proposed HHC applicable to Washington: 80 Fed. Reg. 55065, (Sept 14, 2015); EPA proposed HHC applicable to Maine: 81 Fed. Reg. 23239, 23247 (April 20, 2016)

[117] Washington Department of Ecology (Ecology). 2016. *Washington Water Quality Standards: Human health criteria and implementation tools, Overview of key decisions in rule amendment*. Publication no. 16-10-006. January.

[118] EPA, June 29, 2015.

[119] EPA, 2016. National Bioaccumulation Factors – Supplemental Information (January, 14, 2016)

[120] EPA, September 14, 2015.

[121] Id

more than 100 times higher than the average BCF value. By not accounting for bioaccumulation or biomagnification through the aquatic food chain, the criteria proposed by Ecology, utilizing BCFs rather than BAFs, may significantly underestimate the accumulation of contaminants in fish and shellfish, and the resulting criteria may be significantly underprotective of consumers of fish and shellfish from Washington's waters. This is problematic considering chemicals such as PAHs are among the most common contaminants measured in Puget Sound shellfish.[122]

3. *Ecology appropriately emphasizes the need for sediment cleanup, but continues to segment this relationship to water quality in its regulatory responsibilities.*

Page 33 of Ecology's Decisions document cites studies of toxic concentrations in Puget Sound, pointing out that, "the results underscore the importance of sediment cleanup activities for reducing contaminant uptake and bioaccumulation in the urban bays and at regional contaminant 'hot spots.'"[123] Although the argument is intended to highlight the complexity of predicting bioaccumulation of toxics in aquatic organisms from water alone, it appears to do just the opposite—making a case for the importance of using a BAF model to calculate uptake of toxic chemicals by organisms in Puget Sound, where exposure pathways encompass both sediment and water.

Ecology has recently attempted to treat toxic cleanup of contaminated sediments as unrelated to the quality of the associated water column. During amendments to the state's Sediment Management Standards from 2011-2015, the state sought to remove important regulatory linkages between sediment and water column cleanup, by removing the SMS from review under the Clean Water Act. Tribal concerns were detailed in the attached letter from the Suquamish Tribe to the EPA in 2015.[124] Once again, the Department of Ecology appears to sidestep the relationship between toxic cleanup and the protection of designated uses by using a narrow method (BCF) to calculate bio-accumulation.

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[122] Washington Department of Fish and Wildlife (WDFW). 2014. *Toxic Contaminants in Puget Sound's Nearshore Biota: A Large-Scale Synoptic Survey Using Transplanted Mussels (Mytilus trossulus)*. WDFW Report Number FPT 14-08. Puget Sound Ecosystem Monitoring Program (PSEMP). September.

[123] Osterberg and Pelletier, 2015. Puget Sound Regional Toxics Model, as cited in Ecology 2016 Overview of key decisions in rule amendment. Publication no. 16-10-006.

[124] Suquamish Tribe; October 26, 2015. Letter from Chairman Forsman to Regional EPA Administrator McLerran.

III. CHALLENGING CHEMICALS AND OTHER PROVISIONS

A. Arsenic

B. Mercury

C. PCBs

D. 2,3,7,8-TCDD

E. Protection of downstream uses

A. Arsenic

Ecology proposes to establish the HHC for arsenic at the levels equivalent to the Safe Drinking Water Act, based on the high concentrations of naturally occurring arsenic in regional geology and regulatory precedent by other states. This proposal would potentially raise the allowable concentration of arsenic in permitted discharges by a factor of several hundred, a drastic increase that is not protective of human health. Changing arsenic to a SWDA standard does not change the fact that arsenic has serious health impacts and has been shown to have economic impacts reducing the marketability of seafood. As pointed out by Ecology in the Decisions document, numerous anthropogenic sources of arsenic already enter Washington waters, and these discharges would potentially be masked by a transition to the SWDA standard. Ecology's argument that other states use the SWDA ignores other state strategies, such as Oregon's, that attempt to address background levels of arsenic while recognizing the potential for arsenic to accumulate in fish tissue. Ecology should adopt the EPA proposal for arsenic, and focus on a strategy that would monitor and minimize the discharge of any additional arsenic into Washington waters from pesticides, products containing arsenic, or municipal treatment systems.

1. **Ecology must reconsider use of the Safe Drinking Water Act (SDWA) arsenic standard of 10μg/L and recalculate standards that reflect protection of designated uses.**

2. The tribes request that Ecology reconsider their proposed arsenic water quality standard based on the comments below. The use of the SDWA standard for arsenic as a surrogate, is neither protective of human health, nor compliant with the Clean Water Act, and therefore should not be used as a water quality standard. Ecology should calculate a standard for arsenic that ensures human health is protected of both chronic

and acute exposures, takes into consideration multiple pathways of exposure – not just drinking water, and implements the precautionary principle by erring on the side of protection of human health in light of purported "uncertainty" of the cancer slope factor. **Arsenic is a ubiquitous, harmful toxic substance, which causes serious health impacts at low doses.**

a. Arsenic and its sources

Arsenic, a naturally occurring element, has properties of both a metal and a nonmetal. However, arsenic is generally referred to as a metal and is a solid, steel grey material in its elemental form.

In its inorganic form, it is usually found in the environment combined with other elements, including sulfur, oxygen, or chlorine.[125] Inorganic arsenic compounds include arsenic acid, arsenic trioxide, and arsenic pentoxide. Arsenic can also combine with hydrogen and carbon, creating organic arsenic compounds (metalloids), such as arsanilic acid, arsenobetaine, and dimethylarsinic acid.[126] Most inorganic and organic arsenic compounds are odorless, tasteless, white or colorless powders that do not evaporate.[127] Naturally and man-made inorganic arsenic can be found in soil, many kinds of weathered rock, results of smelting, combustion of fossil fuels, exposed mining waste, wood preservative facilities and ground water associated with mining.[128] Inorganic arsenic is especially associated with minerals and ores that contain copper or lead. Heating these types of ores in smelters will precipitate most of the arsenic as a fine dust which enters the atmosphere. Collection of arsenic by smelters as a compound called arsenic trioxide (As2O3) can be achieved. Copper chromated arsenate (CCA) is the preservative used to make "pressure-treated" wood. Arsenic treated wood products continue to be used in industrial applications.

Organic arsenic compounds, namely cacodylic acid, disodium methylarsenate (DSMA), and monosodium methylarsenate (MSMA) are used as pesticides. Other uses of organic

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[125] ATSDR (Agency for Toxic Substances and Disease Registry). 2007. Toxicological profile for Arsenic. US Department of Health and Human Services. Public Health Service. CAS#: 7440-38-2

[126] EPA (U.S. Environmental Protection Agency). 2012b. Arsenic Compounds Hazard Summary. Available at http://www.epa.gov/ttn/atw/hlthef/arsenic.html.

[127] ATSDR 2007

[128] See Ferguson, J.F. and J. Gavis. 1972. A review of the arsenic cycle in natural waters. Water Research 6: 1259-1274; Smedley, P.L. and D. G. Kinniburgh. 2001. A review of the source, behavior and distribution of arsenic in natural waters. Applied Geochemistry 17: 517-568; Wang, S. and C.N. Mulligan. 2006. Occurrence of arsenic contamination in Canada: sources, behavior and distribution. Science of the Total Environment 366: 701-721.

arsenic include, additives in animal feed and an additive to other metals to form metal mixtures or alloys with improved properties. Predominantly, arsenic in alloys is used in lead-acid batteries for automobiles, as well as is in semiconductors and light-emitting diodes.[129]

Arsenic occurs naturally in the Earth's crust, as well as through deposition from anthropogenic sources and industrial processes.[130] Arsenic from deposition enters the water, sediment, soil, and air, and eventually accumulates throughout the food chain.

Anthropogenic sources of arsenic include agricultural insecticides, larvicides, herbicides, and wood preservatives.[131] Almost 80 percent of arsenic produced by humans is released into the environment through pesticides[132]. Arsenic is found in soils at higher concentrations than the state Model Toxics Control Act (MTCA) cleanup levels in residential areas near Tacoma, WA and was distributed from Asarco Tacoma smelter emissions while in operation from 1890 to 1986.[133]

b. Human Health Impacts Associated with Arsenic[134]

For most of the population, uptake of arsenic through food is the major source of exposure. Among foods, the highest concentrations of arsenic are generally found in fish and shellfish, existing primarily as organic compounds. EPA has classified inorganic arsenic as a human carcinogen. Human exposure to inorganic forms of arsenic may occur through drinking water. Further, elevated concentrations of inorganic arsenic may be present in soil because of natural mineral deposits or contamination from human activities, resulting in human exposure through dermal contact or ingestion.

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[129] ATSDR. 2007. Supra

[130] Bligh, R. and R. Mollehuara. 2012. Arsenic- Sources, Pathways, and Treatment of Mining and Metallurgical Effluents. Outotec. Output SEAP. Available at: http://www.outotec.com/imagevaultfiles/id_552/cf_2/arsenic_-_sources-_pathways_and_treatment_of_minin.pdf.

[131] Bligh and Mollehuara.2012

[132] Id.

[133] Golding, S. 2001. Survey of typical soils arsenic concentraitons in residential areas of the City of University Place. Ecology Publicaiton No. 01-03-008. Washington Department of Ecology, Environmental Assessment Program, Olympia, WA. 50p.

[134] See 66 Fed Reg 6976 at 7000 for additional discussion on health impacts associated with Arsenic exposure, incorporated here by reference.

Additionally, inorganic arsenic released into the air from metal smelting processes or combustion of wood treated with arsenical wood preservative poses risks through inhalation.[135]

Acute oral doses of 600 micrograms per kilogram body weight per day (µg/kg/d) or higher of inorganic arsenic has resulted in death in humans. Lower dose ingestions include effects to the gastrointestinal tract, central nervous system, cardiovascular system, liver, kidney, and blood. Short-term inhalation exposure to inorganic arsenic has resulted in effects to the central and peripheral nervous system. Acute inhalation of arsine, a gas consisting of arsenic and hydrogen, has resulted in mortality at a concentration of 25 to 50 parts per million (ppm) in air. [136]Chronic or al exposure to elevated levels of inorganic arsenic has resulted in gastrointestinal effects, anemia, peripheral neuropathy, skin lesions, hyperpigmentation, gangrene of the extremities, vascular lesions, and liver or kidney damage in humans. Elevated arsenic concentrations in drinking water (including drinking water from wells) have been associated with behavioral and neurocognitive effects in children. Ingestion of inorganic arsenic has also been linked to a form of skin cancer and an increased risk of bladder, liver, and lung cancer. Effects associated with the chronic inhalation of inorganic arsenic include: dermatitis, conjunctivitis, rhinitis, and pharyngitis, or irritation of the mucous membranes and skin. Additionally, inhalation exposure to inorganic arsenic has been shown to be strongly associated with lung cancer[137]. Several studies have suggested reproductive and developmental effects caused by arsenic exposure; however, the studies are not definitive. Inorganic arsenic can cross the human placenta, exposing the fetus, and there is evidence that exposure to arsenic in the womb and during early childhood may increase young adult mortality. Women working or living in close proximity to metal smelters have shown elevated rates of spontaneous abortion or deliver children with lower than normal birth weights.[138] Studies in animals show that large arsenic doses cause low birth weight, fetal malformations, fetal death, and illness in pregnant females.[139] Low-levels of arsenic have been found in breast milk, and chronic exposure in children may result in lower IQ scores.[140]

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[135] EPA. 2012. supra

[136] Id

[137] Id.

[138] Id

[139] ASDTR. 2007

[140] EPA.2012

3. Ecology's proposal to use the SDWA standard for Arsenic is not protective of the designated uses, and therefore is not compliant with the CWA

As discussed in more detail in section III, the CWA, among many things, requires states to establish water quality standards that protect the designated uses. In establishing standards for the protection of human health, EPA recommends the methodology employed in their guidance document "Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health." Nothing in this document suggests that other health-based standards should be adopted whole cloth as surrogates, while circumventing calculation of criteria.[141]

a. The SDWA is not an appropriate CWA surrogate

EPA's SDWA standard for Arsenic is not an appropriate standard to ensure protection of designated uses, because the final standard represents a negotiated outcome, which was selected – not for its protection of chronic and acute exposures to arsenic - but in for its value as a standard which balances many of the SDWA's competing goals. As a result, the proposed surrogate does not satisfy the CWA tests for ensuring protection of designated uses. To further understand this rationale, it is beneficial to understand more about the SDWA Arsenic standard.

i. Standard setting under the SDWA is based on different goals than CWA.

Distinguished from the CWA's singular aim to develop Water Quality Standards that protect designated uses, the SDWA requires the setting of both upper and lower limits for the protection of human health based on several factors.[142] The lower bounds set a protection of human health goal "at the level at which no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety."[143] The upper bound limits are to be based

[141] See EPA.2000.Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health, publication number EPA-822-B-00-004. Page 1-8 Available at http://water.epa.gov/scitech/swguidance/standards/upload/2005_05_06_criteria_humanhealth_method_complete.pdf. Where EPA discusses the need to develop consistency between CWA and SDWA, but explains that CWA and SDWA take different approaches. For example, EPA provided that "[w]ith the 2000 Human Health Methodology, EPA will publish its national 304(a) water quality criteria at a 10-6 risk level, which EPA considers appropriate for the general population. EPA is increasing the degree of consistency between the drinking water and ambient water programs, given the somewhat different requirements of the CWA and SDWA."

[142] See 42 USC § 300g

[143] § 300(b)(4)(A)

as close as possible on the lower bound health limits, while still being "feasible." [144] The SDWA provides a list of factors in determining what is "feasible."

> *the term "feasible" means feasible with the use of the best technology, treatment techniques and other means which the Administrator finds, after examination for efficacy under field conditions and not solely under laboratory conditions, are available (taking cost into consideration).[145]*

Additionally, the SDWA provides EPA with the discretion to determine whether or not the quantifiable and nonquantifiable benefits of an MCL justify the quantifiable and nonquantifiable costs. [146] The 1996 amendments to SDWA further provide to EPA the discretionary authority to then set MCLs that are less protective than what is feasible, when the cost benefit analysis does not justify the "costs of complying."[147] Under this discretionary authority, EPA need only demonstrate that the MCL "maximize[s] health risk reduction benefits at a cost that is justified by the benefits."[148]

In contrast to this discretionary authority that allows for standards to be based in part on treatment limitations, and in part upon the "cost of complying;" nothing in the CWA requires the setting of water quality standards to be based either on cost or best available technology. In fact, amendments to the Federal Water Pollution Control Act, ushering in a water quality standard based regulatory system, were developed in light of the limitations of solely applying technology based limits as an environmental standard.[149] In EPAs history of water quality

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[144] §300(b)(4)(B)

[145] § 300(b)(4)(D)

[146] § 300(b)(3)(C)(i)

[147] §300(b)(6)(a)

[148] id

[149] EPA. Water Quality Standards History, Available at http://water.epa.gov/scitech/swguidance/standards/history.cfm *providng*

The decade of the 1970's saw State and EPA attention focus on creating the infrastructure necessary to support the NPDES permit program and development of technology-based effluent limitations. While the water quality standards program continued, it was a low priority in the overall CWA program. In the late 1970's and early 1980's, it became obvious that greater attention to the water quality-based approach to pollution control was needed to effectively protect and enhance the nation's waters.

standards they explain that for toxics, water quality, as opposed to technology based standards, where necessary to address this priority national issue.

> In the late 1970s, a greater appreciation evolved on the need to expand and accelerate the control of pollutants in surface waters using water quality-based controls. It became clear that primary reliance on industry effluent guidelines or effluent standards under Section 3O7 of the Act would not comprehensively address pollutants, particularly toxic pollutants, and that existing State water quality standards needed to be better developed. EPA moved to strengthen the water quality program to complement the technology based controls.
>
> To facilitate this effort, EPA decided to amend the Water Quality Standards Regulation to explicitly address toxic criteria requirements in State standards and other legal and programmatic issues. This effort culminated in the promulgation of a revised water quality standards regulation on November 8, 1983 (54 FR 51400), which is still in effect. This regulation is much more comprehensive than its predecessor and it includes many more specific regulatory and procedural requirements. Nonetheless, it is still a succinct and flexible regulation for a program with a

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The first statutory evidence of this was the enactment of a CWA requirement that after December 29, 1984, no construction grant could be awarded for projects that discharged into stream segments which had not, at least once since December 1981, had their water quality standards reviewed and revised or new standards adopted as appropriate under Section 303(c). The efforts by the States to comply with this onetime requirement essentially made the States' water quality standards current as of that date for segments with publicly-owned treatment works (POTWs) discharging into them.

Additional impetus to the water quality standards program occurred on February 4, 1987, when Congress enacted the Water Quality Act of 1987 (Pub. L. 1004). Congressional impatience with the lack of progress in State adoption of standards for toxics (which had been a national program priority since the early 1980's) resulted in the 1987 adoption of new water quality standard provisions in the Water Quality Act amendments. These amendments reflected Congress' conclusion that toxic pollutants in water are one of the most pressing water pollution problems.

scope as broad as the national water quality criteria and standards program. [150]

As a result, today's technology-based standards are applied only to NPDES permits, and only to the extent that water quality standards are not violated using such a standard -- otherwise a water quality-based effluent limitation (WQBEL) is required for an NPDES permit.[151] Technology limits are not applied for the purpose of determining the acceptable level of pollutants that will ensure protection of designated uses (as administered through section 303, 401). As EPA has explained, the priority issues of toxic pollution were significant drivers in the reformation of what was primarily a technology based pollution control system.

ii. EPA's Arsenic rule is a negotiated technology-based standard that sets levels of contaminants far exceeding both MCLG and the level that was feasible.

In 2000, EPA originally proposed a health-based, non-enforceable goal, or Maximum Contaminant Level Goal (MCLG) of zero micrograms per liter (µg/L) for Arsenic.[152] EPA also proposed as a preferred standard, the upper bound, or Maximum Contaminant Level (MCL) of 5 µg/L.[153] In proposing this standard, EPA also clearly stated that a more protective standard of 3 µg/L was in fact the "feasible" standard under the meaning of the SDWA. The 3 µg/L feasible MCL was established after considering treatment costs and efficiency under field conditions as well as considering the appropriate analytical methods.[154] However, because EPA determined that the benefits of regulating arsenic at the feasible level would not justify the costs, the EPA eventually proposed an MCL of 5 µg/L, while requesting comment on MCL options of 3 µg/L (the feasible level), as well as, 10 µg/L, and 20 µg/L.[155]

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[150] EPA. Water Quality Standards History. Available at http://water.epa.gov/scitech/swguidance/standards/history.cfm

[151] EPA. "NPDES Permit Writers' Manual." September 2010. Document No. EPA-833-K-10-001. pp. 1-3–1-5.

[152] 66 FR 6979

[153] id

[154] id

[155] 66 FR 6980

After consideration of public comments, EPA ultimately adopted a MCL of 10 µg/L, which greatly exceeded the feasibility standard, of which the SDWA encourages adoption of. In doing so EPA, explained that they reexamined the proposed MCL of 5 µg/L and in comparing this level to 10 µg/L, EPA determined that the benefit-cost relationships were less favorable for 5 µg/L, and that the total national costs at 5 µg/L are also approximately twice the costs of an MCL of 10 µg/L.[156] After determining that associated issues of cost, EPA invoked their discretionary authority for only the second time since passing the SDWA amendments in 1996[157] to set an MCL less protective then what was "feasible" in an effort to address the identified economic concerns. Therefore, by EPA's own admissions, the SDWA standard for arsenic does not ultimately achieve a standard designed solely to protect human health, but instead seeks to balance numerous additional external considerations, e.g. cost of compliance, which are not relevant to determining a safe chronic exposure threshold necessary for protecting designated uses. If Ecology were to import an analogous standard from the SDWA to achieve the purposes of the CWA, a more appropriate standard would be the MCLG.

iii. The SDWA standard does not account for arsenic exposure via bioaccumulation of fish and subsequent fish consumption, and therefore does not protect the fishable designated use or human health.

Another significant flaw in using the SDWA standard as a surrogate for HHC, is that it does not set standards based on multiple exposure pathways. The SDWA is a drinking water only standard, whereas the HHC per EPA's 2000 AWQC guidance, is required to develop criteria based on exposures through fish consumption *and* drinking water (in the case of freshwater criteria). Setting standards based on multiple exposure pathways is important for several reasons. First, one of the designated uses protected by the HHC, is the "fishable" use, and as EPA has recently noted in the partial disapproval of Maine's water quality standards, that use also inherently includes the protected right to safely consume fish and shellfish. [158] Therefore, in order to protect the use of safe

[156] Id

[157] 66 FR 7020

[158] Letter from Curtis Spalding EPA Regional Administrator to Patricia W.Aho, Commisioner February 2 2015 Appendix A

consumption of seafood (also a treaty-reserved right), the CWA must account for safe levels of arsenic. To do that, Ecology must consider both safe levels of arsenic in shellfish and finfish, as well as safe levels of drinking water, which will both be consumed daily. Second, it is important that Ecology consider Arsenic exposure through consumption of seafood, because those exposure pathways may represent the highest levels of exposure. According to the ASTDR:

> ***For most people, diet is the largest source of exposure to arsenic****. Mean dietary intakes of total arsenic of 50.6 µg/day (range of 1.01–1,081 µg/day) and 58.5 µg/day (range of 0.21–1,276 µg/day) has been reported for females and males (MacIntosh et al. 1997). U.S. dietary intake of inorganic arsenic has been estimated to range from 1 to 20 µg/day, with grains and produce expected to be significant contributors to dietary inorganic arsenic intake (Schoof et al. 1999a, 1999b).* ***The predominant dietary source of arsenic is generally seafood.*** *Inorganic arsenic in seafood sampled in a market basket survey of inorganic arsenic in food ranged from <0.001 to 0.002 µg/g (Schoof et al. 1999a, 1999b).* [159]

Additionally, it is well understood that aquatic species bioaccumulate and biocentrate arsenic.[160] These aquatic species are then consumed, and transferred to the human body.

Failing to base an arsenic standard on bioaccumulation and subsequent fish consumption exposure pathways in combination with drinking water intake, will not result in water quality standards that are calibrated to protect the "fishable" designated use, nor calculated to estimate likely exposure of arsenic at levels protective of human health. Instead, the SDWA surrogate is likely to result in a gross underestimate of exposure.

A good example that demonstrates the disparity between a drinking water only standard and a drinking water and fish consumption-based standard, is to

[159] See ASTDR. 2007. Toxicological Profile for Arsenic at page 315. Available at http://www.atsdr.cdc.gov/toxprofiles/tp2.pdf

[160] See M. Azizur Rahman, Hiroshi Hasegawa, Richard Peter Lim. 2012. Bioaccumulation, biotransformation and trophic transfer of arsenic in the aquatic food chain. Environmental Research, Volume 116, July 2012, Pages 118–135; See also ASTDR. 2007. Toxicological Profile for Arsenic. Available at http://www.atsdr.cdc.gov/toxprofiles/tp2.pdf

compare the current NTR with the SDWA arsenic rule. The existing NTR (although underestimating the exposure by utilizing an inaccurate FCR) sets arsenic water quality standards at .018 μg/L for freshwater and 0.14 μg/Lf or marine waters. These standards were calculated using methodology relatively consistent with EPA's 2000 AWQC guidance to account for protection of human health and the fishable designated use. Essentially, this criterion stands for the assumption that safe water quality standards for arsenic (even assuming gross underestimation of fish consumption rates) are below 1μg/L. Also, as a point of comparison, Oregon's water quality standards also utilized EPA's 2000 AWQC guidance, and even though greatly increased the risk level from 10^{-6} to 10^{-4}, set standards at 2.1 μg/L and 1.0 for fresh and marine water criteria respectively. When we compare these levels with the proposed 10μg/L (for total arsenic) imported from the SDWA, it demonstrates that utilizing EPA methodology (AWQ HHC guidance) that accounts for both seafood and drinking water intake results in a much different and much more protective standard. This additional protection is presumably necessary to meet multiple CWA goals, which includes the safe consumption of seafood. To assume otherwise, is to invalidate the purpose of the EPA's 2000 methodology.

The comparison between the AWQC guidance derived criterion and SDWA derived criterion, also demonstrates that SDWA standard is likely to introduce excessive risk, not otherwise approvable by EPA. If Ecology were to use EPA's 2000 methodology to arrive at a criterion value equal to that of the SDWA's arsenic standard of 10 μg/L then it would require Ecology to utilize a cancer risk level well below EPA's recommended levels. For example, if Oregon calculated an arsenic criteria of 1.0 μg/L for marine waters using an FCR of 175 gpd and a cancer risk level of 10^{-4}, then Ecology, which has similarly proposed an FCR of 175gpd would need to utilize a cancer risk level in the range of 10^{-3} (of course adjusting for differences between total arsenic and inorganic) to result in a criteria similar to the proposal. This further demonstrates that Ecology is setting a criteria which proposes substantial risk, which is likely to exceed EPA's allowable thresholds and is inconsistent with AWQC guidance.

Therefore, the proposed arsenic standard of 10 μg/L does not meet the necessary tests for designated use protection, because it ignores the most significant exposures, is not calibrated to address all of the CWA goals, including fishable designated use protection, and exceeds EPA thresholds for an allowable risk level.

b. Increasing allowable arsenic concentrations sets the stage for violations of the CWA's anti-backsliding laws.

The National Discharge Elimination System (NPDES) is designed to ratchet down on pollution discharges over time, with the goal of eliminating pollution and restoring the nation's waters.[161] Under the NPDES program, pollution effluent limits should be reduced as the regulated facility moves through multiple five-year permit cycles. The CWA expressly prohibits the development of NPDES permit effluent limitations that authorize an *increase* in the discharge of pollutants, stating, "a permit may not be renewed, reissued, or modified to contain effluent limitations which are less stringent than the comparable effluent limitations in the previous permit." [162] This prohibition is known as "anti-backsliding." Although the anti-backsliding provisions of the CWA are subject to some exceptions (such as availability of new information), nothing in the law expressly provides for changes in regulation that are intended to make compliance easier for the regulated community.[163] In fact, the anti-backsliding provisions were intended to accomplish quite the opposite – to prevent the discharge elimination goals of the act from being shifted by political winds. However, by setting revised standards that are significantly less protective then those previously codified, Ecology is setting the stage for development of subsequent effluent limitations "which are less stringent than the comparable standards," because the standards that they will ultimately be based on will now allow in excess of a hundred times more arsenic than previously authorized. Moreover, these new allowances for pollution are not based on new science demonstrating that arsenic is somehow less harmful and therefore larger doses are now considered acceptable. In fact, it is quite the opposite – Ecology acknowledges that the SDWA-based standard is above natural background concentrations, and is not based most recent update of the IRIS cancer potency factor (1998). [164]

c. Ecology's proposed footnote requiring AKART and a pollution minimization plan is a positive step, but is not a mitigating factor for a less stringent standard.

It is noted that Ecology does state - through the use of a footnote in the arsenic standard - that facilities will be required to implement all known, available, and

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[161] See 33 USC § 1251 et seq

[162] See 33 USC §1342(o)(1)

[163] See 33 USC §1342(o)(2)

[164] Ecology. 2016. Overview of Key Decisions. pg 59-60

reasonable methods of prevention, control, and treatment (AKART) implemented through the development of pollutant minimization plan, regardless of the relaxing of arsenic criteria. The footnote is an important reminder of state legal requirements that permittees must comply with when developing effluent limits. However, the footnote is not mitigation for excessively relaxing the arsenic standard, because it introduces no new regulatory requirements. The requirement to apply AKART has long been established by state law, and all discharge permits are required to meet these minimums.[165]

d. Uncertainty regarding the cancer potency factor for arsenic is not a reason to use a technology based standards for designated use protection.

The predominant justification for not using the AWQC guidance for calculation of an arsenic standard is the purported "uncertainty" surrounding the cancer potency factor (CPF).[166] Ecology notes that EPA is reexamining the existing CPF in the IRIS database, and therefore the existing CPF should not be used until updates are completed. Ecology further points out that neither the California toxics rule, nor the SDWA arsenic standard used the most recent CPF (1998). The presence of some uncertainty is not *justification to increase* arsenic pollutant concentrations and subsequent potential exposures. If there is in fact a lack current scientific consensus, it is best to apply the precautionary principal, i.e. if an action or policy has a suspected risk of causing harm to human health, then the burden of proof that the action is *not* harmful falls on those taking an action. Merely demonstrating the existence of some uncertainty does not satisfy that burden. In the case of the arsenic, that burden of proof has not been satisfied, based on the aforementioned reasons.

Additionally, it is worth noting that despite purported uncertainty surrounding CPFs in the California Toxics Rule and SDWA, both Oregon's, EPA's national recommended 304(a) criteria, and EPA's proposed human health criteria applicable to Washington, have utilized an arsenic CPF to calculate criteria using EPA's 2000 AWQC guidance methodology. Ecology should strongly consider following a similar approach.

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[165] See RCW 90.48.520 requiring AKART for discharge of "toxicants" and stating "all known, available, and reasonable methods of prevention, control, and treatment."

[166] Ecology. 2014. Washington Water Quality Standards: Human health criteria and implementation tools: Overview of Key decisions document, at page 46.

B. Mercury

Northwest Indian Fisheries Commission requests that Ecology not defer updating criteria for Mercury. Ecology should utilize EPA guidance in combination of with the application of regional FCRs, to develop a methylmercury standard.

Ecology proposes that a single parameter remain under the NTR - mercury (total Mercury). The justification for this decision is not based on a lack of science, or a lack of information to suggest that mercury is a ubiquitous problem in the state. In fact, it is quite to the contrary, EPA has developed guidance on establishing Mercury criterion[167] and implementing it[168](subsequent the publication of the NTR), and numerous Ecology, and Department of Health studies have shown that Mercury is a serious pollution issue in the state of Washington.[169] In fact mercury is continually indentified as a leading problem contaminant for fish health advisories, and therefore has a direct effect on treaty-reserved resources. Nonetheless, Ecology has taken an approach to delay updating Mercury criteria, because they believe updating standards should coincide with a the development of a "comprehensive implementation plan."[170] In doing so, Ecology ignores that there is ample new science, including information regarding FCRs and Bioaccumulation Factors (both of which are discussed at length in this review), which render the current standards inaccurate. Ecology is therefore obligated as a delegated authority to revise mercury standards applying updated, best available science. Ecology should utilize EPA guidance in combination of with the application of regional FCRs, to develop a methyl mercury standard.

1. Methymercury is extremely harmful to human health, and fish consumption is the major exposure pathway.

The major pathway for human exposure to methylmercury is consumption of contaminated fish. Dietary methylmercury is almost completely absorbed into the blood and is distributed

[167] EPA. 2001. Water Quality Criteria: Notice of Availability of Water Quality Criteria for the Protection of Human Health: Methyl Mercury avaiable at 66 FR 1344.

[168] EPA. 2010. Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. EPA 823-R-10-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

[169] See Puget Sound Toxics Loading Study Phases 1-3; Department of Health Fish Advisories; Washingtons Water Quality Assesment and 303(d) list, available at http://www.ecy.wa.gov/programs/wq/303d/currentassessmt.html Ecology. 2003. Mercury Chemical Action Plan. Department of Ecology Publication No. 03-03-001

[170] Ecology. 2015. Overivew of Key Decisions. page 51

to all tissues including the brain; it also readily passes through the placenta to the fetus and fetal brain. [171]

Sources of mercury include atmospheric deposition, erosion, urban discharges, agricultural materials, mining, combustion, and industrial discharges. [172]Mercury exists in three chemical forms: methylmercury, elemental mercury, and other mercury compounds (both inorganic and organic). However, methylmercury is the most important form toxicologically, because it can be readily taken up across lipid membrane surfaces. Moreover, methylmercury can be bioconcentrated in fish tissues over a thousand times from water concentrations as low or lower than 1 micrograms per liter (µg/L).[173] Exposure to methyl mercury is usually through ingestion of fish and shellfish. Minamata disease from eating fish with methylmercury from industrial sources discharged to Minamata Bay in Japan is a famous example of mercury poisoning.[174] Thousands of people suffered from methylmercury poisoning. In terms of determining risk from exposure to mercury, various factors need to be taken into account. These factors include the chemical form of mercury, the dose, the age of the person exposed, the route of exposure, and the overall health of the person exposed. High levels of mercury exposure can have impacts on the brain, heart, kidneys, lungs, and immune system. The Minamata case was one of very high industrial waste discharge over a long period with several routes of exposure accounting for the extreme health concern. However, it has been demonstrated that high levels of methylmercury in the bloodstream of unborn babies and young children may harm the developing nervous system, making the child less able to think and learn. It is well known that pregnant women, infants, and children are most susceptible to the effects of mercury exposure. Exposure to methylmercury in the womb resulting from a mother's ingestion of contaminated fish and shellfish can affect the brain and nervous system of a growing baby, which can lead to impaired cognitive function, memory, attention, language, and fine motor and spatial skills. Symptoms of methylmercury poisoning can include impairment of

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[171] See EPA. 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury, Final. EPA-823-R-01-001 January 2001. Available at: http://water.epa.gov/scitech/swguidance/standards/criteria/health/upload/2009_01_15_criteria_methylmercury_mercury-criterion.pdf

[172] See Dvonch, J.T., J.R. Graney, G.J. Keeler, and R.K. Stevens. 1999. Use of elemental tracers to source apportion mercury in south Florida precipitation. Environ. Sci. Technol. 33: 4522-4527; and see also Wang, Q., D. Kim, D.D. Dionysiou, G.A. Sorial, and D. Timberlake. 2004. Sources and remediation for mercury contamination in aquatic systems – a literature review. Environmental Pollution 131: 323-336.

[173] Peakall, D.B. and R. J. Lovett.1972. Mercury: its occurrence and effects in the ecosystem. Bioscience 22: 20-25.

[174] Harada, M. 1995. Minamata disease: methyl mercury poisoning in Japan caused by environmental pollution. Crit Rev Toxicol. 25(1): 1-24.

peripheral vision, disturbances in sensations, lack of coordination in movement, and impairment of speech, hearing, walking, and muscle weakness. At high levels of exposure, elemental mercury can cause various effects on the kidneys, respiratory effects, and death. High exposure to inorganic mercury can cause gastrointestinal, nervous system, and kidney damage. Symptoms of inorganic mercury exposure include skin rashes/dermatitis, mood swings, memory loss, mental disturbances, and muscle weakness. [175]

Mercury enters surface waters as methylmercury, elemental mercury, or inorganic mercury, where it can exist in dissolved or particulate forms, which can undergo various transformations. The rate of transformation is determined by the balance of forward and reverse reactions related to local water characteristics. Methylmercury typically originates from bacterial reduction of inorganic mercury in sediment, often accompanied by low oxygen or anaerobic conditions. That is, the principal source of methylmercury is concentrated in fish. Recycling of methylmercury from sediment can last for decades after the principal source to a water body has ceased.[176] Mercury can also be present in surface waters in dissolved form, concentrated in the surface microlayer, attached to seston (organisms and non-living matter swimming or floating in a water body), in the bottom sediments, and in resident biota. In general, methylmercury is the most bioavailable and toxic form although it typically makes up less than 20 percent of total mercury within the water column.[177] In terms of availability in sediment, various factors including organic carbon and sulfur content can influence mercury bioavailability. [178]The form of mercury within a particular waterbody determines its bioavailability. Again, methylmercury, converted from other forms by bacteria in sediment and recycled to the overlying water available for uptake, is the most toxic form. Other forms of dissolved mercury are also available for uptake by aquatic plants, fish, and invertebrates. Mercury that concentrates in

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[175] EPA (U.S. Environmental Protection Agency). 2014b. Mercury: Basic Information. Accessed on

6/23/14 at: http://www.epa.gov/mercury/about.html.

[176] Håkanson, L. 1975. Mercury in Lake Vänern- present status and prognosis. Swedish Environ. Prot. Bd., NLU, Report No. 80, 121 pp.

[177] See Kudo, A., H. Nagase, and Y. Ose. 1982. Proportion of methylmercury to the total amount of mercury in river waters in Canada and Japan. Water Res. 16: 1011-1015; Parks, J.W., A. Lutz, and J.A. Sutton. 1989. Water column methylmercury in the Wabigoon/English River-Lake system: Factors controlling concentrations, speciation, and net production. Can. J. Fish. Aquat. Sci. 46: 2184-2202.; Bloom, N.S. and S.W. Effler. 1990. Seasonal variability in the mercury speciation of Onondaga Lake (New York). Water Air Soil Pollut. 53: 251-265; Watras, C.J., K.A. Morrison, J. Host, and N.S. Bloom. 1995. Concentration of mercury species in relationship to other site-specific factors in the surface waters of northern Wisconsin lakes. Limnol. Oceanogr.40: 556-565.

[178] Tremblay, A., M. Lucotte, and D. Rowan. 1995. Different factors related to mercury concentration in sediments and zooplankton of 73 Canadian lakes. Water Air Soil Pollut. 80: 961-970.

the surface microlayer is available to organisms that live or feed on the surface (e.g., neuston). Mercury attached to seston can be ingested by aquatic animals that feed on plankton and mercury accumulated in sediments may be available to benthic plants and animals. Aquatic plants may take up mercury from air, water, or sediments. [179]In locations with mercury-contaminated sediments, levels of mercury in aquatic macrophytes have been measured at 0.01 micrograms per gram (µg/g), indicating strong accumulation from sediments.[180] The primary route of exposure of mercury to aquatic animals is from direct contact with mercury-contaminated sediments and water and ingestion of mercury-contaminated food. Fish can absorb mercury through the gills, skin, and gastrointestinal tract.[181] Contaminated fish then become a mercury source for piscivorous birds and mammals. Emergent aquatic insects represent another potential source of mercury to insectivorous birds and mammals.[182] Mercury tends to occur at higher concentrations at higher trophic levels in aquatic systems e.g., top predators), due to its bioaccumulating potential, mostly through recycling of methylmercury from sediments.

2. **Water quality standards development should not be delayed due to implementation considerations.**

In implementing the Clean Water Act for all parameters, whether conventional or non-conventional, states inevitably face difficulties. For example, in Washington, the state generally lacks an active program to control thermal loading due to degraded riparian habitat. Nonetheless, temperature standards were updated (after partial disapproval), primarily because new science and mapping clearly demonstrated that existing standards

[179] Crowder, A. 1991. Acidification, metals and macrophytes. Environ. Pollut. 71: 171-203; Ribeyre, R. and A. Boudou. 1994. Experimental study of inorganic and methylmercury bioaccumulation of four species of freshwater rooted macrophytes from water and sediment contamination sources. Ecotoxicol. Environ. Safety 28: 270-286.

[180] See Wells, J.R., P.B. Kaufman, and J.D. Jones. 1980. Heavy metal contents in some macrophytes from Saginaw Bay (Lake Huron, USA). Aquat. Bot. 9: 185-193; see also Crowder, A.A., W. Dushenko, and J. Grieg. 1988. Metal contamination of wetland food chains in the Bay of Quinte, Ontario. Environment Ontario, Nov. 28-29, 1988. Toronto, Canada, pp. 133-153.

[181] Wiener, J.G. and D.J. Spry. 1996. Toxicological significance of mercury in freshwater fish. In: Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations. W.N. Beyer, G.H. Heinz and A.W. Redman- Norwood (Eds.), Special Publication of the Society of Environmental Toxicology and Chemistry, Lewis Publishers, Boca Raton, FL, USA. pp. 297-339.

[182] Saouter, E., L. Hare, P.G.C. Campbell, A. Boudou, and F. Ribeyre. 1993. Mercury accumulation in the burrowing mayfly (Hexagenia rigida) (ephemeroptera) exposed to CH HgCl or HgCl in water and sediment. 3 2 Water Res. 27: 1041-1048; see also Dukerschein, J.T., J.G. Wiener, R.G. Rada, and M.T. Steingraeber. 1992. Cadmium and mercury in emergent mayflies (Hexagenia bilineata) from the upper Mississippi River. Arch. Environ. Contam. Toxicol. 23: 109-116.

were not based on best available science, or protective of the designated uses.[183] However, lack of programmatic implementation of nonpoint source control is not a justification for avoidance of development of pollution limits (water quality standards).[184]

The Ninth Circuit's discussion regarding the implementation of § 303(d) is both analogous to the issue at hand and informative. The *Pronsolino* court explained at length that the CWA required implementation, and therefore presumably development, of water quality standards to control "whatever the source of any pollution." The Ninth circuit explained that "one of the purposes of water quality standards therefore - and not surprisingly - is to provide federally approved goals to be achieved both by state controls and by federal strategies other than point-source technology based limits."[185] In further discussing section 303(d), the court noted that CWA regulations applied "whether a water body receives pollution from points sources only, non-point sources only, or a combination of the two."[186] Since water quality standard implementation, including the adaptive management of water quality standards by establishing TMDLs, applies to all waters regardless of the relative influence of either point or nonpoint sources, it is therefore only logical that water quality standard development also applies to all relevant waterbodies regardless of their sources of pollution.

EPA, in their history of Water Quality Standards further explains the importance of standards to the application of CWA programs other than point source regulation under section 402.

> Water quality standards are essential to a wide range of surface water activities, including: (1) setting and revising water quality goals for watersheds and/or individual water bodies, (2) monitoring water quality to provide information upon which water quality based decisions will be made, (3) calculating total

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[183]See Letter from Mike Gearhead, director of office of water and watersheds to David Peeler, Ecology Water Quality Program Manager, re: Partial Disapproval of the 2003 Revisions to the Washington Water Quality Standards Regulations, March 22, 2006.

[184] In Ecologys Key Decision Overview Document, it is argued in the context of Relative Source Contribution, Bioaccumulation Factors, and Methylmercury that the CWA lacks jurisdiction over nonpoint sources and therefore Ecology does not have a duty to use HHC equation variables or update standards that would address nonpoint sources. However, nothing in the CWA provides that section 303, 319 and 401 application of water quality standards should be limited due to the nature of the sources that contribute to pollutant loading.

[185] Pronsolino v Nastri, 291 F.3d 1123 (9th Cir. 2002)

[186] id

> maximum daily loads (TMDLs), waste load allocations (WLAs) for point sources of pollution, and load allocations (LAs) for non point sources of pollution, (4) issuing water quality certifications for activities that may affect water quality and that require a federal license or permit, (5) developing water quality management plans which prescribe the regulatory, construction, and management activities necessary to meet the water body goals, (6) calculating NPDES water quality-based effluent limitations for point sources, in the absence of TMDLs, WLAs, LAs, and/or water quality management plans; (7) preparing various reports and lists that document the condition of the State's or Tribe's water quality, and (8) developing, revising, and implementing an effective section 319 management plan which outlines the State's or Tribe's control strategy for non point sources of pollution.

In an October 2011 press release regarding the development of human health criteria, the then Ecology Director agreed with this position and exclaimed that revised water quality standards were a foundational element of toxic pollution control.

> Ensuring that the state's environmental standards accurately reflect our citizens' exposure is the next step needed to reduce toxics in our environment and protect public health for Washington's fish and shellfish consumers.[187]

In sum, we see no justifiable basis for delaying water quality standard development for Mercury due to the nature of the pollution loading or the difficulty of resolving it.

3. EPA guidance requires states to update their mercury standards, and use local fish consumption data in doing so.

According to EPA, Ecology is required to update Mercury standards through the course of the triennial review process. Given that the current HHC proposal is a product of the triennial review process, it seems only appropriate that Ecology would also undertake development of the Mercury standard required by the EPA. In EPA's 2010 guidance EPA stated:

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[187] Ecology News Release, *Ecology starts dialogue about reducing toxic chemicals in fish to better protect public health,* October 11, 2011, 11-Draft.

At this time [i.e. 2010], about seven states, plus Washington D.C. and two territories have adopted a fish tissue criterion for methylmercury with EPA approval. EPA expects that with the publication of this guidance, states and authorized tribes will include new or revised criteria for methylmercury in their waters as part of the next three year review of standards required by section 303(c) of the Clean Water Act.[188]

In discussing the relationship between EPA's methylmercury criteria and their 2000 AWQC guidance for HHC, EPA explained that the states were still obligated to utilize local fish consumption data, and therefore should not just adopt EPA recommended numeric methyl mercury criteria whole cloth.

EPA encourages States and authorized Tribes to develop and adopt water quality criteria to reflect local and regional conditions…However, when establishing a numeric value based on a section 304(a) water quality criterion modified to reflect site-specific conditions, or water quality criteria based on other scientifically defensible methods, EPA strongly cautions States and authorized Tribes not to selectively apply data in order to ensure water quality criteria less stringent than EPA's section 304(a) water quality criteria. Such an approach would inaccurately characterize risk.[189]

For exposure assessment, States and authorized Tribes are encouraged to use local studies on human fish and shellfish consumption that better reflect local intake patterns and choices."[190]

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[188] EPA 2010 at 17

[189] 66 FR1347 emphasis added

[190] 66 FR 1346

Following EPAs 304(a) recommendations, with the exception of Relative Source Contribution, Oregon adopted methyl mercury criteria. [191] The criterion utilizes, as EPA requires, local fish consumption data.[192]

4. **Ecology already uses fish tissue as a basis for 303(d) listings, which demonstrates the feasibility of developing and implementing a tissue-based standard.**

Utilizing a fish-tissue based standard is not entirely foreign to Ecology. For many years the department of Ecology has used a fish tissue standard as the basis for listing many bioaccumative toxics on the 303(d) list of impaired waters. [193] Although, this approach is somewhat out of date in that in relies upon Bioconcentration Factors as opposed to Bioaccumulation Factors and utilizes criteria that do not incorporate accurate FCRs,[194] it does demonstrates the feasibility of implementing such a standard. First, it shows Ecology's comfort with calculating and correlating fish tissue data with impacts to the designated uses. And second, it demonstrates Ecology's willingness to utilize the standard in a regulatory context. The tribes support this approach, and Ecology should continue to do so using updated methylmercury criteria. To develop a HHC standard on tissue and implement through the NPDES program, Ecology need only run their existing listing process in reverse, i.e. translating a tissue based standard into a numeric water column-based standard. In other words, Ecology is already tackling some of the difficult implementation issue associated with tissue-based standards, such as translation. This is a scientifically sound and vetted approach. Ecology's argument that tissue-based standards create uncertainty and therefore warrant delay, is both contrary to their own existing policies, and generally unavailing.

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[191] EPA. 2011. Technical Support Document for EPA's Action on Oregon's New and Revised Human Health Water Quality Criteria for Toxics and Associated Implementation Provisions Submitted July 12 and 21, 2011 October 17, 2011. At page 33. Available at http://www.epa.gov/region10/pdf/water/or-tsd-hhwqs-2011.pdf

[192] Id.

[193] See Ecology. 2012. Water Quality Program Policy 1-11. at page 50. Available at http://www.ecy.wa.gov/programs/wq/303d/WQpolicy1-11ch1.pdf

[194] Id.

C. Polychlorinated Biphenyls (PCBs)

Ecology Must Update PCB Criteria In Order To Better Protect Human Health, By Incorporating Revised Human Health Criteria Variables Into Criteria Calculation

Ecology has proposed to retain the 1992 NTR criterion of 0.00017 μg/L for total PCBs in the proposed amendments to the state's water quality standards. The proposed criterion for PCBs is the only use of the so-called anti-backsliding provision that has carried over from the state's 2015 proposal into the 2016 rule. Ecology provides no rationale for the proposal regarding PCBs in the 2016 Decisions document, except to state that, "Ecology proposes to use a state-specific risk level exclusively for PCBs. These calculated values are higher than the current NTR values, and because PCBs are a chemical of concern in Washington, Ecology is making a chemical-specific decision not to increase the criteria concentrations above current criteria levels."

Ecology apparently calculates PCBs as a non-carcinogen only, without justification, then back-calculates the potential cancer risk level at 4×10^{-5}. Although it does not meet their own selection of a cancer risk level of 10^{-6}, they consider this risk level to be good enough, since it is, "consistent with the level of risk/hazard in the toxicity factor used by the WDOH in developing fish advisories," and because it, "is more protective than the maximum risk recommended in EPA guidance."[195] In other words, Ecology is using a threshold of fish health advisories and maximum risk as the level of protection for this chemical.

The approach of determining that a criterion is not adequately protective, but then address this lack of protection by taking no further action, is confusing, contrary, and defaults to the criteria defined in the 1999 revisions to the National Toxics Rule (NTR), which utilizes an inaccurate FCR and underestimates exposure.[196] Tribal fishery and cultural resources have been and continue to be greatly impacted by this bioaccumulative carcinogen and tribes cannot support Ecology's proposal to implement a status quo standard, which is based on several outmoded HHC variables as discussed in these comments.

PCBs are bioaccumulative carcinogens, which directly threaten tribal treaty-reserved resources and the tribal members that are economically, nutritionally, culturally and spiritually sustained by them. Washington's standards should be updated for PCBs using variables more accurately reflecting exposure, consistent with EPA 304(a) guidance, and affording better protection of designated uses and human health, i.e. a 1 in 10^{-6} cancer risk level and full consideration of

[195] Ecology 2016 Decisions document, p 54.

[196] See Section II.

relevant bioaccumulation factors. Ecology needs to fully consider the health impacts of this bioaccumulative carcinogen and take the steps necessary to provide protection and build a safer future. Setting stronger regulations will drive technological innovation in the direction of removing this contaminant from Washington's waters to improve protection of the health of future generations.

1. **PCBs are responsible for ubiquitous fish consumption advisories and impaired waters listings in Washington.**

The Washington State Department of Health (DOH) has called PCBs and methylmercury "the main contaminants of concern in Puget Sound Fish."[197] Since 1999, DOH has issued fish consumption advisories because of PCBs[198] for the Lower Columbia River, the Middle Columbia River, Bradford Island, the Upper Columbia River, Lake Roosevelt, the Duwamish River, Green Lake, Lake Washington, the Okanogan River, Puget Sound, the Spokane River, the Walla Walla River, the Wenatchee River, and the Yakima River. The extent of these advisories and the consumption restrictions are included in the electronic attachments.[199] In addition to prompting multiple fish consumption advisories, PCBs are a pollutant in many of the state's impaired waters. EPA's Water Quality Assessment and Total Maximum Daily Loads Information database[200] shows Washington has listed the following miles and acres of water bodies as impaired because of PCBs.[201]

Specific State Causes of Impairment that make up the Washington Polychlorinated Biphenyls (PCBs) Cause of Impairment Group

Description of this table

Cause of Impairment	Size of Assessed Waters with Listed Causes of Impairment		
	Rivers and Streams (Miles)	Lakes, Reservoirs, and Ponds (Acres)	Ocean and Near Coastal (Square Miles)
Polychlorinated Biphenyls (PCBs)	34.0	76,036.0	16.1

[197] See DOH fish consumption advisory webpage at http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories/PugetSound

[198] http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories

[199] Derived from http://fishadvisoryonline.epa.gov/Advisories.aspx

[200] http://www.epa.gov/waters/ir/index.html

[201] http://ofmpub.epa.gov/tmdl_waters10/attains_state.cause_detail?p_state=WA&p_state_name=Washington&p_cycle=2008&p_cause_group_name=POLYCHLORINATED%20BIPHENYLS%20%28PCBS%29

It is clear from the number and extent of Washington's fish consumption advisories and impaired waters that continued reliance on 15 year old standards is not working to keep tribal resources safe for human consumption. More protective water quality standards for PCBs coupled with rigorous implementation of the standards should be part of Washington's efforts to protect the health of its citizens.

2. Health Effects of PCBs

In Ecology's 2015 and 2016 documents titled, "Overview of Key Decisions in Rule Amendment", Ecology appears to downplay the impact of PCBs on human health. The first statement in Ecology's discussion on the health effects of PCBs is that "Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children. PCBs have been shown to cause cancer in animals (EPA 2014)[202]". The discussion of Ecology's key decision on the health impact of PCBs is misleading and incomplete. PCBs are now recognized as endocrine disruptors in humans and exhibit synergistic toxicity with some dioxins and PBDEs,[203] which magnifies health impacts even at low levels of exposure. Existing body burdens of dioxin will also compound PCB's' health impacts.[204] In addition, PCBs are classified as Group 1 human carcinogens according to the International Agency for Research on Cancer (IARC).[205] EPA's 2014 PCB fact sheet report acknowledges that that by using a weight-of-evidence approach research studies now "provide conclusive evidence that PCBs cause cancer" in animals and "the data strongly suggests that PCBs are probable human carcinogens". The National Toxicology Program, in their Thirteenth Report on Carcinogens, further supports EPA's position.[206]

In addition to carcinogenic effects, PCBs have been specifically identified in studies of American Indian communities as potential endocrine disrupters. A study by the Institute of Health and the Environment at the University of Albany found that PCBs in native foods (fish

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[202] EPA, 2014. U.S. Environmental Protection Agency. Hazardous Waste PCBs Fact Sheet. Available online at: http://www.epa.gov/solidwaste/hazard/tsd/pcbs/about.htm

[203] Pellacani, C., et. al., 2012, Synergistic interactions between PBDEs and PCBs in human neuroblastoma cells., Environ. Toxicol. 2012 Mar 20. Doi: 10.1002/tox. 21768.

[204] Uemura, H., et. al., 2009, Prevalence of metabolic syndrome associated with body burden levels of dioxin compounds among Japan's general population, Environmental Health Perspectives, Vol. 117, No. 5,

[205] See International Agency for Research on Cancer, IRAC,Monagraphs on the Evaluation of Carcinogenic Risks to Humans, avaiable at http://monographs.iarc.fr/ENG/Classification/

[206] See Substances Listed in the Thirteenth Report on Carcinogens, http://ntp.niehs.nih.gov/ntp/roc/content/listed_substances_508.pdf

consumed from the St. Lawrence River) were clearly correlated with lower testosterone levels of Mohawk men.[207]

Exposure to PCBs also presents elevated risks to breast-feeding infants. Oregon DEQ, working with toxicologists from EPA Region 10 and the Oregon Health Authority, analyzed the breast-feeding exposure pathway associated with Superfund sites, and stated that, "Our main conclusion is that PCB risks to breastfeeding infants will be 25 times the risk to the mother, assuming long term exposure to the mother."[208] Ecology's decision document fails to account for the elevated risk from the breast-feeding exposure pathway.

Tribes and the general public need to know that Ecology has first and foremost fully considered the most recent evidence of the human carcinogenic and endocrine disrupting impacts of PCBs when making key decisions on setting human health-based criteria. It is not sufficient to default to the status quo, when *stronger* measures are needed to protect the health of tribal members and all Washington citizens that consume fish from Washington waters.

3. Analytic methods for the detection of PCBs

Ecology has recommended EPA standard method 608 for PCBs with a quantitation limit of 0.5 µg/L that is more than three orders of magnitude higher than the proposed standard of 0.00017 µg/L. In September 2010, EPA proposed to add EPA Method 1668C "Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS" to 40 CFR Part 136[209]. The method is a significant improvement in sensitivity. The reporting limits for congeners in aqueous samples using HRGC/HRMS are 0.0001- 0.0004 µg/L. The State of Oregon recommends[210] that certain facilities use EPA method 1668C to monitor for PCB congeners and gives permit writers discretion in selecting the method for compliance monitoring. Ecology should no longer recommend method 608 as a quantitation limit. Washington should recognize that analytical techniques for PCBs have evolved beyond

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[207] Schell, LM, MV Gallo, GD Deane, KR Nelder, AP DeCaprio, A Jacobs, Akwesasne Task Force on the Environment. Relationships of polychlorinated biphenyls and dichlorodiphenyldichloroethylene (p,p'-DDE) with testosterone levels in adolescent males. Environmental Health Perspectives. 2013. DOI:10.1289/ehp.1205984. http://ehp.niehs.nih.gov/1205984/

[208] Poulsen, Mike. Toxicologist for the Oregon DEQ. April 6, 2016 email and associated reference materials, including Oregon DEQ 2010 Risk Assessment Guidance, **http://www.deq.state.or.us/lq/cu/health.htm**

[209] http://www.gpo.gov/fdsys/pkg/FR-2010-09-23/pdf/2010-20018.pdf

[210] ODEQ, 2014. Oregon Department of Environmental Qualtiy. Memo: Implementation Instructions for Polychlorinated Bipheyls (PCBs) Water Quality Criteria (CAS #: 1336363). November 28, 2014.

method 608 and the state should require their use as part of a comprehensive effort to limit the release of PCBs into the environment.

4. Bioconcentration Factor vs Bioaccumulation Factor

PCBs tend to bioconcentrate in organisms at low trophic levels, and through the gills of fish that filter large amounts of water. However, PCBs also bioaccumulate in predatory organisms as the body burden of prey is transferred to the predator, including humans.[211] A prerequisite for a substance's strong bioaccumulation factor is an affinity for fat and persistence in the environment, both of which typify PCBs. Therefore, bioaccumulation factors support the best representation of exposure, and should be utilized when developing criteria for persistent, bioaccumulative, toxic pollutants with high bioaccumulation tendencies such as PCBs. Ecology has little scientific evidence to support their decision that using BCFs for PCB uptake is most reflective of the exposure pathway for PCBs. BAFs have been widely used in the scientific community for the past 35 years to most accurately describe the net increase of PCBs in predator species.[212] [213] Ecology characterizes the choice of using a BCF or a BAF as a risk management decision; tribes disagree with this approach and indicate that the BAF method should be used for determining the impact of PCBs on human health, based on sound scientific principles.

5. Origination from Non-point Sources is not justification for inaction on PCB criterion

Some source assessments have shown that a significant portion of PCB loading may originate from non-point sources.[214] This fact does not alleviate the need to take action to reduce or eliminate as much PCB as possible from municipal and industrial point sources that sequester these pollutants, and provide key interception points to implement removal technologies. Source assessment studies have also shown that concentrations of PCBs in surface waters increase as water flows downstream and become impacted by human activities. To the maximum extent possible, regulations should limit the obvious impacts of human activities on water quality.

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[211] Alexander, D., 1999, Bioaccumulation, bioconcentration, biomagnification. Environmental Geology, Encyclopedia of Earth Science, pp 43-44.

[212] Borga, K. et. al, 2005, Bioaccumulation factors for PCBs revisited. Environmental Science and Technology, Vol. 39, No. 12, pp. 4523-4532.

[213] See also section VI

[214] Washington Department of Ecology, Spokane River PCB Source Assessment, June 5-6, 2012 Workshop presentation.

D. Dioxins

Ecology Must Recalculate Dioxin Criteria and Apply Best Available Science

Although the EPA has determined 2,3,7,8-Tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) and other dioxin-like compounds to be carcinogenic to humans, Ecology has elected in its draft rule to calculate human health criteria for 2,3,7,8-TCDD based only its non-cancer health effects, resulting in a less protective criterion for this highly toxic chemical than the existing NTR. As rationale for this change, Ecology cites "recent scientific information and uncertainty surrounding assessment of carcinogenicity", and the fact that the toxicity factors for dioxin have "been under review for many years". [215] While the EPA has not formally updated the cancer slope factor for dioxins, it has published a draft cancer slope factor which is more than five times higher than the previously published value, which would result in more stringent, not less stringent, criteria.[216]

By treating TCDD as a non-carcinogen, the criteria do not account for the additive carcinogenic effects of other dioxin-like compounds. In its 2002 compilation of national recommended water quality criteria, EPA included the following guidance:

> *The section 304(a) water quality criteria for dioxin contained in this compilation is expressed in terms of 2,3,7,8-Tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) and should be used in conjunction with the national/international convention of toxicity equivalence factors (TEF/TEQs) to account for the additive effects of other dioxin-like compounds (dioxins).*

By applying the TEF/TEQ approach, "the other highly toxic dioxins will be properly taken into account".[217] This approach is also consistent with the treatment of dioxin mixtures in the state's Model Toxics Control Act ("MTCA"; WAC 173-340).

It is the State's policy in other environmental regulatory programs, including MTCA and the Sediment Management Standards (SMS), to rely on other sources of information if toxicity

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[215] Washington Department of Ecology (Ecology). 2016 Key Decisions document. ECY publication no. 16-10-006.

[216] Rice, Glenn. 2010. *The U.S. EPA's Draft Oral Slope Factor (OSF) for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)*. USEPA National Center for Environmental Assessment, Office of Research and Development. Science Advisory Board Dioxin Review Panel Meeting, Washington, DC. October 27.

[217] EPA 2002. National Recommended Water Quality Criteria:

parameters are not available through EPA's Integrated Risk Information System (IRIS). The SMS state that "if the value for a toxicological parameter is not available through IRIS, other sources shall be used" (WAC 173-204-561), and MTCA states that "If a carcinogenic potency factor is not available from the IRIS data base, a carcinogenic potency factor from HEAST or, if more appropriate, from the NCEA shall be used" (WAC 173-340-708). The cancer slope factor for TCDD, which is no longer available through the IRIS database, is available through the Health Effects Assessment Summary Tables (HEAST), and should be used for calculating criteria until a new value is published.

The result of the approach proposed by Ecology is draft human health criteria for dioxins that are among the least protective in the country. The criteria are 2.5 times less protective than the existing national recommended criteria, and 25 times less protective than those adopted by the State of Oregon.

E. Federally Required Protection of Downstream Uses

1. Washington's proposed water quality standards fail to demonstrate protection of downstream standards, including the tribes' and Oregon's, as required by federal regulations.

Pursuant to the CWA and its implementing federal regulation, states are required to demonstrate that new or revised water quality standards do not cause or contribute to violations of downstream standards. Federal regulations state:

> *In designating uses of a water body and the appropriate criteria for those uses, the State shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters.*[218]

EPA explains that the preferred path for states to comply with 40 CFR 131.10(b) is to develop water quality standards that are consistent with those downstream.[219]

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[218] 40 CFR 131.10(b)

[219] See EPA .2014. Protection of Downstream Waters in Water Quality Standards: Frequently Asked Questions. EPA-820-F-14-001. Available at http://water.epa.gov/scitech/swguidance/standards/library/upload/downstream-faqs.pdf

EPA further explains the importance of developing consistency between standards:

> *Designated uses and water quality criteria that ensure attainment and maintenance of downstream WQS are important because they may help to avoid situations where downstream segments become impaired due, either in part or exclusively, to individual or multiple pollution sources located in upstream segments. Designated uses and water quality criteria that provide for the attainment and maintenance of downstream WQS may help support more equitable use of any assimilative capacity available to upstream and downstream pollution sources and/or jurisdictions and may facilitate restoration of the downstream waters. Ensuring the attainment and maintenance of downstream WQS during development of upstream designated uses and water quality criteria may also help limit and/or avoid resource-intensive water quality problems and/or legal challenges that can occur after adoption of uses and criteria that lack consideration of downstream waters' WQS. Furthermore, downstream protection consideration prevents the shifting of responsibility for pollution reductions from upstream sources and/or jurisdictions to downstream sources and/or jurisdictions.*[220]

Unfortunately, not all of Washington's proposed HHC meet these requirements, because they establish standards for shared intra-state/tribal waters (e.g. Oregon, Spokane Tribe) whose current water quality standards for many parameters are more protective than Washington's proposal. [221] This has the effect, as EPA notes in the quote above, of shifting the burden unto the tribes to regulate the inadequacies of upstream standards.[222] This issue is exacerbated by the fact that many tribes' jurisdictional boundaries lie at the mouths of streams, and therefore are downstream of most dischargers.

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[220] Id at page 2

[221] See Ecology's document titled Washington Proposed HHC vs. Oregon Adopted HHC, available at http://www.ecy.wa.gov/programs/wq/swqs/ECYPropvsORHHC.pdf

[222] Although some tribes have adopted NTR-based criteria as a default due to resource constraints, many tribes are in now in process of updating and adopting their HHC and FCRs. Therefore, the adoption of NTR based criteria for tribes is not a reason to maintain state standards, as tribal criteria will be modified in the near future.

2. Ecology must adopt more protective numeric criteria to ensure consistency with federal regulations

Tribes including the Spokane Tribe have adopted more protective water quality standards that have been approved by the EPA; more tribes are in various stages of receiving treatment as a state, and adopting or revising tribal water quality standards. Authorities delegated to the state under the CWA for implementation of water quality standards, currently and in the future, must protect downstream waters within tribal territorial jurisdictions, as well as treaty-reserved rights and resources.

Ecology must take measures to ensure consistency with federal regulations requiring that Washington's proposals are protective of downstream designated uses. Like EPA, the tribes' preferred approach to achieve this goal is to adopt significantly more protective criteria, as requested throughout these comments.

IV. IMPLEMENTATION TOOLS

The Department of Ecology's proposed draft rule for variances, compliance schedules, intake credits, and narrative effluent limits creates a package of regulatory measures that authorizes non-compliance with water quality standards, and as a result fails to protect the treaty-reserved rights of tribes to harvest fish and shellfish under the protection of the federal Clean Water Act. Tribes recognize that EPA regulations authorize states and authorized tribes to adopt water quality standards variances, compliance schedules, and site-specific criteria to provide time to achieve the applicable water quality standards.[223] However, EPA has also stated that, in order harmonize treaty-reserved rights with the CWA, such rights must be considered when determining whether proposed water quality standards amendments adequately protect Washington's fish and shellfish harvesting designated uses.[224] Consideration of treaty-reserved rights must be incorporated into any proposed implementation requirements that enable dischargers to delay or avoid compliance with required standards.

Ecology has proposed "implementation tools" that could suspend protection of any of Washington's designated uses without providing sufficient requirements to assure future attainability. They also remove important requirements to attain standards within reasonable timeframes. The state's proposed implementation tools would give the state broad discretion to permit discharges that are out of compliance with water quality standards for unspecified numbers of years or decades, thereby creating permanent damage to treaty-reserved resources. Clearly, the emphasis of the proposed rule is on achieving more predictability for dischargers to continue to pollute, rather than certainty for clean water.

Although many participants in the rule-making process have noted that toxic contaminants in both point-source and non-point sources must be addressed to achieve water quality, the proposed implementation tools continue to segment such linkage, by removing requirements to prepare TMDLs prior to issuing variances, compliance schedules, and other implementation "tools."

Finally, tribes note that the proposed implementation tools apply to all water quality standards, thereby creating "off-ramps" for compliance that could impact the exercise of treaty rights, recreation, commercial fishing and shellfish cultivation, threatened aquatic resources under the federal Endangered Species Act, and human health.

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[223] See e.g. 80 Fed. Reg. 55063, 55066 (Sept 14, 2015)

[224] ibid

A. Variances

1. Variances fundamentally undermine treaty right protection and the purpose of the Clean Water Act.

a. Variances have potential to cause harm to treaty-reserved rights and resources, and therefore should not be authorized in any circumstances where a treaty-reserved right and a designated use overlap.

The Washington State Department of Ecology's newly proposed rule language authorizes a variance from both the criteria and designated uses for an individual facility, a group of facilities, or stretches of waters.[225] Essentially, this language provides that a variance is effectively a new, albeit time-limited, water quality standard, which changes not only the numeric criteria, but also alters the designated use. The proposed variance rules would allow Ecology broad discretion to suspend a designated use for a potentially long time period, not limited by the regulation. As such, the rules are in conflict with the goals of the Clean Water Act to protect and enhance water quality in a timely manner; and are inconsistent with state and federal obligations to not impede treaty-reserved rights.

Designated uses are the very foundation of the Clean Water Act's (CWA) regulatory structure. A designated use describes both the purpose of the CWA and level of protection afforded to a body of water. Section 101(a) of the CWA establishes some of the most important designated uses – like fishable and swimmable waters - which also concomitantly make up the statutory goals of the Act. The designated uses are also an element of water quality standards, by providing the targets that numeric or narrative criteria should be set to protect.[226] These standards in turn serve as metrics to ensure that other CWA programs are adequately fulfilling the CWA's objectives of restoring the nations water, e.g. §401 certifications, §402 discharge permits, §404 dredge and fill permits, and §303(d) listing procedures and Total Maximum Daily Load development (TMDL). Therefore, a revision or suspension of the designated uses – even temporarily - effectively changes the goals of the CWA and the subsequent levels of protection implemented at a waterbody, permit or multiple permit scale.

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[225] Proposed langauage at WAC 173-201A-420(1)

[226] See 40 CR 131.3(i) defining water quality standards as " provisions of State or Federal law which consist of a designated use or uses for the waters of the United States and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the Act."

As EPA acknowledges, tribal treaty rights and designated uses are inextricably linked.[227] In their recent publication of proposed Human Health Criteria for Washington, EPA determined that Treaty Rights "must be considered when determining which criteria are necessary to adequately protect Washington's fish and shellfish harvesting designated uses."[228] The member tribes of the Northwest Indian Fisheries Commission have treaty-reserved, constitutionally protected, and federally adjudicated rights to harvest and manage various natural resources, including salmon and shellfish, throughout their Usual and Accustomed Areas. These resources are concurrently protected under the fishable designated use throughout Washington's waters. If Ecology were to suspend this fishable designated use and reassign a different designated use - albeit temporarily - through a variance process, they would effectively remove a key federal protection for treaty-reserved rights. In practice, the "time-limited" nature of such a proposal could translate into decades of delay, and would thus be inconsistent with EPA's treaty-trust obligations and Washington's duty to not to take actions that would undermine the treaties as exemplified in the recent federal district court "culvert" decision. [229]

According to federal law, the purpose of a water quality standard is to "enhance the quality of the water."[230] Yet variances, which effectively set a *new* water quality standard, are intended to establish weaker criteria that by definition no longer protects the existing designated use. As stated earlier, this maneuver is inconsistent with the CWA's overarching goals and statutory framework, as well as state and federal obligations to not impede treaty-reserved rights.

b. Variances may not be legally authorized under the CWA, and therefore should only be applied under very limited circumstances

There is no explicit reference or authorizing language for variances in the CWA. In 1977, EPA general counsel opined that, because the CWA used the terminology "*wherever attainable*, water quality standards provide for the protection and propagation of fish, shellfish, etc…" that therefore, the CWA must also provide for situations when those goals were <u>not</u> attainable. The same EPA Office of General Counsel legal opinion considered the practice of temporarily downgrading the WQS as it applies to a specific permittee rather than permanently

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[227] See 80 Fed. Reg. 55063, 55066 (Sept 14, 2015)

[228] *Id.*

[229] *United States v. Washington*, 20 F.Supp.3d,889 Subproceedings No 01-1 (Culverts)(W.D. Wash 2007).

[230] 40 CFR 131.3(i)

downgrading an entire water body or waterbody segment(s) and determined that such a practice is acceptable as long as it is adopted consistent with the substantive requirements for permanently downgrading a designated use. EPA further explains that:

> a state may change the standard *in a more targeted* way than a designated use change, so long as the state is able to show that achieving the standard is "unattainable" for the term of the variance. [231]

To this day, this legal theory is the underpinning of variance programs, and lends itself to two important observations. First, variance programs are supposed to be distinguished from a use downgrade in that they temporarily change standards in a more targeted way. Second, the entire premise of a variance is based on EPA interpretation of two words: "wherever attainable."

Absent express authorization under the CWA, the legality of variances is suspect, and application of the program should be reconsidered, or at a minimum should be applied in extremely limited circumstances. Under the canons of statutory construction, any such provision of law that would authorize a contravention of the very goals and objectives of the act – in this case allowing dischargers to violate existing water quality standards and setting standards not in protection of the designated uses - should be firmly grounded in explicit statutory direction. Currently, the CWA's statutory language provides no such explicit authorization.

c. Retention of "underlying uses" is a legal fiction, which in practice will have no bearing on water quality protection when a new time-limited water quality standard that is less protective gets adopted as a variance. Therefore, Ecology's contention that a variance will actively drive water quality improvements in the longer term is not supported by the regulatory structure, since a variance will perpetuate a less protective standard.

Ecology states that, "By issuing a variance instead of a use change, the underlying use and criteria are preserved."[232] Temporary relief from compliance with existing water quality standards is a benefit to NDPES permittees who will be allowed to discharge pollutants above

[231] EPA. 2013. Discharger-specific Variances on a Broader Scale: Developing Credible Rationales for Variances that Apply to Multiple Dischargers, EPA-820-F-13-012. Avaiable at http://water.epa.gov/scitech/swguidance/standards/upload/Discharger-specific-Variances-on-a-Broader-Scale-Developing-Credible-Rationales-for-Variances-that-Apply-to-Multiple-Dischargers-Frequently-Asked-Questions.pdf

[232] Washington Department of Ecology, 2016 Decisions Document. P 79.

levels legally allowed under the CWA. No such benefit exists for the designated uses, during the term of the variance--potentially for decades. However, removing the existing water quality standards, including the designated uses and attendant criteria, for waterbodies or permits provides no-real protection for aquatic life, which the CWA is designed to protect. Ecology's rules purport to retain the "underlying use" consistent with new federal regulations governing the same issue. However, retention of a use that no longer has associated criteria set to protect it is merely a legal fiction. The fact of the matter is that a variance eliminates the designated use and the criteria of the waterbody or permit, and therefore establishes a new water quality standard.

The argument that the conceptual retention of underlying uses somehow provides more protection for water quality is not supported in reality. A variance does not allow underlying uses to be "maintained" --they are *replaced with the allowance of a variance*, with the hope that the original designated uses can be restored after potentially decades of implementing a less protective water quality standard, based on a less protective designated use. Implementation of a less protective water quality standard is not a pathway to reduce toxic chemicals in fish and human consumers, but instead a slow erosion of water quality protection, and a convenient legal shield for dischargers of harmful pollutants that are unable or unwilling to comply with water quality standards. It is therefore is no great comfort that somehow a variance, i.e. a lesser, substandard water quality standard, can support improved protection of aquatic life or human health.

d. Variances, although "time-limited," will have permanent effects on all of the designated uses, including the status of aquatic resources, and the tribes' ability to harvest and consume fish and shellfish.

Fish populations have currently reached all time lows, leaving little to no allowances for both treaty and non-treaty harvest.[233] Concurrently, it is documented that designated use habitat, i.e. salmon habitat, continues to decline.[234] Many of these same species of salmon are

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[233] See Pacific Fishery Management Council (2016) Preseason Report I: Stock Abundance Analysis and Environmental Assessment Part 1 for 2016 Ocean Salmon Fishery Regulations; Regulation Identifier Number 0648-BF56 (*Published February 2016*), available at http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/preseason-reports/2016-preseason-report-i/

see also Pacific Fishery Management Council (2016) Review of 2015 Ocean Salmon Fisheries Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan (*Published February 2016*). Available at http://www.pcouncil.org/wp-content/uploads/2016/02/Review_of_2015_Salmon_Fisheries_FullDocument.pdf currently listed as threatened under the federal Endangered Species Act. Given the particular fragility of these designated uses, variances are likely to have long-term impacts on the resource. Recent studies on water quality impacts to coho salmon demonstrate that there are fairly immediate effects of stormwater pollution resulting in pre-spawn mortalities.[235] Several years, let alone several decades, of discharges can result in a downward spiral of adverse effects to the salmon lifecycle in a given watershed or near-shore areas. Therefore, although regulations purport to be time-limited, the reality is that authorized pollution discharges above existing standards necessary to protect the designated use, could result in permanent extirpation of treaty-reserved resources. Thus, while regulations hold out hope that a water quality standard will be restored, the species they are designed to protect may not.

2. Variances, if authorized should only be applied under very limited circumstances.

Although the application of variances under the Clean Water Act may not be legally plausible, variances will likely be deployed as an "implementation tool" by the Department of Ecology. As such the following comments are provided to encourage careful and limited application of this rule. Under no circumstances should a variance be applied where it temporarily removes or replaces a designated use that is concomitantly a treaty-reserved right.

a. No variance should be authorized prior to the development of a TMDL

The proposed rules authorize a variance prior to conducting a TMDL. Instead the rules require "water quality data and analysis to characterize receiving and discharge water pollutant concentrations."[236] This approach circumvents the regulatory framework of the federal Clean Water Act, by allowing the department to ignore the requirements of §303(d) to list polluted waters and subsequently develop a TMDL to set pollutant limits. Ecology's proposed rules allow the department to replace the existing water quality standards, without first trying to clean up the water through the predesigned CWA regulatory framework – namely development and implementation of a TMDL. The federal district court has recently provided the Department of Ecology direction on the matter of whether Ecology can and should pursue alternative measures in lieu of TMDLs when water bodies are listed as impaired:

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[235] Spromberg, J. A., Baldwin, D. H., Damm, S. E., McIntyre, J. K., Huff, M., Sloan, C. A., Anulacion, B. F., Davis, J. W., Scholz, N. L. (2016), Coho salmon spawner mortality in western US urban watersheds: bioinfiltration prevents lethal storm water impacts. Journal of Applied Ecology, 53: 398–407. doi: 10.1111/1365-2664.12534

[236] Proposed rules at WAC 173-201A-420(3)(d) &(f)

> States may pursue reasonable courses to reducing pollution in addition to establishing TMDLs. *See, e.g., City of Arcadia v. U.S. EPA*, 411 F.3d 1103, 1106 (9th Cir. 2005) ("states remain at the front line of combatting pollution"). *However, nothing in the CWA provides that states may pursue these courses in place of, or as a means of indefinitely delaying, a TMLD [sic]*. To the contrary, the CWA expressly requires states to produce a TMDL for each pollutant of concern in each 303(d) water segment. [237]

Given both the direction of the courts and the clear statutory language of the CWA requiring TMDLs for impaired waters[238] it seems prudent that Ecology first attempt to restore waters, before changing water quality standards to relieve dischargers of their CWA compliance burdens.

b. Variances that are authorized for excessive periods of time will not be time-limited, because they may have permanent and lasting impacts.

Variances that are allowed to be open ended, whether by process of continual renewal or failure to set a date of expiration, do not fall within the limited EPA interpretation of the CWA to be a time-limited and targeted change in the criteria for the term of the variance. Moreover, variances with durations that extend for generations in length (e.g. 20, 30, or 40 years) are not temporary, because they set in place a less stringent standard of protection for such an excessive length of time that they are likely to permanently impact human health and natural resources. Also, discharging at levels known to violate water quality standards for extensive periods of time is likely to impact designated uses to such an degree that the long term effects on the use may in fact be permanent. This is counter to the intent of variances, i.e., variances are intended to prevent permanent downgrade in use, not effectively encourage a permanent downgrade.

c. The definition of a variance should limit the duration – include requirement for expiration and limit duration between 3 and 10 years.

[237] Sierra Club v EPA, Case No. 11-CV-1759-BJR (W.D. Wash 2015)

[238] 33 U.S.C. § 1313(d)

Proposed variance regulations should require explicit time limits, and the duration of any given variance should be limited between three and ten years.[239] Ecology's proposed rule language denotes variances as "time-limited," consistent with new federal regulations on the subject, but provides no such direction as to the length of time that constitutes a reasonable time limit. Therefore, it is recommended that definitional language or subsequent eligibility criteria include explicit limitations on the duration and require an expiration date, as opposed to providing the "time period for which the variance is applicable."[240]

d. Variances should not apply for purposes of implementing section 303(d) of the Clean Water Act.

According to recent EPA guidance, variances are only intended to apply to section 401 water quality certifications and 402 NPDES permits of the CWA. As discussed above, since a variance is intended to preserve the underlying designated use, CWA programs such as 303(d) listing should still be based on the underlying use, and not the interim criteria, i.e., the variance. EPA has clearly stated, "any implementation of CWA section 303(d) to list impaired waters must continue to be based on the designated uses and criteria for the waterbody rather than the interim requirements."[241] EPA proposed regulations on variances further underscore that variances should not apply for purposes of TMDL development or 303(d) listing.

> The interim requirements specified in the WQS variance are in effect during the term of the WQS variance and apply for CWA section 402 permitting purposes and in issuing certifications under section 401 of the Act for the permittee(s), pollutant(s), and/or water body or waterbody segment(s) covered by the WQS variance.[242]

[239] EPA. 2013. Supplemental Information for Water Quality Standards Regulatory Clarifications Proposed Rule. EPA 820-F-13-027, at sec 131.14(b)(iii) available at http://water.epa.gov/lawsregs/lawsguidance/wqs_index.cfm#proposed

[240] Proposed Rules at WAC 173-201A-420 6(a)

[241] EPA. 2013. supra

[242] EPA. 2013. Supplemental Information for Water Quality Standards Regulatory Clarifications Proposed Rule. EPA 820-F-13-027, at sec 131.14(a)2(ii) available at http://water.epa.gov/lawsregs/lawsguidance/wqs_index.cfm#proposed

Therefore, Ecology rules should clearly state that variances do not apply to section 303 programs such as the impaired waters listings and TMDLs.[243] This is consistent with our comments above regarding TMDLs, in that TMDLs should precede a variance, not come after or during. Ecology should include language in their proposed rules to clarify the appropriate sequence of CWA implementation.

e. Variances, if applicable at all, must only apply to individual dischargers.

To be consistent with EPA guidance to preserve the underlying uses, Ecology should seek to minimize the impacts associated with a time-limited water quality standard change, by not alleviating the burden of protecting the designated uses for both point and nonpoint sources. The only conceivable way to avoid far reaching impacts on natural resources from variances is to limit the scope of the variance to individual dischargers, consistent with EPA's earlier guidance on the subject. In this manner, variances will only apply to a WQBEL for a specific parameter, and need not temporarily change the entire designated use that applies to the waterbody. This simple and straightforward approach will allow Ecology to avoid setting the stage for legal conflicts – such as developing new, lesser protective standards in hopes of preserving the underlying designated uses – which will eventually only add to confusion for the both the discharger and the public.

f. Ecology should include additional variance requirements to ensure that variances do not violate other state and federal regulations or impair treaty rights

Ecology's proposed rules for variances, if pursued despite the objections contained herein, should include a section detailing limitations on eligibility, to avoid potential conflict of laws or situations where subsequent variance approvals will harm resources. Eligibility requirements are also a simple way to communicate to variance applicants that there are other statutory and common law considerations that Ecology and EPA must consider. It also clearly establishes further limitations to avoid conflict of laws.

Most importantly, regulations should clarify that no variance will be authorized that impairs or impedes a treaty reserved right.

The following are suggestions for eligibility requirements that other states have also applied to their variance requirements:

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[243] EPA. 2013. Discharger-specific Variances on a Broader Scale: Developing Credible Rationales for Variances that Apply to Multiple Dischargers, EPA-820-F-13-012. Available at http://water.epa.gov/scitech/swguidance/standards/upload/Discharger-specific-Variances-on-a-Broader-Scale-Developing-Credible-Rationales-for-Variances-that-Apply-to-Multiple-Dischargers-Frequently-Asked-Questions.pdf

- Variances may not jeopardize ESA-listed species or critical habitat
- Variances may not impair or impede treaty-reserved rights and resources.
- Variances may not result in unreasonable risk to human health or environment
- Variances may not impair an existing use
- Variances must comply with antidegradation requirements
- Variances may not impair downstream waters including those within tribal jurisdiction

g. ***Proposed variance rules should continue to require that notice of a variance application and all subsequent actions are given to tribes. Such notification should be provided to those <u>affected</u> not just those tribes that Washington State determines to have "jurisdiction." Tribes should be given notice about all subsequent administrative actions related to variances, not just applications***

Early notification and consultation with tribes regarding application of a variance is important and should be maintained. The current provision in the proposed rules requires notice to tribes and states with "jurisdiction" that is either downstream or adjacent to the proposed variance.[244] While the tribes construe their co-management status and treaty-reserved rights as providing the necessary "jurisdiction," the proposed language leaves such a jurisdictional determination up to the discretion of the department. The treaty tribes of Washington have constitutionally protected, federally adjudicated, treaty-reserved rights to natural resources, which traverse most waters in western Washington. As such many tribes could be impacted by a variance regardless of the location of their reservation or trust (fee) lands. To avoid complications and disputes regarding what is and is not jurisdictional, we recommend that notice requirements be sent to "all affected tribes."

Tribes should also be provided notice about all subsequent actions related to variances including reevaluations, etc.

h. ***Variances that address nonpoint sources must include an enforceable mechanism to ensure compliance with water quality standards***

Ecology's proposed rules provide for documentation of the BMPs for nonpoint sources that meet the requirements of RCW 90.48. However, Washington currently lacks approved BMPs and an adequate program to ensure their implementation consistent with the requirements of WAC 173-201A-510, and other state and federal obligations.

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[244] Proposed rules at WAC 173-201A-420(5)

In order to ensure that a variance structured to make progress as intended, it must contain enforceable limits. To the extent the BMPS are required as a limit for nonpoint sources, those limits need to be accompanied by clear-cut enforceable mechanisms and a demonstration of how the selected BMPs will achieve compliance with water quality standards and the requirements of RCW 90.48. Without enforceable mechanisms, BMPs, variances, and ultimately water quality standard compliance will have no accountability for being achieved within the time frame allotted. Ecology should further expand upon how BMPs for unpermitted dischargers will take effect, be designed to meet water quality standards, and ultimately enforced. Absent clear assurances that BMPs for non-permitted sources will be both implemented and adequately enforced, no such variance should be authorized.

i. Per federal regulations, variance "renewals" should not be authorized separately from a new variance application and review process. Interim reviews of multi-discharger variances should be subject to public process and evaluated on the entirety of the impacts and cumulative effects of the programmatic proposal. Reevaluations of variances must be subject to EPA review, and a variance should be terminated if reevaluation does not occur.

EPA regulations governing variance provisions do not provide for renewal. Instead federal regulations provide that a state may adopt a "subsequent WQS variance consistent with this section."[245] This, however, suggests that a complete variance application must be submitted, again, consistent with the requirements of 40 CFR 131.14, including EPA review and approval. There is no provision that would allow EPA to approve or for Ecology to authorize a variance renewal as Ecology provides for in proposed WAC 173-201A-420(1)(e). Variance renewal sets the stage for continual perpetuation of a variance and administrative extension, which is counter to the definition of a variance in that they are supposed to be "time-limited." Moreover, a renewal has the ability to circumvent public process, EPA and tribal review, and consideration of current information on treatment and water quality data. To avoid potential conflicts with federal regulations, "renewals" should not be authorized.

Additionally, Washington's proposed variances interim reviews do not adequately address public process for variances that apply to multiple dischargers. 40 CFR 131.14(b)(1)(v) provides that variances exceeding five years must include a provision for how "the state intends to obtain public input on the reevaluation." Yet Ecology's proposed rules limit public process on variance reevaluation to individual permits during the permit cycle and water body variances.[246] There is no provision in the proposed regulations to evaluate the cumulative impacts and the

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[245] 40 CFR 131.14(b)(1)(iv)

[246] see WAC 173-201A-420(8)(b)

entirety of the effects from a multi-discharger variance and open such a review to public input, except in the context of individual permit renewals. This approach segments the reevaluation of a potentially broad and far-ranging variance. If variances are evaluated only on the individual permit scale, then they should only be authorized on the individual permit scale. Federal regulations requiring review of variances were intended to be additive to existing public process and review opportunities. If EPA thought the NPDES permit cycle was an adequate mechanism to review variances, then they would have expressly recommended such. Instead, EPA provided for additional review of variances. Dischargers should not be afforded the convenience of applying for a broad exemption, while not being held accountable to the review of the impacts at both the individual and multi-discharger scale. Therefore, the variance in its entirety should be reviewed subject to public input, on a separate schedule; while individualized impacts are again considered during the NPDES permit cycle.

Additionally, federal regulations state that the results of such reevaluation must be submitted to EPA within 30 days of completion,[247] but Washington's proposed regulations make no mention of submission of reevaluations to EPA. To provide consistent messaging to potential applicants, proposed rules should clarify that EPA must review reevaluations.

Finally, proposed rules should include federal requirements that a variance is no longer the applicable water quality standard "if the State does not conduct a reevaluation consistent with the frequency specified in the WQS variance or the results are not submitted to EPA."[248]

j. Variances should include requirements for dedicated monitoring and funding to implement it

In order to ensure enforceability, engage adaptive management, and observe progress, variances will need to require extensive water quality, effectiveness, and implementation monitoring. In the case of toxics, such monitoring can be expensive, and therefore is likely to go unimplemented due to cost. Moreover, existing state ambient monitoring is not comprehensive enough to ensure adequate oversight is maintained. Therefore, variance requirements need to establish mandatory monitoring and assurances of funding as a means to guarantee ongoing observation of progress. Without such monitoring data, enforcement and adaptive management will be impossible, rendering the variance ineffective, and allow failure of its ultimate objectives – attainment of standards in the time allotted.

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[247] 40 CFR 131.14(b)(1)(v)

[248] 40 CFR 131.14(b)(1)(vi)

B. Compliance Schedules

Proposed Compliance Schedule Rules Are Overbroad, And Afford Ecology Too Much Discretion In Delaying Permit Compliance With Water Quality Standards. Rule Language Should Be Further Refined To Limit The Duration And Application.

1. Proposed regulations need to provide guidance on time limits.

According to federal regulations, compliance schedules must require compliance "as soon as possible, but not later than the applicable statutory deadline under the CWA."[249] The CWA sets many deadlines for the reduction and elimination of discharges, many of which have already passed.[250] For example, the CWA set a goal that all discharges to navigable waters be eliminated by 1987.[251] The CWA also sets requirements that technological limits and secondary treatment were established by 1977.[252] While the goal to eliminate harmful discharges by 1987 was admittedly optimistic, nothing in the act establishes that NPDES permit compliance with water quality standards can be suspended indefinitely or provides that states should have unlimited discretion in delaying compliance longer than a five year NPDES permit cycle. Existing Washington State regulations set compliance schedule limits at 10 years. Recent state legislation extended those limitations, but only under limited circumstances. EPA has yet to review and approve the state's proposed extension for compliance schedules, whether legislated or proposed via rule.

Ecology's proposed regulations allow for potentially lengthy periods of noncompliance with state water quality standards, as they do not specify time limits. Longer timelines are problematic for several reasons. The longer the time line for compliance, the more difficult it will be for staff - both inside and outside of Ecology – to track progress. The longer the time line, the more likely administration changes will occur, resulting in a lack of policy and staff

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249 See CFR 122.47(2)(a)

250 See 33 USC sec 1251(a)(1); See also 33 USC sec 1311(b)(1)(A),(B) and (C), 1311(b)(2)(C),(D) and (E), 1311(b)(3), 1311

251 sec 1251(a)(1)

252 See sec 1311(b)(1)

continuity. Longer timelines also make it more likely that permits will be neglected, resulting in less immediate oversight and accountability. And the longer the timeline, the greater the likelihood that damages to treaty-reserved resources could occur, because essentially water quality standard noncompliance is authorized, allowing dischargers to pollute at levels known to be problematic to the protection of designated (also treaty-reserved) uses.

For these reasons, the CWA established permit reissuances on relatively short, five-year cycles. The CWA also intended to usher in pollution controls in rather short order, as evidenced by the numerous deadlines seeking permit compliance decades ago. Long duration compliance schedules could undermine these CWA goals, objectives, and mandates; by allowing permittees to effectively suspend NPDES permit compliance for numerous undefined consecutive years.

Although, EPA does not expressly state the limitations of the "timeframe allowed," everything in the CWA points to the fact that such schedules should be, at a minimum, attuned to compliance with the CWA, which generally speaking, establishes administration of NPDES permits on a maximum of five year cycles.

2. Compliance schedules should require interim numeric effluent limits in conjunction with narrative limits, when such limits are applicable.

The CWA requires, among other things, that compliance schedules establish clearly enforceable limits. The CWA defines compliance schedules as follows:

> The term "schedule of compliance" means a schedule of remedial measures including an *enforceable* sequence of actions or operations leading to compliance with an effluent limitation, other limitation, prohibition, or standard. [253]

For a compliance schedule to be enforceable, it must have clear benchmarks for determining progress; otherwise, attainment with interim limits cannot be assessed, and compliance can only be determined at the expiration of the schedule. If compliance can only be determined upon expiration (meeting a final effluent limit or standard), and compliance is ultimately not achieved, then a discharger could effectively receive "safe harbor" for the entire period of the schedule. This would serve to indemnify dischargers from CWA liability, despite the fact that dischargers are not achieving compliance with standards. To avoid this situation, compliance schedules should utilize numeric interim effluent limits, because they are a simple and transparent way to assess the discharger's progress during the period necessary to achieve

[253] 33 USC sec 1362(17)

compliance. Although there are instances that narrative limits are necessary to set deadlines for construction and other actions, such limits must also be combined with numeric limits for the aforementioned reasons to ensure enforceability.

3. Ecology's proposed regulations should further define the limited circumstances when a compliance schedule applies.

According to EPA, compliance schedules should only be developed "when the designated use is attainable, but the discharger needs additional time to modify or upgrade treatment facilities in order to meet its WQBEL." [254] However, Ecology's proposed authorizing language is vague regarding a compliance schedule's precise application, which could lead to overuse of this tool, allowing the agency or dischargers to circumvent the application of more rigorous, but legally appropriate pathways. To prevent compliance tool overuse, Ecology should clearly distinguish when a compliance schedule versus a variance versus a Use Attainability (UAA) Analysis is applicable. These distinctions will help tribes (and the public) better understand when, and what tools are most likely to apply. Furthermore, better definition of scope will ensure that the entire array of implementation tools (variances, compliance schedules, UAA, permit denial) are not overlapping or allowed to be doubled-up, which could result in a severe relaxing of water quality regulation and a lack of water quality protections for treaty-reserved resources. For example, a compliance schedule should not be authorized for the purpose of meeting the limits established by a variance.

4. Compliance schedules should not be authorized for purposes of "conducting studies."

Ecology is proposing that compliance schedules can be applied for the purposes of allowing noncompliance with quality standards for the period of time needed to "complete water quality studies related to implementation of permit requirements to meet effluent limits."[255] EPA has stated that compliance schedules are not appropriate for such measures. For example, EPA has explained that compliance schedules are not available for the sole purposes of developing

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[254] See EPA. 2014. Water Quality Standards Handbook, available at http://water.epa.gov/scitech/swguidance/standards/handbook/chapter05.cfm#section53

[255] Proposed standards at WA-173-201A-510(4)(a)(iv) available at http://www.ecy.wa.gov/laws-rules/wac173201a/p1203.pdf

either TMDLs or UAAs.[256] Therefore, it is logical that if compliance schedules are inappropriate for developing studies leading to waste load allocations and their subsequent effluent limitations (i.e. TMDLs), then compliance schedules are not appropriate for developing other "studies" which would contain less accountability mechanisms than a TMDL, but presumably used for the similar purpose of developing effluent limits. Allowing for "studies" to delay attainment of water quality standards sets the stage for circumvention of the CWA, because dischargers could take years to conduct research, while avoiding more specific concrete measures that might otherwise achieve compliance or at the very least progress toward clean water. Tribes do not suggest that research or other studies should be avoided – to contrary, the tribes would encourage Ecology and dischargers to undertake the necessary research and studies to advance treatment. However, compliance with standards need not be suspended to complete this work.

5. Ecology should require a transparent demonstration on the record that compliance schedules will achieve attainment with standards in the time allotted.

To ensure that compliance schedules are justified, and consistent with federal and state regulations, Ecology must include a requirement in the proposed rules that all schedules are accompanied by a demonstration that compliance schedules will lead to attainment of water quality standards in the time allotted. Such a justification must be made available to the public. This recommendation is consistent with EPA requirements, where EPA has stated:

> In order to grant a compliance schedule in an NPDES permit, the permtting authority has to make a reasonable finding, adequately supported by the administrative record, that the compliance schedule "will lead to compliance with an effluent limitation ... " "to meet water quality standards" by the end of the compliance schedule as required by sections 301(b)(I)(C) and 502(17) of the CWA. *See also 40* C.F.R. §§ 122.2, 122.44(d)(1)(vii)(A)[257]

[256] EPA. 2007. Memorandum from James A. Hanlon, Director of the EPA Office of Water to Alexi Strauss, Director of Water Division EPA Region 9, re: compliance schedules for water quality based effluent limitations in NPDES permits, May 10, 2007 at 10 and 11.

[257] EPA. 2007. supra

6. ***The rule amendment extends the time limit for compliance schedules beyond ten years without consideration of the circumstances prescribed by RCW 90.48.605, and is therefore not authorized by state law.***

RCW 90.48.605 directs the department to amend the state's water quality standards to allow compliance schedules in excess of ten years. While these extensions may not necessarily be in compliance with federal law CWA (see above), they do establish a very limited state law basis for extending schedules beyond the preexisting ten-year limit. The state law establishes a four-part test for when compliance schedules can exceed ten years.

> Compliance schedules for the permits may exceed ten years if the department determines that:
>
> (1) The permittee is meeting its requirements under the total maximum daily load as soon as possible;
>
> (2) The actions proposed in the compliance schedule are sufficient to achieve water quality standards as soon as possible;
>
> (3) A compliance schedule is appropriate; and
>
> (4) The permittee is not able to meet its waste load allocation solely by controlling and treating its own effluent.[258]

Nothing in RCW 90.48.605 authorizes the department to develop compliance schedules outside the bounds of these limitations. However, the proposed rules establish that compliance schedules can be developed for a duration in excess of ten years without meeting the criteria above. For example, the proposed rules authorize compliance schedules in excess of ten years, without the development of a TMDL, and regardless of whether a permittee is able to achieve compliance by solely treating its own effluent. The above state law was intended to provide additional flexibility for only those limited situations where both point and nonpoint source reductions were simultaneously necessary to achieve compliance with standards, and therefore additional time would be necessary. This approach provided for enhanced flexibility under situations where point and nonpoint source pollutant load reductions were clearly prescribed, as established through a TMDL, and it was evident that nonpoint source controls would be necessary to ultimately bring both the permit and water body into compliance. Presumably, this approach would take more time, given Washington's struggle to successfully control

[258] RCW 90.48.605

nonpoint sources of pollution. However, the proposed rules ignore the legislature's statutory design that provided only limited flexibility for these special circumstances, and instead provides authorization for extended compliance schedules without the required accountability. Ecology must require that TMDL development and subsequent EPA approval is complete and limit extensions to those situations where both point and nonpoint source reductions are a necessary component of permit compliance.

7. Proposed rules create a disincentive to complete approvable TMDLs

The proposed rules set two different legal standards for when and how long a compliance schedule can be authorized, which creates a disincentive to finalize TMDLs. This is problematic because Ecology has allowed the delay of TMDL completion in several cases, resulting in relaxed NPDES discharger liability, including most recently the Spokane River for PCBs and in South Puget Sound for Dissolved Oxygen. These delays have put off triggering the CWA's established process for setting more stringent WQBELs for NPDES permittees.

The structure of Ecology's compliance schedules rules will further avoid the CWA required TMDL development for impaired waters in several ways. First, Ecology provides no limitations on a compliance schedules if a TMDL is not in place, and in fact expressly notes the eligibility of compliance schedules for the purpose of conducting "studies." This allows a discharger to remain in noncompliance, while Ecology studies the problem for potentially decades and also avoids establishing the additional permit and water body limitations to bring waters back into compliance. (Note that the federal court recently held that EPA acted in an arbitrary and capricious manner for approving such an approach in Spokane). In contrast, the adoption of a TMDL would trigger additional requirements under Ecology's proposed rules, limiting the application of a compliance schedule to those circumstances where nonpoint source reductions were necessary for a permittee to meet its own waste load allocation. Creating more stringent requirements for compliance schedules when TMDLs apply, which already include an additional level of accountability for NPDES dischargers, but not doing so when a TMDL does not apply, encourages NPDES dischargers to further avoid TMDL development. Ecology should not effectively create incentives that reward TMDL avoidance. Instead, Ecology should use regulatory incentives as a means to accomplish CWA process (not avoid it), such as applying enhanced flexibility of compliance schedules only under the limited circumstances contemplated by the legislature - when a TMDL was completed and approved, and nonpoint source reductions were a necessary component of meeting WLA.

C. Intake Credits

THE USE AND APPLICATION OF INTAKE CREDITS SHOULD BE FURTHER REFINED AND NARROWED TO ENSURE THAT CREDITS ARE ONLY APPLIED TO CIRCUMSTANCES THAT WILL NOT CAUSE OR CONTRIBUTE TO VIOLATIONS OF WATER QUALITY STANDARDS OR IN ANY WAY INCREASE THE POLLUTANT LEVEL OF DOWNSTREAM TRIBAL WATERS OR DOWNSTREAM WATER RESOURCES OF AFFECTED TRIBES

1. ***To avoid potential violations of water quality standards, intake credits should be limited to the following circumstances***:

   a. The facility does not add the intake pollutant of concern if it is a toxic parameter
   b. The facility does not alter the intake pollutant chemically or physically
   c. When intake of the pollutant of concern comes from the same *surface* body of water from the immediate vicinity of the discharge.
   d. When the intake credit is used to demonstrate *compliance with* effluent limitations, as opposed to avoiding the setting of effluent limitations through the Reasonable Potential Analysis review.
   e. Prohibits the use of mixing zones for demonstrating compliance with requirements and water quality standards.
   f. Prohibit any increase in pollutant concentration to avoid anti-degradation violations

2. ***Further refinement of the definition and criteria applicable to intake credits is needed.***

The proposed definition for intake credits is overbroad in that it allows the application of intake credits to the development of both technology based effluent limits (TBEL), water quality based effluent limits (WQBEL) and Reasonable Potential Analysis (RPA). It also does not adequately define what bodies of water intake and subsequent discharge can come from. Therefore, further refinement of the definition and subsequent criteria are recommended as follows.

   a. ***Definitions and subsequent regulations should prohibit use of intake credits in the RPA.***

Federal regulations provide that intake credits should only apply to TBELs.[259] Therefore, intake credits should <u>not</u> apply to the RPA, because they should generally not be used as procedure to avoid triggering effluent limitations, but instead used solely as a means to demonstrate

[259] 40 CFR 122.45(g)

compliance with end of pipe standards under very limited circumstances. If intake credits are allowed for the RPA, then they could be used to circumvent the development WQBEL, and therefore avoid permit limits that would otherwise help control the discharge of pollutants or at a minimum transparently document that facilities are potential contributors. For example, the RPA should carefully consider and document whether a facility was also adding the pollutant of concern to a water body, in additional to that which was in the intake. If the facility is discharging the pollutant of concern, that discharge should be publically documented through the assignment of an effluent limitation. Documentation of an effluent limitation is a transparent way of establishing that the facility also introduces and subsequently discharges the pollutant of concern. Moreover, establishing effluent limitations is an important part of adaptively managing pollutant loading in a watershed through subsequent efforts such as TMDLs. When pollutant loading from NPDES permits is not documented in an effluent limitation, facilities may be overlooked in the TMDL process. For example, a facility's role in overall pollution reduction could be overlooked in a TMDL analysis, if they were not clearly documented as a facility generating a pollutant of concern. This could then result in a facility failing to reduce overall loading on par with the rest of the watershed's allocations.

b. Prohibition of credits for intake pollutants partially or entirely due to human activity should be maintained

As mentioned above, ground water withdrawal and subsequent discharge presents significant opportunity to alter receiving water quality. Under no circumstances should intake credits authorize the acceleration of pollutant migration. We strongly support this provision.

c. Deletions and clarifications are recommended to further refine application of intake credits and prevent violation of the Clean Water Act.

1) Clarify 460(1)(d). This section proposes the following:

(d) Where intake water for a facility is provided by a municipal water supply system and the supplier provides treatment of the raw water that removes an intake water pollutant, the concentration of the intake water pollutant will be determined at the point where the water enters the water supplier's distribution system.

It is not clear from the language whether a credit is allowed before or after treatment from a drinking water facility. The language should clarify that credits will not be provided for pollutants present in the water prior to treatment. If this provision were to be construed to the contrary, it could provide a pollution allowance for a pollutant that is not actually present in the "intake" of the discharger, because it was removed in the prior drinking water treatment.

Intake credits must only be allowed for pollutants that merely pass through a facility without either an addition or alternation of the physical and chemical proprieties of the pollutant.

2) Delete section 460(1)(e)

Ecology proposes to allow the use of intake credits when intake water is mixed with other sources of intake water, including those not from the same body of water as defined in 460(1)(e). The rule provides that the department "may derive an effluent limit reflecting the flow-weighted amount of each source of the pollutant." This section potentially allows intake credits to apply to intake waters other than those that are from the "same body of water," and therefore is inconsistent with the general provision provided in section 1 that prohibits intake credits applied to waters that are not hydrologically connected (see also issues regarding this provision above). Although Ecology proposes the use of flow-weighting as means to attempt to account for only those pollutants from the same water body, the reality is that these calculations can only provide rudimentary estimations of pollution intake, especially when considering the complexity of accounting for toxics which are often present at low concentrations and are difficult to detect. Also, it is unlikely that flow-weighted calculations will capture the changes in intake flow over the course of the five-year permit cycle, or seasonal/yearly variations in the pollutant concentrations. The result is that it is likely, if not certain, that co-mingling of waters and pollutants are likely to occur, which will not easily be accounted for. This introduces potential for discharge of unpermitted pollutants (from other waters), which are inconsistent with the act and federal regulations.[260] Moreover, the added complexity is likely to obfuscate the crediting process, making it more difficult for the public to track the use of the credits. Ultimately, the provision makes the development of WQBEL more complex, makes the use of intake credits less transparent and more difficult for the public or permit reviewers to understand, and introduces more opportunity for mathematical error or inaccurate representations of pollutant loading, which may lead to unpermitted discharges in violation of the Act.

3) Delete mixing zone allowance in 460(2)(a)(iv)

Ecology should not allow a NPDES permit to factor in additional dilution through use of a mixing zone to demonstrate no net addition of mass through an intake credit. To do so allows for potential net increase of pollutant at the point of discharge and allows intake credits to be used as a means to potentially increase loading.

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[260] See sect 1311; see also 40 CFR 122.44 and 122.45

4) Delete allowance to increase pollutant concentration in discharge unless it violates applicable water quality standard in 460(2)(a)(iv) – this is a direct violation of anti-degradation requirements.

Ecology must remove the language, "unless the increased concentration does not cause or contribute to an excursion above an applicable water quality standard." This language authorizes the use of intake credits to discharge pollutants in excess of the receiving water's existing water quality in situations where existing water quality is of a higher quality than the standards. Ecology's anti-degradation requirements prohibit degrading higher quality waters to the level of water quality standards unless a tier II analysis is conducted and such action is determined to be the "overriding public interest." The relevant provisions of law provide:

> (1) Whenever a water quality constituent is of a higher quality than a criterion designated for that water under this chapter, new or expanded actions within the categories identified in subsection (2) of this section that are expected to cause a measurable change in the quality of the water (see subsection (3) of this section) may not be allowed unless the department determines that the lowering of water quality is necessary and in the overriding public interest (see subsection (4) of this section). [261]

d. TMDLs development must be required prior to allowing intake credits for discharges into 303(d) listed waters.

When receiving waters are polluted, it is important that extra scrutiny is applied to facilitate cleanup, and provide accountability that NPDES permits are not contributing to the problem. Under the CWA, TMDL development is the process by which this occurs.

Permit tools which provide dischargers with relief from CWA compliance should not apply under circumstances when receiving waters are polluted and in need of clean up, i.e., they are listed as category five on the 303(d) list of impaired waters and TMDL development is necessary. Tools such as intake credits should be limited in these circumstances, because they may authorize dischargers to perpetuate status quo conditions. Specifically, the situation to avoid is when the pollutant causing impairment is the same pollutant authorized for an intake credit, and the intake credit is used as a basis for avoiding effluent limitations. Under such

[261] WAC 173-320(1)

circumstances when a discharger has the pollutant of concern in their intake, the discharger should be included in the CWA required analysis and assigned loading reductions via development of a TMDL, waste load allocations, and eventually new WQBELs. Otherwise, intake credits can be used as a means to escape the necessary CWA required watershed adaptive management. Before assigning new permit limits using intake credits, Ecology should undertake the CWA TMDL process. Using this approach, Ecology will have a better informational foundation by which to judge whether an intake credit will ultimately impact downstream designated uses or cause or contribute to a violation of water quality standards.

In sum, intake credits should not be allowed for pollutants that are also listed as impairing the receiving waters (as demonstrated on the 303(d) list of impaired waters), until after a TMDL is conducted, and the appropriate waste load allocations have been assigned and translated into effluent limitations.

e. Documenting, reporting, and transparency requirements should be included when intake credits are applied

To ensure that intake credits are applied in a transparent manner, proposed regulations should include requirements that NPDES permits clearly indicate:

- The application of an intake credit to development of a effluent limit
- The application of an intake credit in an RPA, which otherwise would have resulted in an effluent limit
- The pollutant parameter(s) to which the credits are applied
- The basis for the determination

Additionally, all calculations and justifications for credits should be included as part of the NPDES permits record, and should be easily accessible to the public.

D. Combined Sewer Overflow Treatment Plant Regulations

1. ***Proposed use of narrative effluent limits as the primary means for compliance for CSO should be eliminated, because it does not provide assurance of effective treatment, and may contravene both state and federal regulations.***

Proposed regulations should not limit, emphasize, or otherwise dictate that effluent limits for CSO treatment plants should be "primarily" narrative as opposed to numeric. CSO treatment, like any other permit, must comply with water quality standards and protect the designated uses. Both numeric and narrative limits will likely be necessary to achieve these goals when implementation of human health criteria is at issue, and accountability for compliance needs to be assured. Moreover, Ecology cannot contravene EPA's CSO policy, nor Washington's CSO regulations, requiring full compliance with water quality standards and use of water quality based limits, by limiting permit requirements to narrative limits regardless of their effectiveness or accountability.

2. ***Federal legal requirements provide that water quality based effluent limits are required to show compliance with state standards (including HHC) in the second phase of CSO plan implementation unless permittees can otherwise demonstrate compliance with applicable standards.***

Combined Sewer Overflows (CSO) and the treatment for those dischargers fall squarely within the definition of a "point source" [262] under the federal CWA, and are therefore required to obtain a NDPES permit pursuant to section 301 and 402 of the CWA.[263] Further pursuant to the CWA,[264] CSO orders and permits must conform to EPA's CSO policy. Section 1342(q) provides:

> Each permit, order, or decree issued pursuant to this chapter after December 21, 2000, for a discharge from a municipal combined storm and sanitary sewer shall conform to the Combined Sewer Overflow Control Policy signed by the Administrator on April 11, 1994.

[262] 33 USC §1362(12)

[263] see 33 USC §§ 1311(a) & 1342

[264] 33 USC § 1342(q)

EPA's 1994 policy provides that "CSOs are point sources subject to NPDES permit requirements *including both technology-based and water quality-based requirements* of the CWA."[265] The policy further provides that "water quality based requirements are to be based upon the applicable water quality standards."[266]

The EPA policy also lays out the necessary elements for the second phase of CSO permitting, which occurs after the development of the long-term control plan. Those requirements include technology-based limits, narrative limits, *and* water quality-based limits.[267]

While these provision do allow the development of water quality based effluent limits that utilize "performance standards and requirements" designed to satisfy the requirements of the "demonstrative approach" of EPA's policy, they do not simply authorize either states or permittees to utilize narrative standards as a simple surrogate for WQBELs, without the additional accountability of establishing standards and assurances that WQS will be achieved. As an underscore to this point, EPA's guidance on the demonstrative approach provides that the use of performance standards and requirements must ensure that CSO discharges remaining after implementation of the planned control program "will not preclude the attainment of WQS or the receiving waters' designated uses or contribute to their impairment."[268]

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[265] 59 Fed. Reg. 18688, 18695 (April 14, 1994) emphasis added

[266] Id.

[267] 59 Fed Reg. 18696 stating - "Water quality-based effluent limits under 40 CFR 122.44(d)(l) and 122.44(k).requiring, at a minimum, compliance with, no later than the date allowed under the State's WQS the numeric performance standards for the selected CSO controls, based on average design conditions specifying at least one of the following:

i. A maximum number of overflow events per year for specified design conditions consistent with II.C.4.a.i; or

ii. A minimum percentage capture of combined sewage by volume for treatment under specified design conditions consistent with II.C.4.a.ii; or

iii. A minimum removal of the mass of pollutants discharged for specified design conditions consistent with II.C.Q.a.iii; or

iv. performance standards and requirements that are consistent with II.C.4.b. of the Policy"

[268] 59 Fed. Reg. 18693

3. State law requirements for CSO dischargers, including those from CSO treatment plants, also require compliance with WQS and protection of designated uses

Washington State regulations for CSOs are harmonized with federal requirements in that they also require that CSO discharges do not violate water quality standards and ensure protection of designated uses. They also provide that CSOs should not violate sediment quality criteria.[269]

4. Narrative limits are less protective of water quality, and are likely to generate less water quality data to evaluate progress and compliance with federal and state requirements

The aforementioned regulations point to the fact that CSO dischargers are legally required to assure and demonstrate compliance with water quality standards. Ecology should not limit the permit writer's tools necessary to achieve these goals, because narrative limits - especially when they don't contain numeric benchmarks (as the PCHB recently held) - are often not sufficient to demonstrate compliance. Unless dischargers are given discrete numeric limits and required to monitor discharges for those limits, it seems there is little in the way of accountability that water quality standard compliance will be assured. Additionally, it is necessary for permittees to generate water quality monitoring data for human health criteria to both assess the efficacy of treatment as well as progress to meeting overall clean up goals.

Finally, the requirement for primarily narrative limits may undermine the CWA watershed restoration and adaptive management provisions by limiting the development of WQBELs to implement a waste load allocation. Given that CSO dischargers (which are usually in highly urbanized and polluted environments) may be discharging to impaired waters, it is necessary to not restrict the CWAs restoration tools that may be needed for future clean up efforts.

5. Requiring narrative limits merely because of the variability of discharge sets bad precedent for NPDES permits, and is an approach unsupported by federal law.

EPA regulations require water quality based effluent limitation regardless of the variable nature of CSO dischargers. In fact, EPA's policy goes so far as to provide direction on how to calculate effluent limits given the variability of the discharge.[270] Therefore, it is contrary to federal policy

[269] See WAC 173-245-015(1) providing: "All CSO sites shall achieve and at least maintain the greatest reasonable reduction, and neither cause violations of applicable water quality standards, nor restrictions to the characteristic uses of the receiving water, nor accumulation of deposits which: (a) Exceed sediment criteria or standards; or (b) have an adverse biological effect."

[270] 59 Fed. Reg. 18696

to suggest that somehow variability is justification for avoidance of a WQBELs and the primary application of narrative effluent limits. Moreover, nothing in the state or federal clean water acts provide that permits limits should be relaxed simply because pollution occurs either variably or intermittently. To do so, would create a bad precedent that could effectively send a message to dischargers that seasonality, intermittent timing, or variability in discharges affords the permittee an opportunity for a lesser standard or an opportunity to circumvent the necessary CWA adaptive management approach of reducing discharges by upgrading overtime from TBELs to WQBELs to achieve the acts' overarching goals. With such precedent, forestry practices and other industry operations that operate cyclically or seasonally, including any industrial stormwater permittee could argue that only narrative limits should be required in permits, because their discharges too are subject to "variability." Conversely, the CWA ultimately requires compliance with water quality standards and requires the necessary means and accountability to do so, regardless of frequency of discharge. In the case of effluent limitations, the act requires both narrative and numeric limits, applied as necessary to implement water quality standards (including anti-degradation provisions) and also applicable to waste load allocations. Variability of discharge has not been, is not, and should not be a determining factor for the level of accountability applied in an NPDES permit.

V. APPENDICES

A. Undue Delay by the State of Washington

B. Spreadsheet of Chemical Comparisons: NTR, EPA 2015 proposal, WA 2016 proposal, and Oregon Approved (Ridolfi Environmental, 2016), and Tally of Comparisons (NWIFC Technical Work Group)

C. Fish Consumption Rates

D. Additional supporting documentation (electronic files): References and Materials Cited

A. History of Delay by Washington State for Establishing Human Health Criteria

Timeline Summary: History of HHC development in Washington.	
1991-1992	Development of NTR for Washington
1994-2000	Tribal studies of fish consumption are completed and submitted to the state. In 1999, the state convenes an interagency Risk Assessment Forum, which recommends that fish consumption rates be changed in state standards.
2002-2003	National Environmental Justice Advisory Committee report identifies the need to remedy fish consumption rates in state standards, consistent with treaty rights and environmental justice concerns. The Triennial Review of WA state surface water standards focuses on aquatic life criteria, but tribes comment on the need to establish human health criteria.
2007-2010	Tribes meet with state and EPA to discuss development of revised FCR in HHC. Formal workshops are held, and a leadership group is established by Tribes, EPA, and Ecology to track progress. Triennial Review (2010) identifies the need to establish HHC.
2011-2012	Department of Ecology pauses efforts to adopt an FCR in water quality standards and shifts effort to establish fish consumption rate to Toxics Cleanup Program for amending Sediment Management standards. Ten tribes and two tribal consortiums comment on Technical Support Document related to Fish Consumption Rates. Ecology announces in July, 2012 that they will defer the FCR back to the water quality standards process instead. A target date of Fall 2013 is established for a draft rule for human health criteria. Tribes correspond with the state and EPA to express their frustration with the pivot. Investigate West later documents industry influence on the decision to delay.
2013	Incoming Governor Jay Inslee establishes Governor's Informal Advisory Group. Ecology Director Maia Bellon commits to completion of draft rule by the Fall/Winter of 2013/2014. Industry intervenes in state budget process to influence the development of an FCR.
2014	Multiple delays in issuing a draft rule by the Department of Ecology. In April, EPA indicates that they will begin federal promulgation of revised HHC if the state does not complete rule by the end of 2014. In July, Governor Inslee announces direction for rule making, linked to a toxics reduction strategy to be introduced to the WA State Legislature in 2015.
2015	In January, Ecology issues draft rule for HHC and compliance tools, and legislation for increased use of chemical action plans for toxic reduction is introduced. Legislature fails to pass toxics reduction legislation. Governor directs Ecology to withdraw rule and announces intent to file new draft in 2016. EPA files proposed rule.

Narrative History of the Delay by the State of Washington:

1. **Washington State has unduly delayed the adoption of revised human health criteria, thereby subjecting tribal communities to continued harm from exposure to toxic chemicals.**

   a. Early studies of tribal fish consumption rates documented that the NTR value of 6.5 grams per day grossly underestimated tribal fish consumption in Washington. Regional scientifically-defensible data for tribal fish consumption has been available since 1994 for the Columbia River Tribes[271], and since 1996 for Puget Sound Tribes.[272] The state has acknowledged the deficiencies in state standards since at least 1999, when the WA Department of Ecology published a draft analysis and selection of fish consumption rates for risk assessments and risk-based standards.[273]

   b. Triennial Reviews: Tribes have requested that the state remedy the deficiency in state standards since at least 2002, when the issue was raised during the Triennial Review of the state's water quality standards. The 2002 Triennial Review was focused on aquatic life standards, but the issue was explicitly raised again during the 2010 Triennial Review. The Department of Ecology's response to the 2010 Triennial Review included a commitment to address the inadequate fish consumption rate in state water quality standards.

   c. Deferring the issue: Since 2010, the Department of Ecology has repeatedly switched focus on the FCR issue back and forth between the toxic cleanup and water quality divisions, thereby thwarting the timely adoption of more protective HHC. Ecology assigned the analysis of the FCR to the Toxics Cleanup Program in 2010, with the express objective of establishing a FCR that could be used in both sediment management standards and water quality standards.

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[271] CRITFC (Columbia River Inter-Tribal Fish Commission), 1994. A fish consumption survey of the Umatilla, Nez Perce, Yakama and Warm Springs Tribes of the Columbia River Basin. Columbia River Inter-Tribal Fish Commission Report reference #94-03, Portland, Oregon.

[272] Toy, K.A., Polissar, N.L., Liao, S., and Mittelstaedt, G.D. 1996. A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region. Tulalip Tribes, Department of Environment.

[273] Washington State Department of Ecology, 1999. Draft analysis and selection of fish consumption rates for risk assessments and risk-based standards. Ecology Pub. 99-200. L. Kiell and L. Kissinger and an interagency Risk Assessment Forum.

After at least 18 months down that path, the state abandoned the effort in the Toxics Cleanup Program in July 2012, and initiated a new process by the Water Quality Program. The Governor initiated another discussion process for advisory purposes in 2013, known as the Governor's Informal Advisory Group, which concluded in 2014.

2. **The establishment of human health criteria in state water quality standards has been inappropriately influenced by intervention from industry.**

   a. Industry has advocated for lowering one the protectiveness of one input in exchange for another. In the 2010 Triennial Review, representatives commenting for industrial dischargers remarked that the state ought to lower the protective level for the cancer risk rate if they were to raise the fish consumption rate.[274] At the time, the state responded that they had no plan or purpose to change the cancer risk rate. In these and other remarks posted on the Ecology blog, "What People are Saying," industrial representatives characterized the risk rate as a policy decision—an argument that the state appears to have accepted, as the state characterizes many decisions on human health criteria as "risk management" decisions.[275] As other sections of these comments describe, it is the health of tribal people (and other groups that are major consumers of seafood) that are placed at disproportionate risk.

   b. Several investigative reports conducted in 2012 and 2013 concluded that particular influence was exerted by the Boeing Corporation on the Governor and her staff in 2012, immediately preceding the Department of Ecology's decision to defer establishment of a revised fish consumption rate and remove numerical recommendations from their Technical Support Document.[276,277] In May and June of 2013, private corporations, in particular the Boeing Corporation, were reportedly attempting to influence state budget discussions in the Washington

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[274] Washington Department of Ecology; August, 2011. Washington Water Quality Standards 2010 Triennial Review – Comments and Response. http://www.ecy.wa.gov/programs/wq/swqs/TrienRevComm.html

[275] WA Dept. of Ecology; January 2015. "Overview of Key Decisions in Rule Amendment" Ecology Publication no. 14-10-058.

[276] McClure, Robert. March 30, 2013. Business interests trump health concerns in fish consumption fight. Investigate West.

[277] McClure, Robert and Olivia Henry. April 23, 2013. How Boeing, allies torpedoed state's rules on toxic fish.

State Legislature.[278] The legislative discussions prompted the Environmental Protection Agency regional administrator to write the Director of the Department of Ecology to warn that, "*should Washington's process be unnecessarily delayed, the EPA has the authority to amend the NTR human health criteria for Washington*."[279]

3. Since the commencement of rulemaking for human health criteria in the Water Quality Program in 2012, Ecology has breached their own written commitments for a completion date for a draft rule at least three consecutive times as follows.

a. In July 2012, during the pivot and delay from establishing a fish consumption rate in sediment management standards to water quality standards, Ecology Director Ted Sturdevant included a written timeline that listed a target date for completion of a draft rule as the Fall of 2013, with completion of a final rule by the Spring of 2014.[280]

b. Ecology Director Maia Bellon inherited the issue upon taking office in 2013, and wrote to Michael Grayum, the Executive Director of the Northwest Indian Fisheries Commission in February 2014, indicating that *"Ecology plans to have a draft rule available by the end of March 2014, and a final rule submitted to EPA by December 31, 2014."*[281]

c. By April, 2014 it was clear that the March deadline had been breached, and the EPA again wrote to the Department of Ecology about the delay.[282] EPA committed to the initiation of Federal promulgation in 2015 if the state did not meet their own deadline to complete a rule by the end of 2014. In July 2014, Governor Inslee issued a press release announcing that he was directing the Department of Ecology to complete a draft rule by September 30, 2014. The

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[278] Seattle Times. June 26, 2013. Deal or no deal? Conflicting claims fly as state budget bickering persists.

[279] U.S. Environmental Protection Agency; June 21, 2013. . Letter from Region 10 Administrator Dennis McLerran to WA Department of Ecology Director Maia Bellon.

[280] WA Department of Ecology; July 16, 2012. Open letter from Director Ted Sturdevant.

[281]Washington Department of Ecology. February 14, 2014. Letter from Ecology Director Maia Bellon to NWIFC Director Michael Grayum.

[282] U.S. Environmental Protection Agency; April 8, 2014. Letter from Region 10 Administrator Dennis McLerran to WA Department of Ecology Director Maia Bellon.

Governor did not specify a date for a final rule, indicating that he would review the rule following potential action by the WA State Legislature in 2015.

4. **The net result has been that state decisions for the establishment of human health criteria have been based on political process, rather than public health and science.**

The Governor selected representatives to a "Governor's Informal Advisory Group" (GIAG) in 2013, consisting of invited representatives from business, local government, non-governmental organizations, and four tribal leaders/ representatives. Tribal representatives expressed their concern about delay in rule-making at the onset, and the need to respect government-to-government protocol between the state and tribes in decision making.[283] The GIAG met several times in 2013 to early 2014 to hear a series of presentations and to discuss issues of concern, but did not reach a set of consensus recommendations.

In July, 2014 Washington Governor Inslee announced his decisions with respect to the human health criteria and development of a rule for water quality standards.[284] He indicated that he would direct the Department of Ecology to set a fish consumption rate at 175 grams per day, and that he would reduce the protective level of the cancer risk rate by ten-fold to one-per-100,000 (10^{-5}). Recognizing that these changes would make some chemical criteria less stringent, the Governor included a "no-backslide" provision that no chemical could get worse than what is allowed by current standards. Arsenic was an exception.

At the same time, the Governor announced that he would link rule-making to a toxics reduction policy initiative in the WA Legislature, essentially advancing more lenient provisions in the rule to be mitigated by a potential political process for a toxics reduction strategy. The Governor's announcement did not specify how the legislative effort was related to rule-making, or how the rule might be revised based on the outcome of the political process.

Update prepared November, 2015:

[283] Letter from 4 Tribes to Governor Inslee; August 14, 2013.

[284] Office of Governor Jay Inslee; July 9, 2014. Press release: "Inslee takes new approach to creating meaningful, effective state clean water standards."

July, 2015: "The House passed the governor's proposed bill during the regular legislative session, but the Senate failed to act on it. The governor directed Ecology to not adopt the proposed rule and instead to reevaluate the draft clean water rules while he and the agency assess options…"[285]

August, 2015: – Withdrawal of proposed rule by the Code Reviser's Office (WSR 15-16-100). [286]

September 14, 2015: EPA rule announcement

October 8, 2015: Governor Inslee announces that Ecology will draft a new rule proposal at a FCR of 175 g/day and cancer risk level of 10^{-6}, with special provisions for arsenic, PCBs and mercury.[287] *The Governor's press release indicates that the draft rule will be released in early 2016.*

5. In summary, the state has failed in its responsibility to protect water quality for fish consumption and other beneficial uses mandated by the Federal Clean Water Act.

Throughout the last two decades, tribes have clearly and consistently communicated the need for a change in the state's human health criteria, and have provided scientifically valid data to support this change. In response, the state of Washington has delayed their own recommendations, stalled in establishing human health criteria in water quality standards, allowed decision making on public health to be delayed or swayed by influence from permittees or industry advocates, and has made decisions based on political process rather than public health.

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[285] Washington Department of Ecology website accessed November 30, 2015 at: http://www.ecy.wa.gov/programs/wq/ruledev/wac173201A/1203ov.html

[286] http://app.leg.wa.gov/documents/laws/wsr/2015/16/15-16-100.htm

[287] Washington Governor Jay Inslee website. October 8, 2015. "Inslee announces new path on water quality rule, continues work on broader toxics reduction efforts." http://www.governor.wa.gov/news-media/inslee-announces-new-path-water-quality-rule-continues-work-broader-toxics-reduction

The following detailed chronology documents the history of the establishment of human health criteria in Washington State water quality standards, and the tribes' repeated and consistent attempts to work with the state to remedy the inadequacy of the fish consumption rate and other criteria. All materials cited and/or attached are incorporated by reference.

Detailed Chronology of Tribal Efforts to Establish Revised HHC and State's Response:

1992 National Toxics Rule - EPA adopts national criteria for WA (including FCR of 6.5 and cancer risk rate of 10^{-6}).

The State of Washington specifically urged the EPA to adopt a cancer risk level of 10^{-6}, based on considerations of multiple contaminants. On December 18, 1991, in its official comments on the proposed rule, the Department of Ecology urged EPA to promulgate a criterion for carcinogens at 10^{-6}.

"The State of Washington supports adoption of a risk level of one in one million for carcinogens. If EPA decides to promulgate a risk level below one in one million, the rule should specifically address the issue of multiple contaminants so as to better control overall site risks."[288]

The fish consumption rate for Washington was adopted at the national default value at the time. EPA cited the absence of regional or state-specific data.

1994 CRITFC study documents FCR at 176 grams per day (95th percentile). Higher exposure is documented for tribal members who pursue a traditional diet.[289]

1996 Studies of the Tulalip and Squaxin Island Tribes of the Puget Sound region document consumption rates of 186 to 247 gpd (90th-95th percentile).[290]

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[288] NTR Final Rule Notice, 57 Fed.Reg. 60868 (Dec. 22, 1992).

[289] CRITFC (Columbia River Inter-Tribal Fish Commission), 1994. A fish consumption survey of the Umatilla, Nez Perce, Yakama and Warm Springs Tribes of the Columbia River Basin. Columbia River Inter-Tribal Fish Commission Report reference #94-03, Portland, Oregon. –Accessed from: http://www.critfc.org/reports/a-fish-consumption-survey-of-the-umatilla-nez-perce-yakama-and-warm-springs-tribes-of-the-columbia-river-basin/#sthash.j3j2pYTr.dpuf

Abstract: http://www.critfc.org/reports/a-fish-consumption-survey-of-the-umatilla-nez-perce-yakama-and-warm-springs-tribes-of-the-columbia-river-basin/

[290] Toy, K.A., Polissar, N.L., Liao, S., and Mittelstaedt, G.D. 1996. A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region. Tulalip Tribes, Department of Environment.

1999 WA Dept of Ecology issues draft report analyzing FCRs and acknowledging the need to change state standards due to elevated risk to tribal and Asian populations.[291] The Risk Assessment Forum report recommended a default rate for reasonable maximum exposure of 175 grams per day for freshwater areas, to be used only with exposure assumptions of a bodyweight of 70 kg and 30 year duration of exposure. Further, the RAF recommended that, "the Water Quality Program consider the findings of this report when updating water quality standards."

2000 Suquamish dietary study documents fish consumption rate of 489 gpd (90th-consumers) and 797 gpd (95th-consumers.)[292]

2002 National Environmental Justice Advisory Council (A Federal Advisory Committee to the EPA) report urges states to improve outdated and underprotective FCRs for tribal populations due to elevated risk.[293]

2002-2003 2002 Triennial Review of Washington State surface water quality standards. In a letter to the Dept. of Ecology Director with comments on the triennial review, the Confederated Tribes of the Umatilla Indian Reservation states that the standards should address human health as well as aquatic life.

"The CTUIR recommends that the DOE develop standards to protect the water supply for tribal fisheries such that both Tribal members, with higher consumption rates, and non-Indian consumers are fully protected. These regulations should be developed in consultation with tribal governments and with EPA."[294]

2009-2011 Ecology Directors Jay Manning and Ted Sturdevant commit to the adoption of a more protective FCR in both the Water Quality Standards and the Sediment Management Standards. The issue is added to the 2010-2011 Work Plan[295] for

[291] Washington State Department of Ecology, 1999. Draft analysis and selection of fish consumption rates for risk assessments and risk-based standards. Ecology Pub. 99-200. L. Kiell and L. Kissinger and an interagency Risk Assessment Forum. https://fortress.wa.gov/ecy/publications/publications/99200.pdf

[292] Suquamish Tribe, 2000. Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region. August 2000.

[293] National Environmental Justice Advisory Council, 1992. Fish Consumption and Environmental Justice: A report developed from the meeting of the National Environmental Justice Advisory Council meeting of December 3-6, 2001.

[294] Confederated Tribes of the Umatilla Indian Reservation; March 14, 2003. Letter from CTUIR Natural Resources Director Michael Farrow to WADOE Director Tom Fitzsimmons.

[295] Ecology/Tribal Environmental Council, 2010 / 11 Annual Workplan Development

the Ecology/Tribal Environmental Council (a government-to-government communication forum between Washington State and tribes). Due to existing technical work on the SMS by the Toxic Cleanup Program, Ecology asks the tribes to wait while the SMS is completed first. With the understanding that the SMS process will analyze and document the scientific information on FCR, the tribes agree to a 3-step pathway for adopting an accurate and protective FCR:

- Completion of revised Sediment Management Standards
- Completion of revised Water Quality Standards
- Implementation Rules for Water Quality Standards with revised compliance schedules and variances. These are intended to allow flexibility for industrial and municipal permittees.

2009-2010 The Environmental Protection Agency, University of Washington, and Tribal representatives conduct two intergovernmental workshops on fish consumption and treaty rights. [296] Workshops included presentations from the WA Department of Ecology. [297] The Ecology presentation described the need to amend the FCR.

2010 Triennial Review of State Water Quality standards identifies the need for the FCR to be increased. [298] Comments to that effect were submitted by NWIFC,[299] the Kalispel, Quinault, and the Swinomish Tribes, and the US EPA. In the response to the comments, the state indicates that they will work toward the establishment of an FCR. Note the summary table, pages 14-17 pertaining to TOXICS: Human Health Criteria. Tribal comments recommended various FCR values based on tribal data, ranging from at least 175 gpd (Confederated Tribes of the Umatilla Reservation) to 766.7 gpd (Suquamish).

On p. 17 of the response document table, Stoel Rives LLP comment indicated that, *"If Ecology chooses to revise the criteria to reflect a higher fish consumption rate such as Oregon is considering, then Ecology should also revise the risk level from one in a million (10^{-6}) additional lifetime cancer rate to one in 100,000 (10^{-5})."*

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[296] University of Washington Superfund Research Program. August 12-13, 2009. Agenda for "Tribal Rights and Fish Consumption: Issues and Opportunities in the Pacific Northwest." Accessed from: http://depts.washington.edu/sfund/forthepublic/tribal_rights.html

[297] Ecology, 2010. "Ecology's Perspective on Fish Consumption Rate Revisions and Rule Development." Materials from the Workshop on Fish Consumption Rates, Water Quality Standards and Tribal Treaty Rights, June 16, 2010.

[298] Washington Department of Ecology; August, 2011. Washington Water Quality Standards 2010 Triennial Review – Comments and Response. http://www.ecy.wa.gov/programs/wq/swqs/TrienRevComm.html

[299] Northwest Indian Fisheries Commission; December 17, 2010. Letter from NWIFC Executive Director Michael Grayum to WA Department of Ecology Director Ted Sturdevant.

Ecology responded: *"At present Ecology has no plans to change the risk level …."*

Aug 2011 Ecology contracts with NWIFC to work toward the development of a single FCR to be used in both sediment management standards and water quality standards. From Attachment A: Statement of Work:

"The common need for a revised and appropriate FCR for use in calculating human health-based criteria and clean-up requirements prompted Ecology to ask the NWIFC to coordinate work among tribes in Washington to develop agreement on one fish consumption rate that the tribes would find acceptable in calculating water quality criteria and clean-up levels.

Tribes have been aware of and active on FCR issues for many years and have been requesting water quality criteria review and revision for over a decade. A number of the tribes in Washington have conducted fish consumption surveys to more accurately determine and document the amount (rate) of fish that their people consume, and have revised their Reservation water quality standards to reflect these realistic consumption rates. The issue is one of both public health and environmental protection. It is also important to tribes from an Environmental Justice perspective that Washington's water quality standards do not exclude tribal people and tribal culture from protection."[300]

NWIFC submitted a final report to the Department of Ecology at the end of the contract period (June 30, 2012) describing outreach efforts to tribes and stakeholders, how assumptions changed during the course of the contract, and a summary of comments on the first Technical Support Document process.[301]

Sept 2011 Ecology releases the FCR Technical Support Document recommending a default range of 157-267 gpd.[302] As shown by the original document cover[303] the document was not originally labeled as Version 1. The documents posted on the Ecology website were later re-labeled when Ecology withdrew the document in 2012, removed numerical recommendations, made other changes, and reissued

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[300] Washington Department of Ecology and the Northwest Indian Fisheries Commission. August 15, 2011. Interagency Agreement No. C1200088 for the Development of a Fish Consumption Rate.

[301] Northwest Indian Fisheries Commission. June 30, 2012. Fish consumption rates: tribal outreach, stakeholder exchange and coordination. Final report to the Washington Department of Ecology, Contract No. C1200088.

[302] Washington Department of Ecology, Toxics Cleanup Program. September 2011. Fish Consumption Rates Technical Support Document. Publication no. 11-09-050. (This version was downloaded from Ecology's website after it was re-labeled as Version 1.)

[303] Scanned copy of original report cover for above referenced document.

the document as Version 2.0. Ecology's News Release indicated that the information was intended for revisions in both toxics cleanup and water quality standards, and that standard-setting was a logical follow-up to toxics reduction efforts already in progress.[304]

Oct 2011 EPA approves Oregon FCR in water quality standards at 175 g/day, following a multi-year process with tribes and stakeholders, and including review of tribal fish consumption data.[305]

Dec 2011 Ecology holds workshops on FCR and Implementation Rules for WQ Standards with revised timelines.[306]

Jan 2012 Comments on Technical Support Document Version 1.0 related to tribal concerns are submitted by Spokane, Yakama, Kalispel, Colville, Jamestown S'Klallam, Suquamish, Squaxin Island, Swinomish, Lummi, Lower Elwha Klallam, Northwest Indian Fisheries Commission, Columbia River Intertribal Fish Commission, and the Center for Indian Law and Policy at Seattle University.

Additional letters on the fish consumption issue are submitted from several tribes and tribal organizations to the Governor and Legislators during early 2012.[307, 308, 309] In particular, NWIFC Chairman Billy Frank, Jr. wrote to express tribal concerns about tribes and other groups of high fish consumers being treated differently than the general population.[310]

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[304] Washington Department of Ecology News Release; October 11, 2011. "Ecology starts dialogue about toxic chemicals in fish to better protect public health."

[305] US Environmental Protection Agency; October 17, 2011. Letter from Region 10 Office of Water and Watersheds Director Michael Bussell to Oregon Department of Environmental Quality-Water Quality Division Administrator Neil Mullane. http://www.epa.gov/region10/pdf/water/or-tsd-hhwqs-transmittal-ltr-2011.pdf

[306] Washington Department of Ecology MTCA-SMS-Rule Update Archives for December 2011 Workshop materials and references. http://listserv.wa.gov/cgi-bin/wa?A1=ind1112&L=MTCA-SMS-RULE-UPDATE

[307] Colville Confederated Tribes; February 29, 2012. Letter from Tribal Chairman Michael Finley to Washington State Senator Lisa Brown re: Rulemaking to improve environmental standards for fish consumption.

[308] Suquamish Tribe; February 29, 2012. Letter from Tribal Chairman Leonard Forsman to Washington State Representatives Rolfes, Appleton, and Hansen re: Fish consumption rates and environmental standards.

[309] Tulalip Tribes; February 28, 2012. Letter from Chairman Melvin Sheldon to Washington State Senator Nick Harper re: Fish consumption rates and rule-making by the Department of Ecology.

[310] Northwest Indian Fisheries Commission; February 29, 2012. Letter from Chairman Billy Frank, Jr. to Governor Chris Gregoire re: fish consumption rates and rule-making by the Department of Ecology.

Beginning in February, 2012 the Affiliated Tribes of Northwest Indians adopted a series of resolutions to the state of Washington and the U.S. Environmental Protection Agency urging improved water quality standards.[311],[312],[313]

May 2012 Ecology holds workshops on the Sediment Mgt Standards, indicating they plan to adopt a default FCR using tribal fish consumption levels.
See Washington Department of Ecology MTCA-SMS-Rule Update Archives for May 2012 Workshop materials and references. [314]

June 2012 NWIFC holds a tribal leaders summit followed by Centennial Accord meeting. Ecology indicates they intend to adopt FCR in Sediment Mgt Standards in 2012

July 2012 Ecology announces intent to change the establishment of a FCR in state standards from the Toxics Cleanup Program to the Water Quality Program. [315] Director Sturdevant's letter indicates that Ecology will file a CR-101 to begin the process of establishing human health criteria in surface water quality standards, including a fish consumption rate, by August 2012. A timeline attached to the letter specifies a target for filing the CR-102 by the Fall of 2013, with a rule adopted Spring, 2014. CR-101 was filed September 13, 2012.

August 2012 Director Sturdevant sets up three discussion forums and invites tribes to participate at the Delegates Table of the Policy Forum.[316]

July-Dec 2012 Tribal correspondence to EPA and Ecology documents frustration with the delay, and many tribes choose not to participate in the new state process.

Puget Sound Partnership adopts resolution 2012-04 requesting that the Department of Ecology complete the update of fish consumption rates and adopt it into water quality standards by the end of 2013.[317]

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[311] Affiliated Tribes of Northwest Indians. February, 2012. Resolution 12-19.

[312] Affiliated Tribes of Northwest Indians. September, 2012. Resolution 12-54.

[313] Columbia River Intertribal Fish Commission. October 31, 2014. Letter from CRITFC Chairman Carlos Smith to EPA Administrator Gina McCarthy with attached ATNI Resolution 14-56.

[314] Washington Department of Ecology MTCA-SMS-Rule Update Archives. http://listserv.wa.gov/cgi-bin/wa?A1=ind1112&L=MTCA-SMS-RULE-UPDATE. Accessed March 21, 2015

[315] WA Department of Ecology; July 16, 2012. Open letter from Director Ted Sturdevant.

[316] WA Department of Ecology; August 15, 2012. Letter from Director Sturdevant to tribal chairs.

[317] Puget Sound Partnership; August 9, 2012. Resolution 2012-04 Fish Consumption Rates.

EPA Regional Administrator McLerran writes to Ecology to urge progress and assures tribes that they will oversee timely completion of human health criteria by the state. [318],[319],[320] Director Sturdevant responds that a revised version of the FCR Tech Support Document will be done by November 2012 for use in developing WQS. (second draft came out August 2012, final in January 2013)[321]

Also during this period, the Lummi Nation and Colville Confederated Tribes publish fish consumption studies (see Appendix C for citations)

January 2013 Ecology issues revised final Technical Support Document (V 2.0) without numerical recommendations for the fish consumption rate.

2013 Journalists document industry intervention into the fish consumption rate decision-making process and state budget.[322],[323],[324],[325],[326],[327],[328],[329] Additional description of the issue is published in the American Law Journal.[330]

2013-2014 *New state administration with Governor Inslee and Ecology Director Bellon.*

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[318] August 2012: Letter NWIFC to McLerran—complaint about the delay

[319] Sept 6, 2012 McLerran letter to Sturdevant urging progress on FCR

[320] Sept 14, 2012 McLerran letter to NWIFC stating that they will oversee timely progress by the state

[321] Sept 25 2012: Letter from Sturdevant to McLerran with timelines

[322] McClure, Robert. March 30, 2013. Business interests trump health concerns in fish consumption fight. Investigate West.

[323] McClure, Robert and Olivia Henry. April 23, 2013. How Boeing, allies torpedoed state's rules on toxic fish.

[324] Environmental Health Perspectives 121:11-12. November-December 2013. Meeting the needs of the people: Fish Consumption Rates in the Pacific Northwest.

[325] Seattle Times. June 26, 2013. Deal or no deal? Conflicting claims fly as state budget bickering persists.

[326] Everett Herald. June 25, 2013. Boeing's opposition to fish study a sticking point in budget.

[327] The Inlander. April 23,2013. Deadly catch.

[328] Seattle Times. October 1, 2013. Boeing's economic impact on state estimated at $70B. and October 2, 2013. Inslee wants aerospace tax breaks extended if Boeing builds 777X here. .

[329] Borderlands Research and Education, 2014. No justice on the plate.

[330] O'Neill, C. 2013. Fishable waters. American Law Journal 1:2 (Spring 2013)

Ecology postponement under Inslee administration:

During a meeting with Tribal Leaders on April 25, 2013 at Nisqually, Director Bellon verbally commits to the schedule established by her predecessor, Ted Sturdevant, to complete a draft rule in the "fall/winter of 2013-2014."

Ecology presents a public information meeting on November 3, 2013 with draft rule options.[331]

The schedule established by Sturdevant in 2013 is postponed by Ecology Director Bellon in early 2014:

> *"Ecology plans to have a draft rule available by the end of March 2014, and a final rule submitted to EPA by December 31, 2014."* [332]

EPA writes to Ecology on April 8, 2014 and indicates that the EPA would begin federal rule promulgation in 2015 if a final rule was not completed by the end of 2014:

> *"If Ecology does not follow through with its stated timeframe for final rule adoption, the EPA intends to take the steps necessary to allow for a proposal of federally revised human health criteria for Washington, via amendment of the National Toxics Rule human health criteria for Washington, by May 31, 2015.*[333]

On April 18, 2014, Tribal Leaders met with officials from WADOE, Governor's Office, and EPA. Ecology stated that they still planned on a final rule by the end of 2014, and expected a draft rule around June 30, 2014.

Governor Inslee Involvement and the Governor's Informal Advisory Group

Governor Inslee establishes the Governor's Informal Advisory Group in August 2013 and invites four tribal representatives, who express concerns about participation.[334] A subgroup to the GIAG called the Creative Solutions Group is

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[331] Washington Department of Ecology; November 6, 2013. Water Quality Standards rulemaking – general information meeting. Morning and afternoon presentations.

[332] Washington Department of Ecology; February 14, 2014. Letter from Ecology Director Maia Bellon to NWIFC Executive Director Michael Grayum.

[333] U.S. Environmental Protection Agency; April 8, 2014. Letter from Region 10 Administrator Dennis McLerran to WA Department of Ecology Director Maia Bellon.

[334] Letter from 4 Tribes to Governor Inslee; August 14, 2013

formed and issues a report, but tribal representatives indicate that they are not in agreement with the recommendations.[335] Ecology presents a draft rule overview to the GIAG on September 23, 2013.[336] Business and municipalities representatives including the City of Bellingham and Weyerhaeuser present economic impact information to the GIAG in December, 2013. Tribes present their concerns to the GIAG on February 7, 2014.[337] Following the conclusion of the GIAG process in March 2014, the leaders of the Swinomish, Jamestown S'Klallam and Suquamish Tribe (who were invited to the GIAG) present a letter to the Governor expressing their continuing concerns, and urging the Governor to focus on implementation while retaining protective standards. Additional letters are submitted by the Puyallup Tribe, Port Gamble S'Klallam Tribe, Tulalip Tribes, Lummi Nation, Kalispel Tribe, Stillaguamish Tribe, Northwest Indian Fisheries Commission, and Columbia River Intertribal Fish Commission in March and April of 2014.

On July 9, 2014, Governor Jay Inslee announced a Toxics Reduction Initiative package, consisting of a draft rule for water quality standards linked to legislation for a toxics reduction strategy to be introduced to the 2015 WA State Legislature:

> *"Inslee is directing the Department of Ecology to issue a preliminary draft rule no later than Sept. 30. He will submit legislation to the Legislature in 2015 and will make a decision on whether to adopt the final rule only after seeing the outcome of the session."*[338]

Following Inslee's announcement, letters are submitted from NWIFC, the Lummi Nation, and the Jamestown S'Klallam Tribe to the Governor; and from the Squaxin Island Tribe, Yakama Nation, Lower Elwha Klallam Tribe, NWIFC and CRITFC to EPA requesting EPA take action on the timing and substance of the state rule. (see attached file of official correspondence 2014)

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[335] Yakama Nation; January 28, 2014. Letter from Phil Rigdon, Deputy Director of the Yakama Nation Department of Natural Resources to JT Austin, Policy Advisor-Office of the Governor re: Creative Solutions Summary Report to the Governor's Informal Advisory Group.

[336] Susewind, K., September 23, 2013. Current rule updates for the water quality standards.

[337] Peters, J. and F. Wilshusen; February 3, 2014. Fish consumption rates and Washington water quality standards: tribal perspectives – traditional foods, treaty rights, and human health. (Presentation delayed to February 7, 2014)

[338] Office of Governor Jay Inslee; July 9, 2014. Press release: "Inslee takes new approach to creating meaningful, effective state clean water standards."

The National Congress of American Indians adopts resolution ATL-14-31 in October, 2014 requesting EPA to intervene in the use of a lower cancer risk level in water quality standards.[339]

Dec. 2014 EPA notifies the WA Department of Ecology of intent to begin federal rule promulgation.[340]

2015 The WA Department of Ecology filed a CR102 for a draft rule on January 12, 2015.

The Governor's toxic reduction bill emphasizing the use of chemical action plans was introduced to the WA State Legislature on January 21, 2015 as SB 5406, and failed to pass.

Proposed rule elapses in August, 2015. EPA files proposed rule in September, 2015. Governor Inslee announces intent to prepare a new draft rule in 2016.

2016 WA Department of Ecology files a revised draft rule in February, 2016.

[339] Columbia River Intertribal Fish Commission; December 23, 2014. Letter from CRITFC Chairman Carlos Smith. to EPA Administrator Gina McCarthy with attached NCAI Resolution.

[340] U.S. Environmental Protection Agency; December 18, 2014. Letter from Region 10 Administrator Dennis McLerran to Washington Department of Ecology Director Maia Bellon.

B. Chemical Comparison Spreadsheets

The following spreadsheets compare existing standards under the NTR with the 2015 EPA Proposal for Washington, Washington Department of Ecology 2016 proposal, and the approved Oregon water quality standards. The spreadsheet is divided into two sections for freshwater and marine water criteria (2 pages each). The spreadsheet also denotes which of the proposed standards (EPA or WA 2016) would be more protective, and what criteria primarily cause this discrepancy.

The spreadsheets were prepared in March, 2016 by Ridolfi Environmental under contract with NWIFC.

An Excel version of the spreadsheets is contained in the electronic attachments.

NWIFC prepared a tally of the chemical comparisons between the state proposal and the proposed EPA rule and the Oregon approved rule. This table is also contained in Appendix B.

	A	B	C	D	E	F	G	H	I	J
1										
2	Freshwater		FCR = 6.5 g/day	FCR = 175 g/day	FCR = 175 g/day				FCR = 175 g/day	
3		Water + Organisms	Risk Level =1 x 10^{-6}	Risk Level =1 x 10^{-6}	Risk Level =1 x 10^{-6}				Risk Level =1 x 10^{-6}	
4										
5	Cancer /Noncancer	FRESHWATER	National Toxics Rule	EPA 2015 WA	WA 2016 Proposed	Lower Value	Ratio WA 2016: EPA 2015 WA	Main Reason for Difference	OR Approved	Lower Value (OR approved or WA proposed)
6	nc	1,1,1-Trichloroethane		7711	47000	EPA	6.1	RSC; BAF/BCF		
7	c	1,1,2,2-Tetrachloroethene	0.17	0.103	0.120	EPA	1.2	BAF/BCF	0.12	same
8	c	1,1,2-Trichloroethane	0.60	0.35	0.44	EPA	1.2	BAF/BCF	0.44	same
9	nc	1,1-Dichloroethylene	0.057	280	1200	EPA	4.3	RSC	230	OR
10	nc	1,2,4-Trichlorobenzene	NC	0.036	0.120	EPA	3.4	RSC	6.4	WA
11	nc	1,2-Dichlorobenzene(o)	2,700	287	2000	EPA	7.0	RSC	110	OR
12	c	1,2-Dichloroethane	0.38	0.32	9.30	EPA	28.9	BAF/BCF	0.35	OR
13	c	1,2-Dichloropropane	NC	0.72	0.71	same	1.0	Same	0.38	OR
14	c	1,2-Diphenylhydrazine	0.040	0.0140	0.0150	EPA	1.1	Same	0.014	OR
15	nc	1,2-trans-Dichloroethylene	NC	99	600	EPA	6.0	RSC	120	OR
16	nc	1,3-Dichlorobenzene(m)	400	0.90	13	EPA	14.5	RSC; BAF/BCF	80	WA
17	c	1,3-Dichloropropene	10	0.22	0.24	EPA	1.1	Same	0.3	WA
18	nc	1,4-Dichlorobenzene(p)	400	65	460	EPA	7.0	RSC	16	OR
19	c	2,3,7,8-TCDD	1.30E-08	5.84E-10	6.40E-08	EPA	109.5	WA calculated as non-carcinogen	5.1E-10	OR
20	c	2,4,6-Trichlorophenol	2.1	0.25	0.25	same	1.0	Same	0.23	OR
21	nc	2,4-Dichlorophenol	93	4.4	25	EPA	5.6	RSC	23	OR
22	nc	2,4-Dimethylphenol	NC	88	85	WA2016	1.0	EPA used new lower BAF	76	OR
23	nc	2,4-Dinitrophenol	70	10.1	60	EPA	5.9	RSC	62	WA
24	c	2,4-Dinitrotoluene	0.11	0.039	0.039	Same	1.0	Same	0.084	WA
25	nc	2-Chloronaphthalene	NC	115.3	170	EPA	1.5	RSC	150	OR
26	nc	2-Chlorophenol	NC	24	15	WA2016	0.6	EPA used new lower BAF	14	OR
27	nc	2-Methyl-4,6-dinitrophenol	13	1.2	7.1	EPA	6.1	RSC	9.2	WA
28	c	3,3'-Dichlorobenzidine	0.040	0.0123	0.0031	WA2016	0.3	EPA used new lower BAF	0.0027	OR
29	nc	3-Methyl-4-Chlorophenol		173	36	WA2016	0.2	EPA used new lower BAF		
30	c	4,4'-DDD	8.3E-04	7.9E-06	3.6E-05	EPA	4.5	BAF/BCF	0.000031	OR
31	c	4,4'-DDE	5.9E-04	8.8E-07	5.1E-05	EPA	57.8	BAF/BCF	0.000022	OR
32	c	4,4'-DDT	5.9E-04	1.2E-06	2.5E-05	EPA	20.5	BAF/BCF	0.000022	OR
33	nc	Acenaphthene	NC	10	110	EPA	10.5	RSC; BAF/BCF	95	OR
34	nc	Acrolein	320	3.1	1	WA2016	0.3	EPA used new lower BAF	0.88	OR
35	c	Acrylonitrile	0.059	0.06	0.02	WA2016	0.3	EPA used new lower BAF	0.018	OR
36	c	Aldrin	1.3E-04	4.1E-08	5.7E-06	EPA	137.8	BAF/BCF	0.000005	OR
37	c	alpha-BHC	0.0039	4.8E-05	5.0E-04	EPA	10.4	BAF/BCF	0.00045	OR
38	nc	alpha-Endosulfan	0.93	2.57	97	EPA	37.8	RSC; BAF/BCF	8.5	OR
39	nc	Anthracene	9,600	44.0	3100	EPA	70.5	RSC; BAF/BCF	2900	OR
40	nc	Antimony	14	2.49	12	EPA	4.8	RSC	5.1	OR
41	c	Arsenic	0.018	0.0045	10	EPA	2209.4	WA used Drinking water MCL	2.1	OR
42	c	Asbestos	7,000,000fibers/L	7,000,000 fibers/l	7,000,000 fibers/l	Same	1.0	Same	7,000,000	OR
43	c	Benzene	1.2	0.44	0.44	Same	1.0	Same	0.44	OR
44	c	Benzidine	1.2E-04	1.3E-04	2.0E-05	WA2016	0.2	EPA used new lower BAF	0.000018	OR
45	c	Benzo(a)anthracene	2.8E-03	1.60E-04	1.40E-02	EPA	87.5	BAF/BCF	0.0013	OR
46	c	Benzo(a)pyrene	2.8E-03	1.60E-05	1.40E-03	EPA	87.5	BAF/BCF	0.0013	OR
47	c	Benzo(b)fluoranthene	2.8E-03	1.6001E-04	1.40E-02	EPA	87.5	BAF/BCF	0.0013	OR
48	c	Benzo(k)fluoranthene	2.8E-03	1.60E-03	1.40E-02	EPA	8.7	BAF/BCF	0.0013	OR
49	c	beta-BHC	1.4E-02	1.31E-03	1.80E-03	EPA	1.4	BAF/BCF	0.0016	OR
50	nc	beta-Endosulfan	0.93	3.82	9.7	EPA	2.5	RSC	8.5	OR
51	c	Bis(2-chloro-1- methylethyl)ether	1,400	154	1100	EPA	7.1	BAF/BCF	1200	WA
52	nc	Bis(2-chloroethyl)ether	0.031	0.027	0.020	WA2016	0.7	EPA used new lower BAF	0.053	WA
53	c	Bis(2-ethylhexyl)phthalate	1.8	0.045	0.230	EPA	5.1	BAF/BCF	0.2	OR
54	c	Bromoform	4.3	4.5	5.8	EPA	1.3	BAF/BCF	3.3	OR
55	c	Butylbenzyl Phthalate	NC	0.0127	0.5600	EPA	44.3	BAF/BCF	190	WA

	A	B	C	D	E	F	G	H	I	J
56	Freshwater		FCR = 6.5 g/day	FCR = 175 g/day	FCR = 175 g/day				FCR = 175 g/day	
57		Water Organisms	Risk Level = 1 x 10^{-6}	Risk Level = 1 x 10^{-6}	Risk Level = 1 x 10^{-6}				Risk Level = 1 x 10^{-6}	
58										
59	Cancer /Noncancer	FRESHWATER	National Toxics Rule	EPA 2015 WA	WA 2016 Proposed	Lower Value	Ratio WA 2016: EPA 2015 WA	Main Reason for Difference	OR Approved	Lower Value (OR approved or WA proposed)
60	c	Carbon Tetrachloride	0.25	0.24	0.20	WA2016	0.8	EPA used new lower BAF	0.1	OR
61	c	Chlordane	0.00057	2.2E-05	9.3E-05	EPA	4.3	BAF/BCF	0.000081	OR
62	nc	Chlorobenzene	680	51	380	EPA	7.4	RSC	74	OR
63	nc	Chlorodibromomethane	0.41	0.56	0.65	EPA	1.2	RSC	0.31	OR
64	nc	Chloroform	5.7	52	260	EPA	5.0	RSC	260	OR
65	c	Chrysene	0.0028	0.0160	1.4000	EPA	87.5	BAF/BCF	0.0013	OR
66	nc	Copper	NC	1300	1300	Same	1.0	Drinking water MCL	1300	OR
67	nc	Cyanide	700	3.7	19.0	EPA	5.1	RSC	130	WA
68	c	Dibenzo(a,h)anthracene	0.0028	1.6E-05	1.4E-03	EPA	87.5	BAF/BCF	0.0013	OR
69	c	Dichlorobromomethane	0.27	0.73	0.77	EPA	1.1	Same	0.42	OR
70	c	Dieldrin	0.00014	7.0E-08	6.1E-06	EPA	87.5	BAF/BCF	0.0000053	OR
71	nc	Diethyl Phthalate	23,000	78	4200	EPA	53.6	RSC; BAF/BCF	3800	OR
72	nc	Dimethyl Phthalate	313,000	228	92000	EPA	403.9	RSC; BAF/BCF	84000	OR
73	nc	Di-n-butyl Phthalate	2,700	3	450	EPA	143.4	RSC; BAF/BCF	400	OR
74	nc	Endosulfan Sulfate	0.93	3.57	9.70	EPA	2.7	RSC; BAF/BCF	8.5	OR
75	nc	Endrin	0.76	2.38E-03	3.40E-02	EPA	14.3	RSC; BAF/BCF	0.024	OR
76	nc	Endrin Aldehyde	0.76	0.1270	0.0340	WA2016	0.3	EPA used new lower BAF	0.03	OR
77	nc	Ethylbenzene	3,100	12	200	EPA	17.3	RSC; BAF/BCF	160	OR
78	nc	Fluoranthene	300	2.4	16	EPA	6.6	RSC	14	OR
79	nc	Fluorene	1,300	5.1	420	EPA	83.1	RSC; BAF/BCF	390	OR
80	nc	gamma-BHC (Lindane)	0.019	0.43	15	EPA	35.1	RSC; BAF/BCF	0.17	OR
81	c	Heptachlor	0.00021	3.4E-07	9.9E-06	EPA	29.3	BAF/BCF	0.0000079	OR
82	c	Heptachlor Epoxide	0.00010	2.4E-06	7.4E-06	EPA	3.1	BAF/BCF	0.0000039	OR
83	c	Hexachlorobenzene	0.00075	5.0E-06	5.1E-05	EPA	10.2	BAF/BCF	0.000029	OR
84	c	Hexachlorobutadiene	0.44	1.0E-02	6.9E-01	EPA	67.2	BAF/BCF	0.36	OR
85	nc	Hexachlorocyclopentadiene	240	0.418	150	EPA	359.2	RSC; BAF/BCF	30	OR
86	c	Hexachloroethane	1.9	0.0186	0.11	EPA	5.9	BAF/BCF	0.29	WA
87	c	Indeno(1,2,3-cd)pyrene	0.0028	1.60E-04	1.40E-02	EPA	87.5	BAF/BCF	0.0013	OR
88	c	Isophorone	8.4	30	27	WA2016	0.9	EPA used new lower BAF	27	OR
89	nc	Methyl Bromide	48	121	520	EPA	4.3	RSC	37	OR
90	c	Methyl mercury		0.033				WA didn't adopt		
91	nc	Methylene Chloride	4.7	9.0	16	EPA	1.8	RSC	4.3	OR
92	nc	Nickel	610	30.1	150	EPA	5.0	RSC	140	OR
93	nc	Nitrobenzene	17	10.9	55	EPA	5.1	RSC	14	OR
94	c	Nitrosodimethylamine, N-	0.00069	0.00065	0.00065	Same	1.0	Same	0.00068	WA
95	c	Nitrosodi-n-Propylamine, N-	NC	0.0044	0.0044	Same	1.0	Same	0.0046	WA
96	c	Nitrosodiphenylamine, N-	5.0	0.6232	0.6200	same	1.0	Same	0.55	OR
97	c	Pentachlorophenol	0.28	0.0021	0.0460	EPA	21.5	BAF/BCF	0.15	WA
98	nc	Phenol	21,000	3513	18000	EPA	5.1	RSC	9400	OR
99	c	Polychlorinated biphenyls	0.00017	7.3228E-06	1.7000E-04	EPA	23.2	WA calculated as non-carcinogen	0.0000064	OR
100	nc	Pyrene	960	3.1	310	EPA	98.7	RSC	290	OR
101	nc	Selenium	NC	24.7	120	EPA	4.9	RSC	120	OR
102	c	Tetrachloroethylene	0.80	2.5	4.9	EPA	1.9	BAF/BCF	0.24	OR
103	nc	Thallium	1.7	0.048	0.240	EPA	5.0	RSC	0.043	OR
104	nc	Toluene	6,800	29	180	EPA	6.2	RSC	720	WA
105	c	Toxaphene	0.00073	6.6E-05	3.2E-05	WA2016	0.5	EPA used new lower BAF	0.000028	OR
106	c	Trichloroethylene	2.7	0.34	0.38	EPA	1.1	BAF/BCF	1.4	WA
107	c	Vinyl Chloride	2.0	0.020	0.020	same	1.0	Same	0.023	WA
108	nc	Zinc	NC	452	2300	EPA	5.1	RSC	2100	OR
109										
110	Freshwater	WA Proposed Criteria less stringent than NTR								
111		Both WA and EPA Proposed Criteria less stringent than NTR								

Marine		FCR = 6.5 g/day	FCR = 175 g/day	FCR = 175 g/day				FCR = 175 g/day	
	Organisms Only	1 x 10^-6	1 x 10^-6	1 x 10^-6				1 x 10^-6	
Cancer /Noncancer	MARINE	(NTR)	EPA 2015 WA	WA 2016 Proposed	Lower Value	Ratio WA 2016: EPA 2015 WA	Main Reason for Difference	OR Approved	Lower Value (OR approved or WA proposed)
nc	1,1,1-Trichloroethane		18286	160000	EPA	9	RSC; BAF/BCF		
c	1,1,2,2-Tetrachloroethane	11	0.27	0.46	EPA	1.7	BAF/BCF	0.40	OR
c	1,1,2-Trichloroethane	42	0.9	1.8	EPA	2	BAF/BCF	1.60	OR
nc	1,1-Dichloroethylene	3.2	1,758	4,100	EPA	2	RSC	710	OR
nc	1,2,4-Trichlorobenzene	NC	0.037	0.14	EPA	4	RSC	7	WA
nc	1,2-Dichlorobenzene(o)	17,000	334	2,500	EPA	7	RSC	130	OR
c	1,2-Dichloroethane	99	73	120	EPA	1.6	BAF/BCF	3.70	OR
c	1,2-Dichloropropane	NC	3.3	3.1	WA2016	0.95	Same	1.5	OR
c	1,2-Diphenylhydrazine	0.54	0.021	0.023	EPA	1	Same	0.02	OR
nc	1,2-trans-Dichloroethylene	NC	389	5,800	EPA	15	RSC; BAF/BCF	1000	OR
nc	1,3-Dichlorobenzene(m)	2,600	0.96	16	EPA	17	RSC; BAF/BCF	96	WA
c	1,3-Dichloropropene	1,700	1.2	2	EPA	2	BAF/BCF	2.1	WA
nc	1,4-Dichlorobenzene(p)	2,600	76	580	EPA	8	RSC	19	OR
c	2,3,7,8-TCDD	1.40E-08	5.86E-10	6.40E-08	EPA	109	WA calculated as non-carcinogen	5.10E-10	OR
c	2,4,6-Trichlorophenol	6.5	0.28	0.28	EPA	1	Same	0.24	OR
nc	2,4-Dichlorophenol	790	5.7	34	EPA	6	RSC	29	OR
nc	2,4-Dimethylphenol	NC	261	97	WA2016	0.37	EPA used new lower BAF	85	OR
nc	2,4-Dinitrophenol	14,000	42	610	EPA	15	RSC; BAF/BCF	530	OR
c	2,4-Dinitrotoluene	9.1	0.18	0.18	EPA	1.02	Same	0.34	WA
nc	2-Chloronaphthalene	NC	122	180	EPA	1.48	RSC	160	OR
nc	2-Chlorophenol	NC	85	17	WA2016	0.20	EPA used new lower BAF	15	OR
nc	2-Methyl-4,6-dinitrophenol	765	2.7	25	EPA	9	RSC; BAF/BCF	28	WA
c	3,3'-Dichlorobenzidine	0.077	0.015	0.0033	WA2016	0.22	EPA used new lower BAF	0.0028	OR
nc	3-Methyl-4-Chlorophenol		234	36	WA2016	0.15	EPA used new lower BAF		
c	4,4'-DDD	0.00084	7.94E-06	3.60E-05	EPA	5	BAF/BCF	0.000031	OR
c	4,4'-DDE	0.00059	8.83E-07	5.10E-05	EPA	58	BAF/BCF	0.000022	OR
c	4,4'-DDT	0.00059	1.22E-06	2.50E-05	EPA	20	BAF/BCF	0.000022	OR
nc	Acenaphthene	NC	11	110	EPA	10	RSC; BAF/BCF	99	OR
nc	Acrolein	780	46	1.1	WA2016	0.02	EPA used new lower BAF	0.93	OR
c	Acrylonitrile	0.66	0.85	0.028	WA2016	0.03	EPA used new lower BAF	0.025	OR
c	Aldrin	0.00014	4.14E-08	5.80E-06	EPA	140	BAF/BCF	0.000005	OR
c	alpha-BHC	0.013	4.84E-05	5.60E-04	EPA	12	BAF/BCF	0.00049	OR
nc	alpha-Endosulfan	2	2.7	10	EPA	4	RSC	8.9	OR
nc	Anthracene	110,000	45	4,600	EPA	102	RSC; BAF/BCF	4000	OR
nc	Antimony	4,300	37	180	EPA	5	RSC	64	OR
c	Arsenic	0.14	0.0059	10	EPA	1684	WA used Drinking water MCL	1.0	OR
cn	Asbestos	NC							
c	Benzene	71	1.7	1.6	WA2016	0.96	Same	1.4	OR
c	Benzidine	0.00054	0.0012	2.30E-05	WA2016	0.02	EPA used new lower BAF	0.00002	OR
c	Benzo(a)anthracene	0.031	1.61E-04	2.10E-02	EPA	131	BAF/BCF	0.0018	OR
c	Benzo(a)pyrene	0.031	1.61E-05	2.10E-03	EPA	131	BAF/BCF	0.0018	OR
c	Benzo(b)fluoranthene	0.031	1.61E-04	2.10E-02	EPA	131	BAF/BCF	0.0018	OR
c	Benzo(k)fluoranthene	0.031	1.61E-03	2.10E-01	EPA	131	BAF/BCF	0.0018	OR
c	beta-BHC	0.046	0.0014	0.002	EPA	1	BAF/BCF	0.0017	OR
nc	beta-Endosulfan	2	4.2	10	EPA	2	RSC	8.9	OR
nc	Bis(2-chloro-1- methylethyl)ether	170,000	366	7,400	EPA	20	BAF/BCF	6500	OR
c	Bis(2-chloroethyl)ether	1.4	0.24	0.06	WA2016	0.25	EPA used new lower BAF	0.053	OR
c	Bis(2-ethylhexyl)phthalate	5.9	0.046	0.25	EPA	5	BAF/BCF	0.22	OR
c	Bromoform	360	12	27	EPA	2	BAF/BCF	14	OR
c	Butylbenzyl Phthalate	NC	0.013	0.58	EPA	46	BAF/BCF	190	WA
c	Carbon Tetrachloride	4.4	0.47	0.35	WA2016	0.75	EPA used new lower BAF	0.16	OR
c	Chlordane	0.00059	2.18E-05	9.30E-05	EPA	4	BAF/BCF	8.10E-05	OR
nc	Chlorobenzene	21,000	83	890	EPA	11	RSC; BAF/BCF	160	OR
nc	Chlorodibromomethane	34	2	3	EPA	1.50	RSC	1.3	OR
nc	Chloroform	470	241	1,200	EPA	5	RSC	1100	OR
c	Chrysene	0.031	0.016	2.1	EPA	131	BAF/BCF	0.0018	OR
nc	Copper	NC							

Marine		FCR = 6.5 g/day	FCR = 175 g/day	FCR = 175 g/day				FCR = 175 g/day	
	Organisms Only	1 x 10^{-6}	1 x 10^{-6}	1 x 10^{-6}				1 x 10^{-6}	
Cancer /Noncancer	MARINE	(NTR)	EPA 2015 WA	WA 2016 Proposed	Lower Value	Ratio WA 2016: EPA 2015 WA	Main Reason for Difference	OR Approved	Lower Value (OR approved or WA proposed)
c	Dibenzo(a,h)anthracene	0.031	1.61E-05	2.10E-03	EPA	131	BAF/BCF	0.0018	OR
c	Dichlorobromomethane	22	2.8	3.6	EPA	1	Same	1.7	OR
c	Dieldrin	0.00014	6.97E-08	5.10E-06	EPA	88	BAF/BCF	5.40E-06	OR
nc	Diethyl Phthalate	120,000	80	5,000	EPA	63	RSC; BAF/BCF	4400	OR
nc	Dimethyl Phthalate	2,900,000	229	130,000	EPA	569	RSC; BAF/BCF	110000	OR
nc	Di-n-butyl Phthalate	12,000	3.2	510	EPA	162	RSC; BAF/BCF	450	OR
nc	Endosulfan Sulfate	2	3.9	10	EPA	3	RSC; BAF/BCF	8.9	OR
nc	Endrin	0.81	0.0024	0.035	EPA	15	RSC; BAF/BCF	0.024	OR
nc	Endrin Aldehyde	0.81	0.13	0.035	WA2016	0.27	EPA used new lower BAF	0.03	OR
nc	Ethylbenzene	29,000	13	270	EPA	21	RSC; BAF/BCF	210	OR
nc	Fluoranthene	370	2.4	16	EPA	7	RSC	14	OR
nc	Fluorene	14,000	5.2	610	EPA	118	RSC; BAF/BCF	530	OR
nc	gamma-BHC (Lindane)	0.063	0.43	17	EPA	40	RSC; BAF/BCF	0.18	OR
c	Heptachlor	0.00021	3.38E-07	1.00E-05	EPA	30	BAF/BCF	7.90E-06	OR
c	Heptachlor Epoxide	0.00011	2.37E-06	7.40E-06	EPA	3	BAF/BCF	3.90E-06	OR
c	Hexachlorobenzene	0.00077	4.98E-06	5.20E-05	EPA	10	BAF/BCF	2.90E-05	OR
c	Hexachlorobutadiene	50	0.01	4.1	EPA	395	BAF/BCF	1.8	OR
nc	Hexachlorocyclopentadiene	17,000	0.42	630	EPA	1493	RSC; BAF/BCF	110	OR
c	Hexachloroethane	8.9	0.019	0.13	EPA	7	BAF/BCF	0.33	WA
c	Indeno(1,2,3-cd)pyrene	0.031	1.61E-04	2.10E-02	EPA	131	BAF/BCF	0.0018	OR
c	Isophorone	600	201	110	WA2016	0.55	EPA used new lower BAF	96	OR
nc	Methyl Bromide	4,000	1,306	2,400	EPA	2	RSC	150	OR
nc	Methyl mercury		0.033				WA didn't adopt		
c	Methylene Chloride	1,600	142	250	EPA	2	RSC	59	OR
nc	Nickel	4,600	39	190	EPA	5	RSC	170	OR
nc	Nitrobenzene	1,900	59	320	EPA	5	RSC	69	OR
c	Nitrosodimethylamine, N-	8.1	0.34	0.34	same	1	Same	0.046	OR
c	Nitrosodi-n-Propylamine, N-	NC	0.058	0.058	same	1	Same	0.051	OR
c	Nitrosodiphenylamine, N-	16	0.69	0.69	same	1	Same	0.5	OR
c	Pentachlorophenol	8.2	0.0022	0.1	EPA	46	BAF/BCF	0.3	WA
nc	Phenol	4,600,000	28,872	200,000	EPA	7	RSC	85000	OR
c	Polychlorinated biphenyls	0.00017	7.33E-06	1.70E-04	EPA	23	WA calculated as non-carcinogen	6.40E-06	OR
nc	Pyrene	11,000	3.2	460	EPA	144	RSC; BAF/BCF	400	OR
nc	Selenium	NC	95	480	EPA	5	RSC	420	OR
c	Tetrachloroethylene	8.85	3	7.1	EPA	2	BAF/BCF	0.33	OR
nc	Thallium	6.3	0.05	0.27	EPA	5	RSC	0.047	OR
nc	Toluene	200,000	52	410	EPA	8	RSC	1500	WA
c	Toxaphene	0.00075	6.60E-05	3.20E-05	WA2016	0.49	EPA used new lower BAF	2.80E-05	OR
c	Trichloroethylene	81	0.7	0.86	EPA	1	BAF/BCF	3	WA
c	Vinyl Chloride	525	0.18	0.26	EPA	1	Same	0.24	OR
nc	Zinc	NC	584	2,900	EPA	5	RSC	2600	OR

Marine

WA Proposed Criteria less stringent than NTR

Both WA and EPA Proposed Criteria less stringent than NTR

Technical Summary Tally (NWIFC)

WA State proposal as compared to		Freshwater # of regulated chemicals (out of 98)	Marine # regulated chemicals (95)	Comments
Existing standard (NTR)	Increase in protectiveness (Lower chemical criteria)	58	66	The state's proposal shows improvement for the majority of chemicals compared to existing standards, but EPA's proposal is more protective than existing standards for 93 chemicals in the freshwater criteria, and 84 chemicals in the marine water criteria. EPA's proposal also goes substantially further in increasing the level of protection.
	Remain the same	1	1	PCB's remain the same as existing standard in the state proposal because Ecology applied a no-backsliding policy.
	Decrease in protectiveness	24	11	State proposes to change Arsenic to Safe Drinking Water Act standard. Other decreases from existing standards are largely due to changes in toxicity factors. Dioxin is also a major concern.
	Other differences			State will add approximately 10 additional chemicals to the standards.
EPA Proposal 99 regulated chemicals	State is more protective (lower criteria) than EPA	13	13	State proposal is more protective than EPA proposal for 13 chemicals.
	State and EPA are the same	10	10	
	State is less protective than EPA	76	78	State proposal is less protective than EPA for approximately 80% of chemicals. Major differences are in the challenging chemicals: arsenic, PCBs, and dioxins. Most of the other differences between EPA and the state proposal is due to the state's use of older bio-concentration factors, and relative source contribution.

	Other differences			EPA proposes to regulate methyl mercury. State has deferred for future consideration without a timeline.
Oregon's standards	WA is more protective than Oregon	17	10	Oregon's criteria, approved by EPA in 2011, are more protective for 80 to 90 % of regulated chemicals than WA. Oregon used a FCR of 175 g/day and cancer risk of 10^{-6} but they used different values for body weight, drinking water, bioconcentration, toxicity factors, and relative source contributions. Oregon also used a different approach for arsenic, which falls between the EPA and Washington proposals, but is much more protective than WA.
	WA less protective	77	83	

C. Fish Consumption Rates—Description of studies and definition of terms

All documents described or cited are incorporated by reference.

1. **Definitions of terms:**
As used herein, the following terms are applied:

Heritage Rates "refer to the rates of fish intake consonant with traditional tribal practices, prior to contact with European settlers" and assume rates that were "uncontaminated and available" and not subject to suppression.[341] The term Heritage Rates, used herein, represents the same definition as used by Donatuto, Harper and O'Neill [342] and submitted in comments to the state of Idaho related to state rule-making for Human Health Criteria (2014).
(Donatuto et al. use the term "Aspirational Rates" to refer to fish consumption rates that are higher than what is currently consumed. The term aspirational rates is intended to recognize that present-day fish consumption may be suppressed due to resource availability, resource contamination, lack of access to fishing areas and other factors that have resulted in a reduction in consumption from heritage rates. Aspirational rates are not interchangeable with heritage rates; aspirational rates may be established at a level equal to heritage rates, or set at a lower level.)

Contemporary rates of tribal fish consumption, as used in this document, refers to fish consumption that has occurred in recent history, i.e. since the early 1990s when tribes began conducting dietary surveys to document modern consumption. The term "contemporary" is a temporal term and describes consumption rates identified as snapshots in time, generally through a similar methodology.[343]

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[341] Catherine O'Neill, Professor of Law, Seattle University School of Law, Comments to IDEQ, *Risk, Human Health, and Water Quality Standards* (Jan. 20, 2015).

[342] Donatuto, J., B. Harper and C. O'Neill; February 14, 2014. "Heritage, Subsistence, and Aspirational Fish Consumption Rates: Comments on Usage.

[343] It should be noted that some tribes (e.g. the Lummi Nation) have conducted studies that retroactively estimate fish consumption rates during the peak of salmon harvest levels in the 1980's. This was an effort to quantify some suppression factors, but such analysis is not characterized as heritage, aspirational, or contemporary.

Traditional refers to harvest and consumption practices, similar to ancestral use of fisheries resources, and is not a rate.

Subsistence does not refer to a rate and may be used in two ways in this document: 1) as used by EPA and the Department of Ecology in reference to water quality criteria to describe personal use by sports fishers, economically disadvantaged individuals, and other groups; and 2) as used in treaty tribal fisheries management to describe harvest that is not sold commercially but is obtained for the personal use of the treaty tribal fisher. The intent must be inferred from context.

Subsistence is described by Donatuto et al. as, "a term that is inconsistently used and understood." They point out that use of the word "subsistence," as it is applied to fish consumption rates, differs from the way that the word is commonly understood in colloquial use. They also point out that subsistence is used by the Environmental Protection Agency in various guidance documents as described below.

a) The Department of Ecology uses the term "subsistence" in the context of EPA usage in Ambient Water Quality Criteria. The EPA, as described by Donatuto, et al., uses the term, "in a more generic sense, i.e., to refer to individuals who simply eat a lot of fish, for whatever reason" rather than specific reference to tribal fishers and consumers. As described by EPA, the term subsistence would encompass both subsistence fishing by treaty tribal harvesters and recreational harvest by non-treaty fishers.

b) In the context of treaty-reserved fishing rights held by tribes, tribal fisheries managers typically use subsistence to differentiate treaty tribal catch for personal use from commercial, ceremonial, or recreational fisheries, as follows[344]:

   Commercial – fish/shellfish caught by a licensed fisher (treaty or non-treaty) and sold to someone (tourist, local store, wholesale buyer, etc.)

   Subsistence – treaty harvest for personal use and the fisher's family

   Ceremonial – treaty harvest that takes place for a culturally important event (funeral, marriage, annual event, etc.)

   Recreational – non-treaty sport harvest for personal use (no sales)

[344] Chitwood, S. 2015. Pers. Comm. with the Natural Resources Director of the Jamestown S'Klallam Tribe.

The term “sustenance” was used by the Department of the Interior in January 2015 related to Maine’s water quality standards and tribal fishing rights in Maine, and stated that, “it is reasonable to include that the term encompasses, at a minimum, the notion of tribal members taking fish to nourish and sustain themselves.”[345] By this description, the term sustenance is similar to “subsistence” in the context of treaty-reserved fishing rights in the Pacific Northwest. However the circumstances in Maine differ from Washington State, and the terms cannot necessarily be used interchangeably.

Other terms and usage:

“Traditional” refers to a body of fish harvest and consumption practices. In general, traditional fishing families rely extensively on fisheries resource consumption similar to ancestral practices. Traditional fish consuming families are generally high consumers, and may represent consumers who eat parts of the fish that may be discarded by other users (and thereby susceptible to exposure to toxic chemicals at a different level).

Fish Consumption Rates in Tribal Water Quality Standards**:** Several tribes have developed their own set of human health criteria in water quality standards. The fish consumption rates adopted in tribal standards vary widely depending on the timing, circumstances, and evidence that was available at the point of tribal approval and subsequent EPA approval. Some tribes adopted the existing National Toxics Rule standards as a default value, or other national criteria in effect at the time. Other tribes have adopted individualized standards based on contemporary dietary surveys, heritage rates, or other information. Tribal standards are in various stages of development, approval by EPA, and revision.

[345] U.S. Department of the Interior, Office of the Solicitor. January 30, 2015. Letter from Hilary C. Tomkins to Avi Garbow, General Counsel, U.S. Environmental Protection Agency. RE: Maine’s WQS and Tribal Fishing Rights of Maine Tribes.

2. Tribal Fish Consumption Studies

Comprehensive tribal fish consumption studies have been regionally available since 1994. A summary of tribal fish consumption rates is listed in the following table, and followed by a short description of Pacific Northwest tribal fish consumption studies. (Values reported for these surveys by Ecology and others may vary slightly depending on whether original results are reported, or the re-analysis of data using different methods used by Polissar, et al.)

Table of fish consumption rate surveys from Tribal FCR studies:

Tribal Survey and year published	Type of Fish	Mean	Median	75th percentile	90th percentile	95th percentile	99th percentile
Columbia River Tribes 1994	Finfish (A, F)	63	40	60	113	176	389
Tulalip Tribe 1996	Finfish (A, E) Shellfish	72	45	85	186	244	312
Squaxin Island Tribe 1996 (upper value) and EPA 2013 reanalysis (lower value)	Finfish (A, E) Shellfish	73	43	-	193	247	-
		95			283	318	
Suquamish Tribe 2000	All seafood	214	132	284	489	797	
Lummi Nation 2013	Finfish (A, E) Shellfish	383	314	-	800	918	-
Nez Perce Tribe (Polissar, et al. 2015)		123.4	70.5	-	270.1	437.4	
Asian/Pacific Islanders 1999*	Finfish (A, E) Shellfish	117	78	139	236	306	-

A=Anadromous, F=Freshwater, E=Estuarine. All values expressed in grams per day.
*Also included for comparison is a study of seafood consumption by Asian and Pacific Islander communities in King County. (Sechena, et al., 1999)

Annotated References: Tribal Studies:

- CRITFC (Columbia River Inter-Tribal Fish Commission), 1994. A fish consumption survey of the Umatilla, Nez Perce, Yakama and Warm Springs Tribes of the Columbia River Basin. Columbia River Inter-Tribal Fish Commission Report reference #94-03, Portland, Oregon.

  The CRITFC study was used as a major fish consumption reference in the development of the water quality standards in Oregon, following the rejection of Oregon's proposed FCR standard of 17.5 grams per day by the EPA. The CRITFC study documented a FCR of 176 g/day at the 95th percentile of respondents in the study. In the interest of protecting more tribal consumers, and the recognition that fisheries were severely suppressed at the time, Columbia River tribes advocated for the use of the 99th percentile value, or 389 g/day, during the development of the standards, but a final criterion of 175 was adopted by OR Department of Environmental Quality and approved by EPA in 2011. The difference between the study value of 176 g/day and the standard at 175 g/day is attributable to rounding by OR DEQ.

  "DEQ determined that a fish consumption rate of 175 g/d is a reasonable and protective fish consumption rate to use as the basis for Oregon's human health criteria. A fish consumption rate of 175 g/d represents approximately 6.2 ounces per day (or approximately 23 8-oz fish or shellfish meals per month). This rate represents the 95th percentile value from the Columbia River Inter-Tribal Fish Commission study and is within the range of the 90th percentile values from various studies from the Northwest…." (Oregon DEQ, 2011. p 9)[346]

  In response to public questions about the validity of tribal data and requests to have individual response data released, CRITFC submitted a letter to the Department of Ecology in 2012 describing the study design, implementation, and review in detail.[347]

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[346] Oregon Department of Environmental Quality, 2011. Human health criteria final issue paper. Matzke, A., D. Sturdevant and J. Wiegle.

[347] Columbia River Inter-Tribal Fish Commission; March 19, 2012. Letter from Executive Director Babtist Paul Lumley to Ecology Director Ted Sturdevant. Published by the WA Department of Ecology as Attachment B to the Fish Consumption Rate Technical Support Document, Version 2.0 in August, 2012.

- Toy, K.A., Polissar, N.L., Liao, S., and Mittelstaedt, G.D. 1996. A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region. Tulalip Tribes, Department of Environment.

  Puget Sound tribes conducted dietary surveys beginning in 1996, with the involvement of EPA the University of Washington, and other advisors in the field of public health. The 1996 assessment of the Tulalip and Squaxin Island tribal fish consumption included finfish and shellfish, and estimated an FCR of 244-247 at the 95th percentile.

- U.S. Environmental Protection Agency (EPA). (2013) Reanalysis of fish and shellfish consumption data for the Tulalip and Squaxin Island Tribes of the Puget Sound Region: Consumption Rates for Consumers Only. National Center for Environmental Assessment, Washington, DC; EPA/600/R-06/080F.

  US EPA worked with the earlier data for Tulalip and Squaxin Island Tribes to remove non-consumers from the estimated fish consumption rate, as inclusion of non-consumers would inappropriately skew the FCR lower, thereby underestimating the potential risk to fish consumers. The FCR for the Squaxin Island Tribe at the 95th percentile for consumers was estimated at 318 g/day (the earlier estimate including non-consumers was 247 g/day).

  EPA and the Squaxin Island Tribe further analyzed the data to assess differences in consumption per body weight among adult males, females, and children. They found that children consumed fish at a rate almost 3 times that of adult males.

- Suquamish Tribe, 2000. Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region. August 2000.

  The Suquamish survey was funded by the Agency for Toxic Substances and Disease Registry (ATSDR) through a grant to the Washington State Department of Health. The Suquamish Tribe was designated as the study manager and was the co-principal investigator with DOH in all aspects of the study. Technical peer reviewers and consultants included staff from DOH, Ecology, EPA, the University of Washington, and the Fred Hutchinson Cancer Research Institute.

Suquamish data indicated substantially higher fish consumption rates than the earlier studies, with a mean consumption rate of 214 g/day and a 90th percentile value of 489. The Suquamish analysis was referenced by the WA Department of Health in 2006, indicating that high-end fish consumers from the tribe would exceed PCB health quotients in Puget Sound Chinook and coho salmon.

- Lummi Natural Resources Department, Water Resources Division. 2012. Lummi Nation Seafood Consumption Study. (J. Freimund, M. Lange and C. Dolphin; August 31, 2012)

  The Lummi Seafood Consumption Study consisted of recall interviews to assess 1985 consumption levels. The use of this technique was intended to identify fish consumption rates before modern salmon fishing was suppressed by the curtailment of US fisheries and the listing of some Puget Sound salmon as threatened species in the late 1990's and 2000's.
  The Lummi survey identified a mean FCR for adult male respondents of 383 grams per day, and values of 800 and 918 g/day for the 90th and 95th percentiles, respectively.

- Colville Confederated Tribes:
  Westat, 2012. Upper Columbia River Site Remedial Investigation and Feasibility Study: Tribal Consumption and Resource Use Survey. Final Report. http://www.epa.gov/region10/pdf/sites/ucr/tribal_consumption_resource_use_survey_final_report_june2012.pdf

  The study of the Colville Confederated Tribes was a comprehensive human health risk assessment associated with a settlement agreement between Teck Cominco Metals, Ltd., US Dept. of Justice, and US Environmental Protection Agency. The purpose of the study was to analyze human health risk at the Upper Columbia River remedial site for both dietary and non-dietary use of resources. A FCR in a comparable data format to the other tribal studies is not available.

- Nez Perce Tribe:
  Polissar, N.L., Salisbury, A., Ridolfi, C., Calahan, K., Neradilek, M., Hippe, D.S., and W.H. Beckley for The Mountain-Whisper-Light-Statistics, Pacific Market Research, and Ridolfi Inc. September 30, 2015. A Fish Consumption Survey of the Nez Perce Tribe. Final draft for Idaho DEQ.

The Nez Perce study was conducted as part of a larger fish consumption survey of federally recognized tribes in Idaho, initiated by the US EPA. Volume I presents information on heritage fish consumption by the Nez Perce Tribe. Volume II describes the methods and results of a current fish consumption survey.

- Harper, B.L. and Walker, D.E. 2015. "Columbia Basin Heritage Fish Consumption Rates." Human Ecology (2015) 43: 237-245.
  This paper looked at two approaches for estimating heritage fish consumption rates in the Columbia Basin using dietary reconstruction, and evidence of abundance, harvest and consumption rates. The two approaches support a FCR of 620 to 725 g/day as the average heritage rate for the Columbia River mainstem.

- Harper, B.L. and Walker, D.E. 2015. "Comparison of Contemporary and Heritage Fish Consumption Rates in the Columbia River Basin." Human Ecology (2015) 43: 225-236.
  This paper provides an overview of the contemporary and heritage fish consumption rates relevant to the Pacific Northwest, and notes that the selection of an appropriate FCR will depend on the derivation and context.

- Additional references on regional fish consumption studies:

  i. Sechena, R., C.Nakano, S.Liao, N.Polissar, R.Lorenzana, S.Truong, and R.Fenske. "Asian and Pacific Islander Seafood Consumption Study in King County, Washington." EPA 910/R-99-003. May 1999. http://www.epa.gov/region10/pdf/asian_pacific_islander_seafood_consumption_1999.pdf

  ii. Oregon Department of Environmental Quality; 2011. Human Health Criteria Final Issue Paper; Toxics Rulemaking 2008-2011. (A. Matzke, D. Sturdevant, and J. Wigal; May 24, 2011).

  iii. McCormack, C., 2011. Fish Consumption Rate Report: Brief Overview and Issues for Consideration. Presentation to the Washington Department of Ecology Technical Workshop on Fish Consumption, December 12, 2011. http://www.ecy.wa.gov/toxics/docs/20111212_fishworkshop_mccormack.pdf , http://www.ecy.wa.gov/toxics/fish_publicinvolvement.html

3. Ecology's Technical Support Document, Supplements, and Comments

a) The Washington Department of Ecology recommended a default fish consumption rate in the range of 157 to 267 g/day based on a detailed review of available scientific studies.

Ecology published a Technical Support Document in September 2011 as a comprehensive overview of regional fish consumption data in Washington. Ecology had indicated to tribes and EPA in 2010 that they intended to complete an analysis of fish consumption rates in the context of setting Sediment Management Standards—information which would subsequently be transferrable to the development of Water Quality Standards. Ecology personnel from the Toxics Cleanup Program undertook the analysis of regional fish consumption data and published the Technical Support Document in September 2011, which included the following preliminary recommendation:

"Ecology has concluded that available scientific studies support the use of a default fish consumption rate in the range of 157 to 267 grams per day (g/day). The preliminary recommendation of this report is that default fish consumption rates should be within this range for state regulatory purposes."

Ecology arrived at this range by conducting a composite statistical analysis of the tribal and Asian/Pacific Islander data that met Ecology's requirements for scientific validity. The recommendation for the composite range represented values from the 80^{th} to the 95^{th} percentiles.

b) Comments on the 2011 Technical Support Document

Comments from the University of Washington School of Public Health submitted during the public comment period stated that the September 2011 version of the FCR Technical Support Document was, *"a robust, scientific-based assessment that is both clear and transparent."* [348]

[348] Faustman, E.M. January 18, 2012. Letter from the Director of the Institute for Risk Analysis and Risk Communication in the Department of Environmental and Occupational Health Sciences, University of Washington to M. Hankins, Toxics Cleanup Program, WA Department of Ecology

Ten tribes, two tribal consortiums, and the Center for Indian Law and Policy (Seattle University School of Law) commented on the 2011 Technical Support Document. (see attached folder: Comments early 2012) Comments included the following points:

- NWIFC comments indicated that many tribes could support an FCR at or above the high end of the recommended range of 157-267 g/day as a step forward, but noted that many tribes have documented higher rates and that the low end of the range was below mean consumption levels for some tribes. NWIFC also stated that 175 g/day is a low rate, and described contemporary rates at approximately 500 grams per day and heritage FCRs of 1,000 g/day.[349]

- Comments from Swinomish, Squaxin Island, and CRITFC all discussed the need to factor in the suppression of treaty fishing opportunities and fisheries resources.

- Lower Elwha Klallam and CRITFC described the uptake of toxic chemicals in salmon throughout their life cycle and the need to include salmon in an FCR. The need to include salmon was reiterated in most tribal comments.

- The Spokane Tribe indicated that they were waiting for EPA approval of a fish consumption rate of 865 grams per day in tribal water quality standards (since approved—see references for letter).

- The Lummi Nation stated that the use of an 80th percentile value was too low and that the lower bound should be at least the 90th percentile, and that 95th was typical. The Lummi comments also spoke to the need to include anadromous fish in the rate, and described their seafood consumption study, then in progress.

- Suquamish comments indicated that the upper bound of the recommended range was lower than the 75th percentile of the FCR study

[349]NWIFC; January 3, 2012. Letter from Chairman Billy Frank, Jr. to WA Department of Ecology Director Sturdevant re: comments on fish consumption rates technical support document.

of Suquamish tribal members and recommended that Ecology use 90^{th} to 95^{th} percentile values.

- Jamestown S'Klallam indicated that they did not have a tribal-specific fish consumption study at the time, but described examples of suppression from bacterial contamination of shellfish in Dungeness Bay and habitat degradation in the Dungeness River that would affect a tribally-derived rate.

- Colville Confederated Tribes described their health risk assessment and indicated that preliminary results showed that over 83% of tribal members actively consumed local sources of fish.

- The Kalispel Tribe commented that fish consumption rates and other human health criteria should be established independently from economic considerations, in order to protect human health.

- The Yakama Nation stated that *"Asking us to accept health risk at the 90^{th} percentile is the same as asking us to accept that over 1000 Yakama tribal members will be subjected to increased health risk because they choose to eat a traditional diet."*

- The Center for Indian Law and Policy at the Seattle University School of Law summarized treaty fishing rights, historical consumption practices, suppression factors that have reduced fish consumption, and the need to include salmon.

Washington Department of Health personnel provided a presentation at the Environmental Law Education Center conference in June, 2012, endorsing a fish consumption rate of 175 g/day in Washington State standards at a minimum.[350]

At the request of industry (described previously), Ecology withdrew the 2011 Technical Support Document in July of 2012. Ecology did not dispute the findings of the first version of the document, but indicated that they had concluded that the numerical recommendation was a policy decision requiring

[350] McBride, D.; December 20, 2012. Email to Craig McCormack, Washington Department of Ecology re: Fish Consumption.

further discussion.[351] A preliminary draft of Technical Support Document Version 2.0 was issued in August 2012 and a Final in January 2013.

During preparation of the second version of the document, staff from the WA Department of Health commented that they were concerned about the removal of the recommended range from the first version of the document:

"I am concerned that the consumption rates cited as recommendations in the previous draft were removed from the current document. DOH believes that there are ample well conducted, scientifically defensible studies available as described in the TSD to establish a range of consumption rates. DOH has previously commented to Ecology that a fish consumption rate should, at a minimum, be on par with Oregon's adopted value of 175 grams per day. DOH also recommended that a range of rates be considered, with the low end of 175 grams per day, along with higher rates associated with many Puget Sound Tribes as well as ethnic populations as detailed in the document. DOH would also suggest that Ecology determine whether the fish consumption rate of 500 pounds per capita per year (which equates to 620 grams per day) as cited in the 1974 Boldt decision on treaty rights is a legally enforceable rate.[352]

c) Supplements to the Technical Support Document.
Comments on the Technical Support Document Version 1 prompted the Department of Ecology to prepare supplemental information: estimating annual fish consumption rates using short term dietary surveys, recreational fish consumption rates, health benefits and risk of consuming fish and shellfish, chemical contaminants in dietary protein sources, and salmon life history and chemical body burdens.[353]

Ecology also commissioned a statistical analysis of national Washington State fish consumption data, published as a draft in September 2012 and a final in September, 2014. [354] The report by Polissar, et al. compared NHANES data to

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[351] WA Department of Ecology; July 16, 2012. Open letter from Director Ted Sturdevant.

[352] McBride, D. Washington Department of Health comments to M. Hankins, Washington Department of Ecology via email, quoted in internal memo summary August 17, 2012.

[353] WA Department of Ecology; July 20, 2012. Supplemental information to support the fish consumption rate technical support document.

[354] Polissar, N.L., M. Neradilek, A.Y. Aravkin, P. Danaher, and J.Kalat. September 7, 2014. Statistical Analysis of National and Washington State Fish Consumption Data. Final. Mountain-Whisper-Light Statistics. Seattle, WA.

methods utilized by the National Cancer Institute and the EPA's Exposure Factors Handbook. The study commissioned by Ecology also found that, "Among the consumption rates for **locally harvested fish**, the Native American tribes have the highest consumption rates." [355] (emphasis added) We further note that the WA Department of Ecology cited the 2012 version on page 19 of the 2016 Key Decisions document, but did not cite the final 2014 version of the report. We have included both versions in the electronic attachments.

d) Additional documents:

- Washington Department of Ecology; September 2011. Fish Consumption Rates: Technical Support Document—A Review of Data and Information About Fish Consumption in Washington. Publication no. 11-09-050. Washington Department of Ecology Toxics Cleanup Program. Olympia, WA. (Note that this later became known as Technical Support Document Version 1.0)

  Also incorporated are documents referenced in the Technical Support Document Version 1.0, all comments received during the public comment period, Ecology's publication No. 12-09-055 "Response to Comments on Fish Consumption Issues," and all attachments and supplements issued by the Department of Ecology associated with the Technical Support Document, Version 1.0, whether draft or final.

- Washington Department of Ecology; January 2013. Fish Consumption Rates: Technical Support Document—A Review of Data and Information About Fish Consumption in Washington, Version 2.0, Final. Publication no. 12-09-058. Washington Department of Ecology Toxics Cleanup Program. Olympia, WA.

  Also incorporated is the Public Review Draft of Version 2.0 issued in August, 2012, all comments received during the public comment period, and all references, attachments and supplements issued by the Department of Ecology associated with the Technical Support Document, Version 2.0.

4. FCR studies from Idaho rule making.

During rule development for water quality standards in Idaho, a series of fish consumption analyses were prepared under contract with EPA. Table 24 is included here comparing contemporary Idaho results and other regional studies. From:

Polissar, N.L., Salisbury, A., Ridolfi, C., Calahan, K., Neradilek, M., Hippe, D.S., and W.H. Beckley for The Mountain-Whisper-Light-Statistics, Pacific Market Research, and Ridolfi Inc. September 30, 2015. A Fish Consumption Survey of the Nez Perce Tribe. Final draft for Idaho DEQ. https://www.deq.idaho.gov/media/60177353/58-0102-1201-fish-consumption-survey-nez-perce-tribe.pdf

Table 24. Total FCRs (g/day) of adults in Pacific Northwest Tribes (with consumption rates available) and the U.S. general population. Consumers only.

Population	No. of Consumers*	Percentiles			
		Mean	50%	90%	95%
Nez Perce Tribe, FFQ rates, Group 1	451	123.4	70.5	270.1	437.4
Nez Perce Tribe, NCI method, Group 1	451	75.0	49.5	173.2	232.1
Shoshone-Bannock Tribes, FFQ rates, Group 1	226	158.5	74.6	392.5	603.4
Shoshone-Bannock Tribes, NCI method, Group 1	226	34.5	14.9	94.5	140.9
Tulalip Tribes, FFQ rates	73	82.2	44.5	193.4	267.6
Squaxin Island Tribe, FFQ rates	117	83.7	44.5	205.8	280.2
Suquamish Tribe, FFQ rates	92	213.9	132.1	489.0	796.9
Columbia River Tribes, FFQ rates	464	63.2	40.5	130.0	194.0
USA, NCI method *	16,363	23.8	17.6	52.8	68.1

*Adults ≥ 21 years old; includes both consumers and non-consumers. Data for populations outside of Idaho from CRTIFC, 1994 (Columbia River Tribes), The Suquamish Tribe, 2000, Toy et al, 1996 (Tulalip and Squaxin Island Tribes) and U.S. EPA, 2014 (USA).

5. Additional information about the presence of toxic chemicals in regional freshwater and marine aquatic species

WA Department of Ecology prepared a supplement document[356] in 2012 to evaluate the inclusion of fish and shellfish in the default fish consumption rate, then under consideration. The supplement focused on health benefits and risks of fish consumption, and the contaminant body burdens of regional salmonid species, including:

- Health Benefits and Risks of Consuming Fish and Shellfish
- Chemical Contaminants in Dietary Protein Sources
- Salmon Life History and Contaminant Body Burdens

The Ecology supplement cites numerous studies that document the uptake of toxic chemicals among salmon at various life stages within the jurisdictional waters of Washington, including freshwater, estuarine, and marine waters. In particular, studies by the WA Department of Fish and Wildlife document higher levels of persistent organic pollutants in Puget Sound resident Chinook (Chinook that spend their adult life cycle in the marine waters of Puget Sound rather than migrating to the north Pacific Ocean), indicating higher exposure in the inland waters of Puget Sound as compared to Chinook that originate in or migrate to other areas of the Pacific Northwest. [357]

Documents and presentations prepared by NOAA/National Marine Fisheries Service, the WA Department of Ecology, WA Department of Health, WA Department of Fish and Wildlife, Environment Canada, and the Puget Sound Ambient Monitoring Program describe chemical contamination in a wide range of fish, shellfish, and marine mammal species in Washington freshwater, estuarine, nearshore and coastal waters including Puget Sound and the Columbia River basin .[358], [359],[360] More recent studies confirm the uptake of contaminants in nearshore

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[356] Washington Department of Ecology, Toxics Cleanup Program; July 20, 2012. Supplemental Information to Support the Fish Consumption Rates Technical Support Document. Olympia, WA.

[357] O'Neill, S.M. and J. E. West, 2009. Marine Distribution, Life History Traits, and the Accumulation of Polychlorinated Biphynols in Chinook Salmon from Puget Sound, WA. Transactions of the American Fisheries Society 138:616-632,2009. DOI: 10.1577/TO8-003.1

[358] West, James E. 2011. PCBs in Puget Sound's Food Web. Presentation to the Washington Department of Ecology Technical Fish Consumption Workshop on December 12, 2011 at the University of Washington, Seattle, WA. Accessed at: http://www.ecy.wa.gov/toxics/docs/20111212_fishworkshop_west.pdf
http://www.ecy.wa.gov/toxics/fish_publicinvolvement.html

[359] O'Neill, S.M., G.M. Ylitalo, J.E. West, J. Bolton, C.A. Sloan and M.M. Krahn. April, 2006. Regional patterns of persistent organic pollutants in five Pacific salmon species (*Onchorhychus spp)* and their contribution to

areas.[361],[362],[363] In a recent study conducted by the Washington State Department of Fish and Wildlife, out-migrating Chinook and steelhead were shown to accumulate significant body burden of toxic pollutants within Washington's fresh and marine waters. [364],[365] Studies of pollutants in juvenile Chinook salmon in the Columbia River basin have also been published, similarly demonstrating accumulation of toxic body burdens of salmon in Washington waters. [366] Additionally, there are numerous studies regarding the presence of toxics in both finfish and shellfish within Washington's waters. [367]

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contamination levels in northern and southern resident killer whales *(Orcinus orca).* Extended abstract presented to the 2006 Southern Resident Killer Whale Symposium. Seattle, WA.

[360] Presentations at the 2014 Toxics Reduction Conference; Seattle, WA. November 17, 2014.

[361]West, J, Lansbury, J., O'Neil, S., and Marshall, A. March, 2011. Persistent Bioaccumulative and Toxic Contaminants in Pelagic Marine Fish Species from Puget Sound. Washington Department of Ecology Publication Number 11-10-003.

[362] O'Neill, S.M., J.E. West, and J.C. Hoeman. 1998. Spatial trends in the concentration of polychlorinated biphenyls (PCBs) in chinook (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) in Puget Sound and factors affecting PCB accumulation: results from the Puget Sound Ambient Monitoring Program. Pages 312-328 in R. Strickland, editor. Puget Sound Research 1998 Conference Proceedings. Puget Sound Water Quality Action Team. Olympia, Washington.

[363] Sandie O'Neill, James West, Andrea Carey, Laurie Niewolny, Jennifer Lanksbury, Gina Ylitalo, and Lyndal Johnson, November 12, 2015. Toxic contaminants in outmigrant Chinook salmon from Puget Sound, Washington. Focus presentation for WRIA 9. Available at: http://www.govlink.org/watersheds/9/committees/archive/1511/7-JimWest_WDFW_WRIA9_JuvenileChinookTalk.pdf

[364] Sandie O'Neill, James West, Gina Ylitalo, Andrea Carey, Laurie Niewolny, Jennifer Lanksbury, and Lyndal Johnson, "Assessing the threat of toxic contaminants to early marine survival of Chinook salmon in the Salish Sea" (May 1, 2014). Salish Sea Ecosystem Conference. Paper 240. Available at http://cedar.wwu.edu/ssec/2014ssec/Day2/240

[365] West, James; March 9, 2015. Email re: Puget Sound toxic chemical uptake in salmon.

[366] Johnson,L., B. Anulacion, M. Arkoosh, O.P. Olson, C. Sloan, S.Y. Sol, J. Spromberg, D.J. Teel, G. Yanagida and G. Ylitalo. 2013. Persistent organic pollutants in juvenile Chinook salmon in the Columbia River basin: Implications for stock recovery, transactions of the American Fisheries Society, 142:1, 21-40.

[367] Johnson, L., C. Bravo, S. O'Neill, J. West, M. S. Myers, G. Ylitalo, N. Scholz, and T. Collier 2010. A Toxics-Focused Biological Observing System for Puget Sound (Developed by the Washington Department of Fish and Wildlife and NOAA Fisheries for the Puget Sound Partnership). Washington Department of Ecology Publication #10-10-04. 30pp.
Lanksbury, J., J. E. West, K. Herrmann, A. Hennings, K. Litle and A. Johnson. 2010. Washington State 2009/10 Mussel Watch Pilot Project: A Collaboration between National, State and Local Partners. Olympia, WA. Puget Sound Partnership, 283pp.
O'Neill, S.M., and J.E. West. 2009. Marine distribution, life history traits and the accumulation of polychlorinated biphenyls (PCBs) in Chinook salmon (*Oncorhynchus tshawytscha*) from Puget Sound, Washington. Transactions of the American Fisheries Society 138:616-632.

West, J.E., S.M. O'Neill, and G.M. Ylitalo. 2008. Spatial extent, magnitude, and patterns of persistent organochlorine pollutants in Pacific herring (*Clupea pallasi*) populations in the Puget Sound (USA) and the Georgia Basin (Canada). Science of The Total Environment 394:369-378.

Johnson, L.L., D.P. Lomax, M.S. Myers, O.P. Olson, S.Y. Sol, S.M. O'Neill, J. West, and T. K. Collier. 2008. Xenoestrogen exposure and effects in English sole (*Parophrys vetulus*) from Puget Sound, WA. Aquatic Toxicology 88(1):29-38.

West, J.E., and S.M. O'Neill. 2007. Thirty years of persistent bioaccumulative toxics in Puget Sound: time trends of PCBs and PBDE flame retardants in three fish species. 2007 Research in the Georgia Basin and Puget Sound Conference. Puget Sound Action Team. Vancouver, B.C.

O'Neill, S.M. and J.E. West. 2007. Persistent Bioaccumulative Toxics in the Food Web. Pages 140-148; 151-156 *in* Puget Sound Action Team, editors. 2007 Puget Sound Update: Ninth Report of the Puget Sound Assessment and Monitoring Program. Olympia, Washington.

O'Neill, S.M., G.M. Ylitalo, J.E. West., J.Bolton, C.A. Sloan, and M.M. Krahn. 2006. Regional patterns of persistent organic pollutants in five Pacific salmon species (*Oncorhynchus* spp.) and their contributions to contaminant levels in northern and southern resident killer whales (*Orcinus orca*). Presentation at 2006 Southern Resident Killer Whale Symposium. Seattle, Washington.

O'Neill, S.M., G.M. Ylitalo, M. . Krahn, J.E. West, J. Bolton, and D. Brown. 2005. Elevated levels of persistent organic pollutants in Puget Sound versus other free-ranging populations of Pacific salmon: the importance of residency in Puget Sound. Abstract of presentation at 2005 Puget Sound Georgia Basin Research Conference. Seattle, Washington.

Moser, M.L., M.S. Myers, B.J. Burke, and S.M. O'Neill. 2005. Effects of surgically-implanted transmitters on survival and feeding behavior of adult English sole. Pages 269-274 *in* M. T. Lembo and G. Marmulla, editors. Aquatic telemetry: advances and applications. Proceedings of the Fifth Conference on Telemetry held in Europe. FAO/COISPA, Ustica, Italy.

O'Neill, S.M., J.E. West, G.M. Ylitalo, C.A. Sloan, M.M. Krahn, and T.K. Collier. 2004. Concentrations of polybrominated diphenyl ethers (PBDEs) in fish from Puget Sound, WA, USA. Poster presentation: SETAC World Congress and 25th Annual Meeting in North America Society of Environmental Toxicology and Chemistry. Portland, Oregon.

West, J. E., S. M. O'Neill, and D. D. Doty. 2002. Polycyclic Aromatic Hydrocarbons in Dungeness crabs. Page 62 *in* Puget Sound Water Quality Action Team, editors. 2002 Puget Sound Update: Eighth Report of the Puget Sound Ambient Monitoring Program. Olympia, Washington.

O'Neill, S.M., and J.E. West. 2002. Contaminants in Fish. Pages 66-77 *in* Puget Sound Water Quality Action Team, editors. 2002 Puget Sound Update: Eighth Report of the Puget Sound Ambient Monitoring Program. Olympia, Washington.

West, J.E., S. M. O'Neill, G.R. Lippert, and S.R. Quinnell. 2001. Toxic contaminants in marine and anadromous fishes from Puget Sound, Washington: Results of the Puget Sound Ambient Monitoring Program Fish Component, 1989-1999. Washington Department of Fish and Wildlife. Olympia, Washington.

West, J., S. O'Neill, D. Lomax, and L. Johnson. 2001. Implications for reproductive health in quillback rockfish (*Sebastes maliger*) from Puget Sound exposed to polychlorinated biphenyls. Puget Sound Research 2001 Conference Proceedings. Puget Sound Water Quality Action Team. Olympia, Washington.

O'Neill, S.M., and J.E. West. 2001. Exposure of Pacific herring (*Clupea pallasi*) to persistent organic pollutants in Puget Sound and the Georgia Basin. Puget Sound Research 2001 Conference Proceedings. Puget Sound Water Quality Action Team. Olympia, Washington.

O'Neill, S.M., and J.E. West. 2000. Toxic Contaminants in Fish. Pages 56-64 *in* Puget Sound Water Quality Action Team, editors. 2000 Puget Sound Update: Seventh Report of the Puget Sound Ambient Monitoring Program. Olympia, Washington.

West, J.E., and S.M. O'Neill. 1998. Persistent pollutants and factors affecting their accumulation in rockfishes (*Sebastes* spp.) from Puget Sound, Washington. Pages 336-345 *in* R. Strickland, editor. Puget Sound Research 1998 Conference Proceedings. Puget Sound Water Quality Action Team. Olympia, Washington.

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PCB accumulation: results from the Puget Sound Ambient Monitoring Program. Pages 312-328 *in* R. Strickland, editor. Puget Sound Research 1998 Conference Proceedings. Puget Sound Water Quality Action Team. Olympia, Washington.
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O'Neill, S.M., J.E. West, and S. Quinnell. 1995. Contaminant monitoring in fish: overview of the Puget Sound Ambient Monitoring Program Fish Task. Pages 35-50 *in* E. Robichaud, editor. Puget Sound Research 1995 Conference Proceedings. Puget Sound Water Quality Authority. Olympia, Washington.

D. References and Source Documents

Also attached is a flash drive with source documents, to be hand carried to Ecology with a hard copy of the NWIFC comments.

Folders:

- Economic Information
- FCR studies and analysis
- Health and Nutrition
- History of Delay in Washington
- Statutory information, guidance, EPA docs, EPA Maine docs
- Toxic chemicals in water and aquatic organisms
- Treaties and Treaty Fishing Rights
- Previous comments on rulemaking submitted by NWIFC:
  - NWIFC Comments March 23, 2015 RE Washington Water Quality standards proposed rule
  - NWIFC letter to EPA Oct 30, 2015, re request for rulemaking in 90 day time period
  - NWIFC Comments December 21, 2015 on the Proposed Federal Rule, Docket ID No. EPA-HQ-OW-2015-0174
- Additional reference materials
  - Ridolfi: Chemical comparison spreadsheets (excel file) same as Appendix B
  - PCB section supporting documents
  - Letter from Suquamish Tribe re Sediment Management Standards

Note:
Any documents cited in the NWIFC comments are incorporated by reference, whether or not they are included on this flash drive.

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April 21, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments on Washington Department of Ecology's 2016 Draft Rule for Human Health Criteria and Implementation Tools for State Water Quality Standards

Dear Director Bellon:

The Columbia River Inter-Tribal Fish Commission (CRITFC) thanks you for the opportunity to comment on Washington's draft rule for human health criteria and implementation tools for state water quality standards. CRITFC has worked with the state of Washington and the EPA for many years to develop and adopt regionally consistent water quality standards that will protect the health of tribal people that fish in the Columbia River watershed. Ecology's February 2016 draft rule for human health criteria and implementation tools finally includes a fish consumption rate (FCR) and cancer risk level that is the same as the Oregon rule that was adopted in 2011. CRITFC has urged Ecology to adopt these parameters throughout the rulemaking process and believes that this is a step forward in achieving our goal of a more healthful river system. However, as stewards of the Columbia River fishery, CRITFC can only support the implementation of regulations and programs that improve water quality to a level that is sufficient to protect our watershed from the harmful impacts of waterborne pollutants. Ecology's proposed rule once again falls short of the stated goal of protecting people who consume fish from Washington's waters and should be revised.

EPA's proposed rule for Washington "Revision of Certain Water Quality Criteria Applicable to the State of Washington" that was issued in September 2015 specifically includes the safe harvest of treaty-reserved resources as a designated use in regulating water quality in Washington. EPA's rule uses a FCR of 175 grams per day, a cancer risk level of 1 in 1,000,000, and other parameters from the 2015 304(a) human health recommended criteria update[1]. In contrast, Ecology has chosen to adopt only some of the revised national 304(a) criteria and

[1] U.S. Environmental Protection Agency, Final Updated Ambient Water Quality Criteria for the Protection of Human Health. FR Doc. 2015-15912 (June 29, 2015), EPA-HQ-OW-2014-0135-0155.

recommendations, generally to the detriment of the protectiveness of the standards. In working towards the achievement of regionally consistent water quality standards, EPA's September 2015 proposed rule for Washington sets a new level for water quality standards for the region that combines the currently best available science with local knowledge about the use of the region's water and fishery resources. CRITFC's member tribes hold treaty-secured and federally recognized tribal fishing rights that must be protected by the water quality regulations in Washington and all states in the watershed.

Additionally, Ecology has proposed to retain the 1992 National Toxics Rule criterion of 0.00017 µg/L for total PCBs. PCBs are bioaccumulative carcinogens that threaten the treaty-reserved resources of CRITFC's member tribes. Substantial portions of the Columbia River are currently under fish consumption advisories because of this contaminant and clearly the state's current water quality standards are not sufficient to protect the uses of these waters for fishing. Retaining the status quo for the state's water quality standards for PCBs does not serve to reduce pollution in the waters that we share and will never drive the technological development needed to reduce pollutant discharges.

CRITFC's member tribes also believe that Washington's final rule should quantitatively specify requirements for how Washington will "maintain a level of water quality when entering downstream waters" and who will be responsible for the inadequacies of upstream standards. Washington shares waters with Oregon and with tribes that currently have or are working to have water quality standards that are more protective than Washington's proposed rule. The narrative in the proposed rule is not sufficient to assure the attainment of downstream standards either with Oregon's or those of the tribes. Downstream protection and regional consistency in water quality standards is a high priority for our member tribes and is supported by Resolutions #13-44 and #12-54 of the Affiliated Tribes of Northwest Indians that call for regional consistency in water quality standards.

Finally, CRITFC hereby, supports, adopts, and incorporates by reference the complete Northwest Indian Fisheries Commission comments submitted to Ecology in April, 2016. CRITFC fully supports the principal goal of the Clean Water Act to eliminate pollution from our Nation's waters and believes in a future where the Columbia River fishery is once again free of harmful contaminants. Thank you for considering our comments during this rulemaking. If you have any further questions please contact me or Dianne Barton, Water Quality Coordinator at 503-238-0667.

Sincerely,

Babtist Paul Lumley
Executive Director

Cc: Dennis McLerran, EPA Region 10 Administrator
Dan Opalski, EPA Region 10 Director for the Office of Water and Watersheds

EPA Region 10 RTOC
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April 21, 2016

Becca Conklin
Washington Department of Ecology
PO Box 47600
Olympia, WA 98503-7600

Submitted via email (swqs@ecy.wa.gov)

RE: Comments of Region 10 RTOC Tribal Caucus on the Draft Water Quality Standards for Protecting Human Health

Dear Mr. Conklin:

This letter is sent on behalf of the Tribal Caucus members of EPA Region 10's Tribal Operations Committee (RTOC). This letter is not sent on behalf of EPA Region 10 or any employees of EPA, but solely tribal government representatives of the RTOC. These comments are submitted on the Draft Water Quality Standards for Protecting Human Health ("draft standards").

The Clean Water Act requires states to develop water quality standards necessary to meet the requirements of the Clean Water Act, including protecting designated uses of water. 33 U.S.C. § 1313. Those designated uses encompass the "fishable and swimmable" protections of the Clean Water Act -- including protecting and cleaning up lakes and rivers so that they are clean enough for drinking, for direct human contact for fishing and recreation, for healthy aquatic resources, and for catching and consuming fish and shellfish.

The Region 10 RTOC includes Tribes across Alaska, Washington, Idaho, and Oregon. Many of these Tribes have called for changes to state water quality standards to adequately address subsistence use of resources by tribal communities, including fish, aquatic plants, and aquatic birds and mammals.

Clean water is essential to many Tribes, not just as a source of sustenance, but also for cultural, medicinal, and spiritual reasons, as well as a treaty-reserved right for many Tribes in the Northwest. The ability of Tribes to control pollution and protect water quality is vital to the survival of Tribes. Almost no activity has more potential for significantly affecting the economic and political integrity and the health and welfare of all reservation citizens than water use, quality, and regulation.

The Tribal Caucus commends that the Washington Department of Ecology ("Ecology") for changes to the draft standards that were made from the previous version, particularly adoption of a consumption rate of 175 grams per day with a cancer risk of one in one million. However, the draft standards fall short in protecting tribal health and meeting the goals of the Clean Water Act in making our waters "fishable."

These specific concerns include:

Toxics Standards for Mercury, PCBs, and Arsenic: The draft standards are inadequate with regards to toxics, particularly mercury, PCBs, and arsenic. Instead of adopting more stringent standards for three of the most toxic pollutants, Ecology chose to leave the standards exactly the same as under the National Toxics Rule ("NTR"), with no steps forward despite a better fish consumption rate.

Ecology proposes to use a dramatically lower cancer risk rate for PCBs—rather than one in one million, it proposes one in 25,000 cancer risk for PCBs alone without explained why cancer risk originating from PCBs is less concerning than cancer risk for other chemicals such that it would allow a forty times greater risk. It is not clear what justification exists for this disparity in treatment. As Ecology knows, PCBs are still introduced into the environment from products such as yellow pigments, hydroseed, and other commercially available products. The State could certainly address these products through products bans (such as the state-enacted PBDE ban).

Moreover, the State is already address a much more stringent PCB limit on the Spokane River, where dischargers will be expected to meet a PCB limit based upon the Spokane Tribe's fish consumption rate of over 700 grams/day.

Likewise, for mercury applying a revised fish consumption rate and the proper factors from EPA's EFH recommendations would have resulted in a more protective water quality standard. Instead, Ecology simply proposes to put off any new regulation and will leave the current mercury standard as is. To justify its action, Ecology asserts it is simply too difficult to complete a mercury standard at this time. This assertion that it is too difficult is not a legitimate basis for failing to adopt a proper standard (particularly given that EPA has proposed a mercury limit for Washington).

For arsenic, the draft standards propose a 555-fold increase in the permitted amount of arsenic in fresh water. This is justified by citing the higher concentrations of arsenic in the Region. The draft standards suggest that adopting the "drinking water standard," meets the State's Clean Water Act obligations. This is incorrect. EPA has directly addressed this issue and has made plain that Safe Drinking Water Act ("SDWA") standards are not to be used as a substitute for Clean Water Act section 304(a)(1) human health standards.

Getting these standards correct is an important environmental justice issue. All of these toxics bio-accumulate and bio-magnify in the food chain in such a way that makes fish problematic to consume. The standards for PCBs are still exceeded in some fish and statewide mercury advisory remains in place making their consumption extremely problematic for pregnant women, children, and tribal members who for cultural and economic reasons consume far more than the recommended allowance. Currently, EPA has proposed standards for these toxics that are more protective. The Tribal Caucus believes these standards should be adopted.

Compliance Schedules: The draft standards allow a significant increase in timeframes for compliance schedules, which is unacceptable.

Compliance schedules are recognized by EPA as a tool in permitting under some circumstances. 40 C.F.R. § 122.47. Compliance schedules are appropriate where an existing permittee needs time to comply with a new standard such as a new water quality standard or a new technology standard or both.

Ecology already provide for the use of compliance plans in permitting. The justification for compliance schedules is that compliance with a new standard cannot happen instantly, and so a plan may be created that includes interim, enforceable milestones with a firm date by which time permit requirements must be met.

While EPA does not set a maximum allowable time for compliance schedules, they must ensure compliance "as soon as possible." 40 C.F.R. § 122.47(a)(1). Courts have indicates that these schedules cannot exceed the five-year term of a permit. *See Citizens for a Better Environment v. Union Oil Co. of Cal.*, 83 F.3d 1111, 1120 (9th Cir. 1996). Further, "schedule of compliance" as defined in the Clean Water Act plainly contemplates a period of time constrained by the four corners of a five-year permit. *See* 33 U.S.C. § 1362(17)...

The draft standards uses vague language "as soon as possible" when refereeing to must meeting water quality standards, which is contrary to the law and threatens to result in a perpetual delay in compliance. The draft standards must require specific timeframes to meet standards to ensure accountability that our waters are clean.

Variance: The increased availability and/or potential use of variances in the draft standards are unacceptable. The variances proposed here will result in significant delays in improvement of water quality.

The draft standards should result in significant reductions of discharge of health impacting pollutants from point source – not efforts by the State to delay improvement to the health of our waters, fish, and people.

Intake Credits: The draft standards should eliminate the proposal for intake credits. Intake credits allow a polluter to discharge water that violates water quality limits if the discharger has not added pollutants to the water.

While conceptually good, intake credits are difficult when dealing with toxics. Many toxics, such as PCBs, accumulate in fish tissue and water over time such that even small additions are harmful. Allowing intake credits could weaken the ability to eliminate toxics and would contribute to and/or perpetuate the death by a thousand cuts problem of bioaccumulation that Washington is currently experiencing with these pollutants.

If intake credits will be included in the final standards, Ecology must address potential impacts from bioaccumulation and develop incentives to capture all pollutants coming through the systems that end up in our waters.

The Tribal Caucus has previously indicated strong support for adoption of the proposed standards by EPA. Accordingly, we urge Ecology to revise its proposal to more closely mirror the proposal of EPA or to simply defer adoption to EPA.

The RTOC appreciates your consideration of these comments.

Sincerely,

William (Billy) J Maines

William (Billy) J. Maines
Region 10 RTOC, Tribal Caucus Co-chair

UPPER SKAGIT INDIAN TRIBE

25944 Community Plaza Way • Sedro-Woolley, Washington 98284
Phone (360) 854-7000 • FAX (360) 854-7004

April 22, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments on the State's 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon,

The Upper Skagit Indian Tribe submitted comments March 23, 2015 on the initial Human Health Criteria proposed for Washington Water Quality Standards, and again with this letter submit comments to be considered on the proposed 2016 Draft Rule for Human Health Criteria revision. The Tribe has requested for many years that Washington State or the U.S. Environmental Protection Agency develop and adopt water quality standards that will be protective of the health of our tribal people and respect our treaty-reserved rights to the harvest of fish and shellfish. The Department of Ecology has now proposed a second draft rule for human health criteria and implementation tools that we believe fail to be protective of fish and shellfish consumption rates healthy for our tribal community. The Upper Skagit Indian Tribe hereby, supports, adopts, and incorporates by reference the complete Northwest Indian Fisheries Commission comments submitted to Ecology in April, 2016. Finally, the Upper Skagit Indian Tribe would like to express our support for the more protective draft rule for human health criteria applicable to Washington State, issued by the U.S. Environmental Protection Agency on September 14, 2015. Please contact Lauren Rich, Manager, Environmental Planning and Community Development at 360-854-7006 if there are any questions.

Respectfully,

Doreen M. Maloney

Doreen Maloney, General Manager & Executive Director, Economic Development and Treaty Entitlements

CC: Scott Schuyler, Natural Resources Policy Director
Jon-Paul Shannahan, Fisheries Biologist

COMMENTS ON BEHALF OF THE NORTHWEST PULP & PAPER ASSOCIATION, WESTERN STATES PETROLEUM ASSOCIATION, WESTERN WOOD PRESERVERS INSTITUTE, TREATED WOOD COUNCIL, ASSOCIATION OF WASHINGTON BUSINESS, THE BOEING COMPANY, ALCOA WENATCHEE WORKS, INTALCO ALUMINUM CORPORATION, INLAND EMPIRE PAPER COMPANY, KAISER ALUMINUM WASHINGTON, LLC, KAPSTONE KRAFT PAPER CORPORATION, NIPPON PAPER INDUSTRIES USA, NUCOR STEEL SEATTLE, INC., PACKAGING CORPORATION OF AMERICA, PONDERAY NEWSPRINT COMPANY, SCHNITZER STEEL INDUSTRIES, THE WEYERHAEUSER COMPANY, AND THE PORT TOWNSEND PAPER CORPORATION ON THE DEPARTMENT OF ECOLOGY PROPOSED CHANGES TO WATER QUALITY STANDARDS FOR SURFACE WATERS OF THE STATE OF WASHINGTON – WAC 173-201A

WSR 16-04-092 February 1, 2016

April 22, 2016

Prepared by James Tupper and Lynne Cohee, Tupper Mack Wells PLLC

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The Northwest Pulp & Paper Association, Western States Petroleum Association, Western Wood Preservers Institute, Treated Wood Council, Association of Washington Business, The Boeing Company, Alcoa Wenatchee Works, Intalco Aluminum Corporation, Inland Empire Paper Company, Kaiser Aluminum Washington, LLC, KapStone Kraft Paper Corporation, Nippon Paper Industries USA, Nucor Steel Seattle, Inc., Packaging Corporation of America, Ponderay Newsprint Company, Schnitzer Steel Industries, The Weyerhaeuser Company, and the Port Townsend Paper Corporation submit the following comments on the Department of Ecology proposed changes to water quality standards for surface waters of the state of Washington- WAC 173-201A announced in WSR 16-04-092 (February 1, 2016).*****

Introduction

The signatories to this comment letter appreciate the public involvement opportunities provided by the Department of Ecology to develop revisions to human health-based water quality criteria and implementation tools. We appreciate that over the last four years, it has been a difficult task to fairly balance revising standards that appropriately protect human health uses with reasonably available and foreseeable wastewater treatment technology. We strongly support the proposed water quality criteria for polychlorinated biphenyls (PCBs), arsenic and mercury, as well as the position taken by the Department on the relative source contribution and bioconcentration factors. We also strongly support the three implementation tools proposed by the Department of Ecology—variances, intake credits and expanded compliance schedules. The much more stringent water quality standards will force NPDES permittees to rely on these implementation mechanisms to maintain compliance. There are concerns on whether the Department and permittees will be able to administratively deliver these important permitting tools.

Our greatest concerns remain with the incremental excess cancer risk level and the significantly increased fish consumption rate, which combined with other conservative factors will result in unnecessarily stringent water quality criteria. Water quality criteria serve as the foundation for implementing most Clean Water Act programs. Many of the proposed criteria are unattainable with current wastewater treatment technologies. NPDES permittees—including cities, counties, ports and the private sector—will be challenged with a demand for expensive wastewater treatment system upgrades, an inability to comply with permit terms, and litigation threats. We cite the lack of any meaningful basis in the administrative record for the risk management decision made for the cancer risk factor. The Department of Ecology was unable in supporting materials to demonstrate meaningful health protection gains from these more stringent water quality standards.

Comment No. 1: Ecology should adopt a criterion for polychlorinated biphenyls based on its risk assessment not the NTR.

Polychlorinated biphenyls (PCBs) present a unique environmental challenge in the state of Washington. Despite a ban and phase out in manufacturing after 1979, PCBs are persistent in the environment due to, for example, airborne deposition, in EPA-allowed incidental PCB concentrations in certain products, and in FDA-allowed concentrations in fish feed used in hatcheries. The burden on regulated entities to comply with stringent PCB water quality criteria is not justified by the limited benefits and potential costs due to the inability to test or treat to extremely low criteria as well as the ongoing sources of PCBs from airborne deposition and products. Over-regulation of PCBs could also lead to a regulatory stalemate resulting in a ban on any new or expanded construction or discharges until Washington waters achieve impossibly low criteria, effectively stifling economic growth in the state of Washington, a suspension of federal, state and Tribal hatchery programs, a complex TMDL process, and management of the NPDES permit process through variances and compliance schedules. This regulatory commitment would likely come at the expense of efforts that could actually reduce PCBs in the environment through sediment cleanup actions and other hazardous waste cleanup actions, source control, implementing the recently approved PCB Chemical Action Plan[1] as well as continued pressure on EPA to reform its Toxic Substance Control Act (TSCA) regulations.

Ecology is well within EPA guidance to address the unique challenges of PCBs through a chemical specific risk management decision.[2] EPA has approved state standards using alternative risk methodologies—most recently for the state of New Jersey.[3] The methodology used by Ecology to derive the PCB criteria is scientifically defensible.

A unique approach to PCBs is justified by the unresolved technical issues in regulating PCBs at a national level. The EPA itself has struggled with how to regulate PCBs. The EPA did not update the national recommended water quality criterion for PCBs in its June 29, 2015, final action on the Clean Water Act (CWA) section 304(a) criteria for the protection of public health. EPA withheld action "due to outstanding technical issues, including new toxicity factors and bioaccumulation factors."[4] EPA has also acknowledged the "complex issues" regarding PCBs in declining to enforce current EPA limits on inadvertent generation of PCBs in products.[5] EPA has further declined to reduce allowed levels of inadvertently generated PCBs due to "policy and scientific challenges."[6] Ecology is more than justified to treat PCBs differently in deriving new

[1] Ecology and Department of Health, *PCB Chemical Action Plan*, Publication No. 15-07-002 (February 2015)(04016-4238).

[2] Ecology, *Washington State Water Quality Standards: Human Health Criteria and Implementation Tools, Overviewof Key Decisions in Rule Amendment*, Publication No. 14-10-058 (January 2015)(00001-73), at 39.

[3] EPA, *Response to Comments for Water Quality Standards; Withdrawal of Certain Federal Water Quality Criteria Applicable to California, New Jersey and Puerto* Rico, EPA-HQ-OW-2012-0095, 4-5 (2012)(01072-1085) at 6.

[4] EPA, *Human Health Ambient Water Quality Criteria: Draft 2014 Update*, EPA-820-F-14-003 (May 2014)(01772-1774).

[5] D. McLerran, Letter to A. Borgias (February 24, 2015)(04239-4241).

[6] *Id.*

criteria and should consider adopting a total PCB criterion consistent with the methodology and risk management decisions made by Ecology in its prior proposed rulemaking.

The risk management assessment by Ecology is consistent with the EPA national approach to regulating PCBs under the CWA. EPA claimed that it did not update the PCB criterion due to "outstanding technical issues."[7] EPA explained the scope of these technical issues with updating the PCB criteria in a letter to the Spokane River Regional Toxics Task Force through Ecology:

> Revising current regulations to reduce inadvertently generated PCBs presents both policy and scientific challenges. Before proposing more stringent regulations on the inadvertent generation of PCBs in pigments, the EPA would seek to further understand the complexities and contributions of not only pigments, but also other congeners that be present [in receiving water]….
>
> …The aggregation of PCB congeners may in some instances be problematic for risk assessment because the toxicity of different PCB congeners varies and a fixed water quality concentration for total PCBs may not adequately represent the variable toxicity of the various congeners actually present in a particular water body. While the EPA is not proposing to undertake a comprehensive analysis of the remaining PCB congeners, we are examining the characterization of PCBs in water bodies. As stated above, characterizing all of the PCBs in the EPA recommended water quality criteria for PCBs (i.e., expressed as total PCBs) is one topic we are discussing.[8]

Ecology should not adopt a new PCB criterion for Washington as long as EPA does not have the ability for the reasons set forth in the above letter to revise PCB regulations under the TSCA or the national recommended water quality standards under section 304 of the CWA. EPA affirmed as recently as August 3, 2015, that revising PCB regulations "presents both policy and scientific challenges."[9]

It will be all but impossible to comply with a more stringent PCB criterion due to the ongoing release of PCBs that EPA authorizes as adequately protective under TSCA. A recent study in Washington documented the presence of low PCB levels in a broad range of manufactured products including paints, used motor oil, road striping paint, dust suppressants, antifreeze, hydro-seed materials, packaging, toothpaste, hand soap, laundry soap and shampoo.[10] The TSCA regulations allow PCB concentrations up to 50 ppm in manufactured products. 40 C.F.R. §§ 761.3 and 761.20. EPA has maintained that PCB concentrations at these levels do not pose a threat to human health or the environment under TSCA, 40 C.F.R. § 761.20.[11]

[7] EPA, Human Health Ambient Water Quality Criteria: Draft 2014 Update (01772-1774).

[8] D. McLerran, Letter to A. Borgias (February 24, 2015)(04239-04240).

[9] L. Mann, Email to M. MacIntyre at 2 (August 3, 2015)(05063-5065).

[10] City of Spokane, PCBs in Municipal Products (Rev.), Table B-1 (July 21, 2015)(06694-6738).

[11] NTR at 60848-01, 60868. (00768-847)

For many dischargers in Washington, the EPA allowed PCB concentrations are a significant portion of the PCBs in their effluent. For pulp and paper mills using recycled paper, their primary source of PCBs is from EPA-allowed concentrations in inks and dyes. [12] The same is true for wastewater treatment plants. In a 2015 report, Spokane County reported that PCB-11, a PCB congener associated with EPA allowed PCB concentrations, "was measured at relatively high concentrations…in both the influent and effluent."[13] PCB-11 was the "single most abundant congener in the effluent."[14] The same study evaluated PCB concentrations from three neighborhoods predominantly developed before 1970, from 1970 to 1985 and after 1985. The study found the highest PCB concentrations from the two most recently developed neighborhoods and concluded that there is "little correlation between the year of construction and the source of PCB contamination."[15]

It is also apparent that tribal and federal fish hatcheries discharge a significant percentage of the annual PCB loading to Washington waters. EPA authorizes the operation of these hatcheries and the contamination of fish released by these hatcheries under the authority of a general NPDES permit.[16] Ecology has identified hatcheries as a significant source of PCB loading to waters of the state. To be clear, these PCBs are not coming from concentrations of PCBs in Washington waters, they are coming from concentrations of PCBs in fishmeal allowed under FDA regulations for use in hatcheries. Ecology has estimated that as much as ten percent of annual PCB loading to Puget Sound is attributable to returning salmon.[17]. In 2011, Ecology calculated that returning salmon contribute up to 0.3 kg/yr based on PCB residues per whole-body fish ranging from 7 µg for pink salmon to 336 µg for Chinook salmon.[18]

Ecology has also acknowledged, in addition to the PCB loading from returning salmon, that PCB contaminated hatchery fish play a significant role in section 303(d) listings for PCBs.[19] Ecology concluded that hatchery fish "may contribute to impairment and, in some cases, may cause the bulk of impairment."[20]

The 2006 Ecology report on hatchery fish included an analysis of skin-on fillets of pre-release rainbow trout from 11 hatcheries with PCB concentrations ranging from <2.3 to 67 ng/g (wet weight) with an average of 13.0 ng/g (wet weight) PCBs.[21] Assuming that the fillet

[12] D. Krapas, Slide Show "Dealing with PCBs in the Spokane River" at 3 (October 2, 2012)(06443-6463).

[13] Brown and Caldwell, 2015 Annual Toxics Management Report Spokane County Regional Water Reclamation Facility NPDES Permit WA-0093317 at 2-18 (2015)(04861-4948).

[14] *Id.* at 2-18.

[15] *Id.* at 2-27.

[16] EPA, Preliminary Draft NPDES Permit for Federal Aquaculture Facilities and Aquaculture Facilities Located in Indian Country, Permit No. WAG-130000 (August 2015)(06216-6319).

[17] Ecology, Control of Toxic Chemicals in Puget Sound: Assessment of Selected Toxic Chemicals in Puget Sound 2007-2011 at 93 (2011)(Ecology Pub. 11-03055)(04297-4593).

[18] *Id.*

[19] Ecology, Persistent Organic Pollutants in Feed and Rainbow Trout from Selected Trout Hatcheries (April, 2006)(Ecology Pub. No. 06-03-017)(04681-4732).

[20] *Id.* at 30.

[21]. *Id*.

concentrations reflect whole-body concentrations, these concentrations corresponded to <103 to 9,700 ng total PCBs per fish (using hatchery-specific average fish weights, which ranged from 83 to 678g). Other researchers have found between 39 and 59 ng/g total PCBs in whole-body juvenile Chinook salmon from six west coast hatcheries.[22] The authors concluded, "contaminated salmon may be a significant source of toxicants in the environment and in the food chain."[23] A study of British Columbia hatcheries found on average 25.5 and 48.5 ng/g (wet weight) PCBs in Chinook smolts from two hatcheries and 34.9 ng/g (wet weight) in Coho smolts from a third (BC) hatchery.[24] An analysis of pre-release juvenile Chinook from eight hatcheries feeding on the Columbia River found whole body concentrations of PCBs ranging from 6.9 to 61 ng/g (wet weight), corresponding to 22 to 323 ng per fish (individual hatchery-specific average weights from 3.2 to 6.2 g).[25] An analysis of pre-release juvenile Chinook salmon from the Soos Creek hatchery on Puget Sound over a three year period found total PCB concentrations ranging from 10 to 50 ng/g (wet weight), corresponding to 90 to 125 ng PCB per fish (fish weight ranged from 2.5-9.4 g).[26] NOAA Fisheries has also documented the significant PCB concentrations in hatchery fish feed and in hatchery origin fish.[27]

Tribal and federal hatcheries are undoubtedly an increasing source of PCB loading to Washington waters. In 2010, the combined hatchery release in Washington was 229.5 million fish including 117.4 million Chinook salmon.[28] In 2015, the Northwest Indian Fisheries Commission reported that tribal hatcheries alone released 40 million salmon and steelhead.[29] EPA appears to believe that this level of PCB loading to Washington waters is consistent with applicable water quality standards and will not cause any degradation to existing beneficial uses. EPA has not sought to regulate these discharges or require any additional monitoring or best management practices in the preliminary draft general hatchery permit in Washington that will authorize tribal hatcheries to continue to release PCBs to the environment.[30]

Ecology should not adopt a criterion more stringent than the National Toxics Rule (NTR) PCB criterion as long as the outstanding technical issues are unresolved and in light of the on-

[22] L. Johnson *et al*, Contaminant Exposure in Outmigrant Juvenile Salmon from Pacific Northwest Estuaries of the United States, 124 ENVIRON. MONIT. ASSESS. 167-194 (2007)(04955-4982).

[23] *Id.* at 22.

[24] Kelly et al, Persistent Organic Pollutants in Aquafeed and Pacific Salmon Smolts from Hatcheries in British Columbia, Canada, 285 AQUACULTURE 224-233 (2008).

[25] Johnson et al, Contaminant Concentrations in Juvenile Fall Chinook Salmon from Columbia River Hatcheries, 72 N. AMERIC. J. AQUACULTURE73-92 (2010).

[26] Meador et al,. Bioaccumulation of Polychlorinated Biphenyls in Juvenile Chinook Salmon (Oncorhynchus Tshawytscha) Outmigrating through a Contaminated Urban Estuary: Dynamics and Application, 19 ECOTOXICOLOGY141-152 (2010).

[27] NOAA Fisheries, Draft Environmental Impact Statement on Two Joint Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs, Appendix K (2014)(04257-4273).

[28]The Role of Hatcheries in North American Wild Salmon Production, The Great Salmon Run: Competition Between Wild and Farmed Salmon, Table IV-1 at 44 (06739-6752).

[29] Northwest Indian Fisheries Commission, Tribal Natural Resources Management, A Report from the Treaty Tribes in Western Washington at 4 (2015)(06530-6545).

[30] EPA, Preliminary Draft NPDES Permit for Federal Aquaculture Facilities and Aquaculture Facilities Located in Indian Country, Permit No. WAG-130000 (August 2015)(06216-6319).

going PCB loading attributable to EPA authorization of PCB concentrations in manufactured products and in hatchery fish. EPA has concluded through TSCA and its general hatchery permit for federal and tribal hatcheries that these levels of PCBs do not pose a threat to human health or the environment.

Comment No. 2: Ecology has appropriately proposed a separate approach for polychlorinated biphenyls in light of the potential costs that would be incurred in implementing a more stringent and unnecessary criterion.

Available water quality data indicates that large portions of state waters would classify as impaired under CWA section 303(d) for failing to meet the EPA proposed PCB criteria of 7.6 pg/L. It is likely that every publicly owned wastewater treatment plant in Washington has the potential to cause or contribute to a violation of the EPA proposed PCB criteria. The technology to treat for PCBs in a five million gallons a day (MGD) treatment plant would be membrane filtration followed by reverse osmosis, with a Net Present Value (2013 dollars) cost of $75 to $175 million, These capital and operation/maintenance costs are documented in Attachment C—HDR, Treatment Technology Review and Assessment for Association of Washington Business, Association of Washington Cities and Washington State Association of Counties, at 38, Table 9 (December 2013).

There is substantial PCB water column data for Puget Sound and the major tributaries to Puget Sound. This data was collected by Ecology in 2009 and 2010.[31] From this data alone there are well over 12,000 PCB sampling results from Haro Strait, the Strait of Juan de Fuca, the Whidbey Basin, Main Basin, South Sound and Hood Canal.[32] This includes PCB water column data for total congeners collected at each of these sites.[33] All of the total congener data is either unqualified or J qualified. EPA, in its separate rulemaking, denied all such data relevant for assuming the cost benefit of proposed water quality standards.

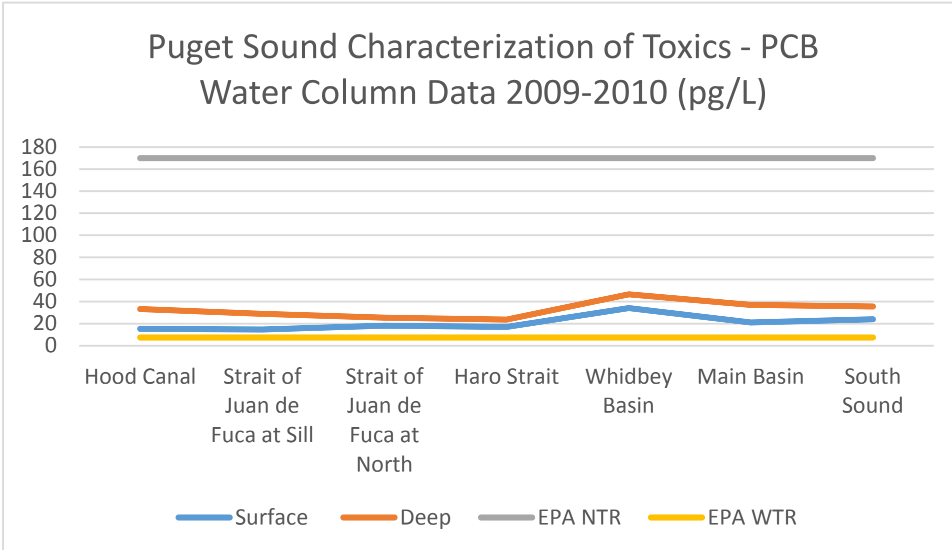
All of the total PCB water column data from the 2011 Ecology report is above the EPA proposed PCB criterion for Washington but below the NTR criteria. The following chart, based on water column data in the 2011 report,[34] shows an average of the total PCBs for each monitoring station at the surface and at depth:

[31] Ecology, Control of Toxic Chemicals in Puget Sound: Characterization of Toxic Chemicals in Puget Sound and Major Tributaries, 2009-10 (January 2011)(05155-5395) (available at https://fortress.wa.gov/ecy/publications/documents/1103008.pdf).

[32] Ecology, Email (07311) and attached EIM Data for Puget Sound (December 8, 2015)(05987). The attached data is limited to water column data for total PCBs.

[33] *Id.*

[34] *Id.*



In evaluating the potential impact of a more stringent PCB criterion it should be noted that every wastewater treatment plant sampled by Ecology in one study, with the exception of two facilities with reporting levels of 600 pg/L, were well above the proposed EPA criteria.[35]

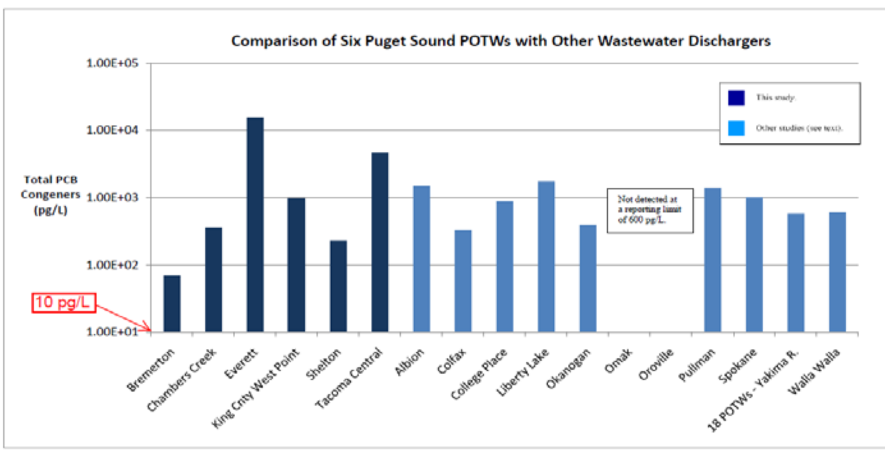


Figure 2. Comparison of Average Total PCB Results among Several POTWs

The EPA proposed PCB criteria would have direct impacts on these and other wastewater treatment plants. EPA has relied on the above information from the Ecology studies to perform a narrative reasonable potential analysis for three municipalities on the Spokane River. In the 2012 Fact Sheet for the City of Coeur d'Alene wastewater treatment plant NPDES permit EPA makes the following statement regarding the data presented in Figure 2:

> PCBs have been detected in effluent from POTWs discharging to the Spokane River in the State of Washington (i.e., the City of Spokane and Liberty Lake Sewer and Water District) as well as other POTWs in Washington State operated

[35] Ecology, Control of Toxic Chemicals in Puget Sound Summary Technical Report for Phase 3: Loadings from POTW Discharge of Treated Wastewater, Figure 2 (December 2010)(Publication No. 10-10-057)(05746-5986).

> by the Cities of Medical Lake, Okanogan, College Place, Walla Walla, Pullman, Colfax, Albion, Bremerton, Tacoma, and Everett, and King and Pierce counties. Effluent concentrations of total PCBs at these 14 facilities (a total of 34 samples) ranged from 46.6 to 39,785 pg/L with a median concentration of 810 pg/L...[36]

The Spokane River offers a precedent for how Ecology may have to implement a more stringent PCB criterion throughout the state of Washington. At issue on the Spokane River is the EPA-approved water quality standards for the Spokane Tribe of Indians in 2013 that include a PCB criterion of 1.3 pg/L. EPA has represented, in litigation regarding the obligation of EPA to impose a PCB TMDL for the Spokane River, in federal court that year-round tertiary membrane filtration treatment is an appropriate best management practice for a wastewater treatment plant.[37]

Available data indicate that most state waters would not meet the EPA proposed criteria and that most NPDES wastewater treatment plants will have to apply membrane filtration treatment and additional treatment technologies to address PCBs. Attachment C, at ES-3, Table ES-1, provides an incremental cost for such treatment including construction costs and operation and maintenance costs of between $75 and $160 million for a 5 MGD plant and net present value unit cost of between $15 and $32 per MGD per day. EPA, in its draft rule documentation, identified 406 NPDES permits administered by Ecology including 73 so-called major permits. If Ecology were to follow the same approach on Puget Sound that it has on the Spokane River, this would amount to a range of compliance costs from nearly $6 billion to over $11 billion for just the major permits identified by EPA.[38] A more stringent PCB criterion is also likely to impact how stormwater is managed as PCB concentrations have been detected in stormwater throughout the state.[39]

Ecology has appropriately proposed to maintain a protective standard for PCBs by adopting the current NTR PCB criterion. The uncertainties about PCB toxicity, and potential expense of compliance for more stringent standards justifies this approval.

Comment No. 3: Ecology has appropriately proposed a criterion for arsenic based on the MCL for arsenic under the Safe Drinking Water Act.

The arsenic criteria proposed by Ecology based on the Maximum Contaminant Level (MCL) for arsenic under the Safe Drinking Water Act (SDWA) is the same approach approved by EPA for many states including California, Idaho and Alaska. This approach is protective of public health and recognizes both the high natural background of arsenic in Washington waters

[36] EPA, City of Coeur d'Alene Revised Fact Sheet NPDES Permit No. ID0022853 at 17 (2013)(07468-7569).

[37] *Sierra Club v. EPA*, Case No.2:11-cv-017959-BJR Doc. No. 129-1 EPA's Plan for Addressing PCBs in the Spokane River (July 14, 2015)(06320-6350).

[38] $75 MM x 73 = $5.5 Billion; $160 MM x 73 = $11.7 Billion.

[39] W. Hobbs, Memorandum Spokane Stormwater (October 15, 2015)(06427-6435); Ecology, Western Washington NPDES Phase I Stormwater Permit: Final S8.D Data Characterization 2009-2013 (February 2015)(Ecology Publication No. 15-03-001)(05592-7745);King County, PCB/PBDE Loading Estimates for the Greater Lake Washington Watershed (September 2013)(06546-6617).

and the technical difficulty of regulating arsenic for the protection of human health under the Clean Water Act.

As with PCBs, the June 29, 2015, EPA final updates to the section 304 human health criteria did not include new criteria for arsenic.[40] EPA stated in the announcement of the proposed updates in 2014, that the agency did not have the ability to update the arsenic criteria due to "outstanding technical issues."[41]

These technical difficulties are reflected in final NTR arsenic criterion where EPA places an asterisk next to its arsenic criteria noting that it only applies to "inorganic arsenic."[42] EPA describes in its response to comments that this action reflects that only inorganic arsenic is toxic to humans.[43]

In 1997 EPA approved arsenic criteria from Alaska based on the SDWA MCL and withdrew application of the NTR criteria to the state.[44] In that action EPA stated that "a number of issues and uncertainties arose concerning the health effects of arsenic" since the adoption of the NTR.[45] EPA deemed these issues sufficiently significant to require a careful evaluation of the risks of arsenic exposure. A large area of uncertainty in the regulation of arsenic is the form of arsenic present in marine fish. EPA reported in 1997 that the form of such arsenic is typically organic and thus not relevant to establishing human health criteria.[46] The report recommends that EPA use the SDWA MCL for arsenic as the ambient water quality criteria until EPA updates its risk assessment for arsenic.[47]

In 2002 EPA adopted toxic criteria for the state of California but did not include criteria for arsenic.[48] EPA explained that this action was necessary due to the ongoing "issues and uncertainties" and contemplated revision to the SDWA MCL based on a report from the National Research Council (NRC). The NRC recommended to EPA that the MCL be reduced from 50 µg/L to 10 µg/L. EPA stated that after "promulgating a revised MCL for drinking water, the Agency plans to revise the CWA 304(a) human health criteria for arsenic in order to harmonize the two standards."[49] EPA has yet to harmonize the two.

[40] EPA, Final Updated Ambient Water Quality Criteria for the Protection of Public Health, 80 Fed. Reg. 36986, at 36987. (June 29, 2015)(04807-4810).

[41] EPA, Human Health Ambient Water Quality Criteria: Draft 2014 Update, EPA-820-F-14-003 at 1 (May 2014) (01772-1774).

[42] NTR at 60848-01, 60868. (00768-847)

[43] *Id.*

[44] EPA, Withdrawal from Federal Regulations of Applicability to Alaska of Arsenic Human Health Criteria, 62 Fed. Reg. 27707 (May 21, 1997)(04803-4806).

[45] *Id.* at 27708.

[46] EPA, Arsenic and Fish Consumption, 2-5 (December 3, 1997)(05043-5062)

[47] *Id.* at 1.

[48] EPA, Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, 65 Fed. Reg. 31682 (May 18, 2000) (00861-898).

[49] *Id.* at 31696.

Nationally, about half of the states have obtained EPA approval for arsenic human health criteria based on the SDWA MCL.[50] The same approach by Ecology is accordingly well within the requirements of the Clean Water Act for developing human health criteria.

Comment No. 4: Ecology has appropriately proposed to defer action on mercury criteria.

Ecology has appropriately proposed to defer action on a methylmercury criterion (MeHg) for the state of Washington. EPA has acknowledged unresolved technical issues and delayed action on updating mercury criteria in its 2015 recommended human health water quality criteria.[51]

Washington already has in place criteria for mercury based on human health protection that are more stringent than the NTR criteria. [52] The NTR criteria are 0.14 µg/L (organisms and water) and 0.15 µg/L (organisms only), 40 C.F.R. § 131.36(b), compared to the Washington chronic freshwater criterion of 0.012 µg/L, WAC 173-201A-240, Table 240(3).

Ecology has previously identified to EPA the numerous technical difficulties it will have in implementing EPA's tissue based criterion.[53] These include unresolved technical issues regarding:

- Mixing zones
- Variances
- Field sampling recommendations
- Assessing non-attainment of fish tissue criteria
- Developing TMDLs for water bodies impaired by mercury
- Incorporating methylmercury limits into NPDES permits.[54]

Ecology has explained to EPA that the EPA guidance on implementing the NTR criteria does not address these outstanding issues.[55] EPA has not responded to these concerns or explained how the state and regulated community in Washington can feasibly implement the tissue based criteria.

Ecology has appropriately not adopted the EPA fish tissue concentration criterion of 0.033 mg/kg (wet weight) proposed in September 2015. This value is derived from the outdated basis for the EPA 2001 recommended criteria for methylmercury.[56] Additionally, even if the 2001 national criterion was still valid, EPA's proposed MeHg fish tissue criterion of 0.033 mg/kg (wet weight) is not. It is overly conservative and unattainable in Washington (and the rest

[50]. Ecology, Overview at 44 (00050).

[51]. EPA, Final Updated Ambient Water Quality Criteria for the Protection of Public Health and. EPA, Human Health Ambient Water Quality Criteria: Draft 2014 Update. (01772-1774)

[52]. Ecology, Overview at 49 (00055).

[53] Ecology, Overview at 50 (00056)

[54] Ecology, Overview. (00001-00073)

[55] *Id.*

[56] Ecology, Overview at 50 (00056).

of the United States) as the levels of mercury in fish are consistently higher than the proposed criterion.

EPA derived its proposed criterion following the methodology used to develop the national criterion but changed two key variables in the exposure assumptions: (1) the body weight from 70 kg to 80 kg; and (2) the fish consumption rate of 17.5 g/day to 175 g/day. Ecology offers no information or evidence that the nationally-recommended MeHg fish tissue criterion of 0.3 mg/kg would ***not be*** protective of residents in Washington, even tribal groups with relatively high fish consumption rates, assuming the issues previously discussed can be and are resolved. This is not surprising as there is no support in the technical literature that human health would be adversely affected if residents consumed fish having an average MeHg concentration of 0.3 mg/kg. There likewise can be no scientific evidence supporting the assumption that consuming fish—even at moderate to high ingestion rates—with tissue concentrations exceeding 0.033 mg/kg causes, or is likely to cause, adverse health effects.

There also is controversy surrounding the reference dose for MeHg (0.1 µg/kg/day) used in deriving the national and Washington criterion. The National Academy of Science selected this value based on a Faroes Island study. [57] Island residents consumed both fish and pilot whales, and subtle effects were observed in some children. In addition to mercury, the pilot whales contained elevated levels of PCBs and other chlorinated, recalcitrant pollutants. These confounders were not appropriately considered in establishing the mercury reference dose. The most comprehensive study on potential health effects of mercury in children is the Seychelles Island study.[58] In that study, women of childbearing age consumed fish having mercury levels higher than most fish species in the United States and there was no evidence of developmental or neurological adverse effects in the children studied from birth to age five.

Significantly, the Ecology proposed MeHg fish tissue criterion is well below observed concentrations of mercury in several fish species collected in Washington waters as documented in various studies.[59] For example, the median concentration of mercury in 97 fish samples collected and analyzed in 2004 and 2005 was 0.154 mg/kg (wet weight), five times the proposed MeHg criterion. A study conducted by USGS in Franklin D. Roosevelt Lake and the upper Columbia River basin reported the mean and minimum mercury concentrations in walleye, smallmouth bass, and rainbow trout, all of which were four to five times higher than EPA's proposed criterion for Washington.[60] The walleye mean and minimum fillet concentration was

[57] National Academy of Science, Toxicological effects of methylmercury. Committee on the Toxicological Effects of Methylmercury, Board on Environmental Studies and Toxicology, National Research Council. National Academy Press, (2000)(07570-7934).

[58] Davidson, et al., Effects of Prenatal and Postnatal Methylmercury Exposure from Fish Consumption on Neurodevelopment: Outcomes at 66 months of Age in the Seychelles Child Development Study. 280 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION 701–707 (1998)(07349-7355).

[59] Ecology, Washington State Toxics Monitoring Program: Contaminants in Fish Tissue from Freshwater Environments in 2004 and 2005 (2007)(Publication No. 07-03-024)(available at www.ecy.wa.gov/biblio/0703024.html)(07356-7390).

[60] United States Geological Survey, Concentrations of Mercury and Other Trace Elements in Walleye, Smallmouth Bass, and Rainbow Trout in Franklin D. Roosevelt Lake and the Upper Columbia River, Washington, USGS Open-File Report 95-1951995 (1994)(available at http://pubs.er.usgs.gov/publication/ofr95195)(07391-7429); *See also* Munn and Short, Spatial Heterogeneity of Mercury Bioaccumulation by Walleye in Lake Roosevelt and the Upper

0.33 mg/kg and 0.11 mg/kg, respectively; the smallmouth bass mean and minimum fillet concentration was 0.28 mg/kg and 0.17 mg/kg, respectively; and the rainbow trout mean and minimum fillet concentration was 0.20 mg/kg and 0.16 mg/kg, respectively. From a national perspective, for predator (game fish) species for all states combined, the median mercury concentration was 0.285 mg/kg. The 5th percentile concentration was 0.059 mg/kg.[61] Based on these data, adoption of the proposed criterion would lead to widespread and pervasive water quality impairment in Washington streams, rivers, and lakes. The economic impact would be staggering, while the human health benefit would likely be none.

Indeed, the EPA proposal could result in adverse health impacts if people reduce their consumption of fish because of this criterion. The health benefits of eating fish are well-documented relative to the potential risks of contaminants in the fish.

> For major health outcomes among adults, based on both the strength of the evidence and the potential magnitudes of effect, the benefits of fish intake exceed the potential risks. For women of childbearing age, the benefits of modest fish intake, excepting a few selected species, also outweigh risks. [62]

In future actions on MeHg, Ecology should consider the protective effect selenium has on potential mercury health effects as many toxicologists have advocated that traditional risk assessments of mercury in fish without concomitant information on tissue selenium levels is scientifically flawed and misleading.[63] Recent reports have explained the mechanisms of this protective effect.[64] When the molar ratio of selenium to mercury in fish tissue exceeds 1.0 in freshwater and marine fish, a protective effect can be assumed.[65]

Comment No. 5: The proposed Relative Source Contribution factor is consistent with the Clean Water Act and EPA guidance for deriving human health criteria.

The Relative Source Contribution (RSC) is a factor in the derivation of criteria representing the portion of exposure to a contaminant that is attributable to sources regulated by the CWA.[66] Ecology has appropriately proposed to use a RSC factor of 1.0 in deriving the proposed criteria where it is simultaneously using a fish consumption rate that includes all fish whether or not that fish is purchased from a store or a marine fish that does not accumulate pollutants in waters regulated by the state's water quality standards. By using a fish

Columbia River, Washington. 126 *TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY* 477–487 (1997)(07935-7946).

[61] EPA, The National Study of Chemical Residues in Lake Fish Tissue at 2 (2009)(EPA-823-R-09-006)(07430-7433).

[62] Mozaffarian and Rimm, Fish Intake, Contaminants, and Human Health: Evaluating the Risks and the Benefits, 296 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION 1885 at 1885 (2006)(07434-7449).

[63] Zhang, Chan and Larssen, New Insights into Traditional Health Risk Assessments of Mercury Exposure: Implications for Selenium, 48 ENVIRONMENTAL SCIENCE & TECHNOLOGY 1206 at 1208 (2014)(07947-7953).

[64] Ralston and Raymond, Dietary Selenium's Protective Effects Against Methylmercury Toxicity, 278 TOXICOLOGY 112 (2010)(07954-7959).

[65] Peterson, et al., How Might Selenium Moderate the Toxic Effects of Mercury in Stream Fish of the Western U.S.?, 43 ENVIRONMENTAL SCIENCE & TECHNOLOGY 3919 (2009)(07450-7467).

[66] Ecology, Overview at 21 (00027).

consumption rate that reflects the 90th to 95th percentile of tribal consumption rates that includes all fish, there is no other source of water intake or fish consumption that should be accounted for in a RSC of less than 1.0.

EPA 2014 guidance clearly states that human health considerations in deriving water quality criteria are based only on the risk from exposure to fish and drinking water:

> A complete human exposure evaluation for toxic pollutants of concern for bioaccumulation would encompass not only estimates of exposures due to fish consumption but also exposure from background concentrations and other exposure routes[.] The more important of these include recreational and occupational contact, dietary intake from other than fish, intake from air inhalation, and drinking water consumption. For section 304(a) criteria development, EPA typically considers only exposures to a pollutant that occur through the ingestion of water and contaminated fish and shellfish. This is the exposure default assumption, although the human health guidelines provide for considering other sources where data are available. **Thus the criteria are based on an assessment of risks related to the surface water exposure route only**.[67]

This guidance is the same as EPA set forth in the 2000 Human Health Methodology: "[Ambient Water Quality Criteria] for the protection of human health are designed to minimize the risk of adverse effects occurring to humans from chronic (lifetime) exposure to substances through the ingestion of drinking water and consumption of fish obtained from surface waters."[68]

EPA Region 10 has endorsed the use of an RSC of 1.0 where a state is including all salmon in its criteria development methodology. The state of Oregon applied a RSC of 1.0 in the human health criteria approved by EPA in 2012. The rationale for this risk management decision included a discussion that it is a preferred means to account for salmon consumption compared to a lower or fractional RSC.[69] EPA Region 10 has urged Northwest states to consider EPA action on water quality standards for other states.[70] EPA Region 10 has further endorsed the Oregon approach as "the right outcome."[71]

This endorsement is also set forth in a letter dated September 5, 2014, from EPA to the state of Idaho.[72] EPA submitted this letter to Idaho on the question of whether the state should include or partially include salmon in its consumption rate for developing human health criteria. The letter sets forth alternatives to inclusion of salmon by reducing the RSC. EPA states that an

[67] EPA, Water Quality Standards Handbook, Chapter 3, Section 3.1.3 (2014)(available at http://www2.epa.gov/wqs-tech/water-quality-standards-handbook)(emphasis added)(06158-6215).

[68]. EPA, 2000 Human Health Methodology at 1-11 (00103). *See* D. Essig, Email to C. Niemi (September 6, 2012)(06685-6688).

[69] Oregon DEQ, Oregon Human Health Criteria Issue Paper Toxics Rulemaking at 9 (00484). Oregon used RSC values recommended by EPA for 15 of 17 chemicals and a RSC value of 1.0 for all other non-carcinogens.

[70] L. Macchio, Letter to D. Essig (January 20, 2015)(01086-1088).

[71] C. Niemi, Handwritten Notes (March 20, 2013)("Dennis [EPA Region 10 Administrator] thinks the OR outcome was the right outcome, regionally wants to explore that position.")(00455-0458).

[72] L. Macchio, Letter to D. Essig (September 5, 2014)(04242-4244).

"acceptable approach to reducing the RSC is to fully include salmon consumption in the consumption rate."[73] EPA also approved the Spokane Tribe of Indians human health criteria using a RSC of 1.0 where the tribe used a historical rate of consumption.[74]

Ecology has appropriately described the significant differences between risk assessment in other programs such as the Safe Drinking Water Act (SDWA) and Superfund Cleanup Program from the Clean Water Act.[75] The SDWA uses a RSC of 0.2 and 0.8 of exposure but does so in terms of goals, not water quality criteria.[76] The SDWA is using this range of RSC for establishing Maximum Contaminant Level Goals that are not by definition regulatory limits.[77] This is in contrast to criteria in approved water quality standards that must be enforced through TMDLs and end of the pipe limits in NPDES permits.

In this instance Ecology is proposing a RSC that is entirely consistent with EPA guidance and there is no basis for using a RSC value of less than 1.0.

Comment No. 6: The proposed use of Bioconcentration Factors (BCFs) is consistent with the Clean Water Act and EPA guidance for deriving human health criteria.

As Ecology correctly points out, bioconcentration factors (BCFs) are based in science and have been acceptable for purposes of Clean Water Act criteria development at least since 1980. Historically, EPA relies on BCFs in developing recommended HHWQC and continues to recommend BCFs for many priority pollutants, including PCBs and 2378-TCDD, as evidenced by its most recent (2015) national recommended criteria.

Bioaccumulation represents a more comprehensive model of the degree to which fish and shellfish consumed by humans may become contaminated in the environments in which they live, due to the inclusion of important ecological processes such as contaminant uptake through the food web, sediment/water interactions, metabolic elimination, and others. As part of the process of updating the national human health water quality criteria in 2014 and 2015, EPA developed new factors for representing bioaccumulation (a BAF or BCF) for each substance from either measured or predicted BAFs or BCFs from laboratory or field studies. EPA has provided these new default factors for states to consider using when deriving their own state-specific HHWQC. However, it is widely recognized that BAFs are influenced by several local environmental factors (e.g., food web structure, water temperature, dissolved carbon) that can have a large influence on the resulting value. In other words, a default BAF developed based on field studies for specific species and in waters with specific chemistries, for example, is unlikely to represent bioaccumulation in any water body whose species makeup and chemistry differ from those used to develop the default value.

[73] *Id.* at 2.

[74] EPA, Letter approving Spokane Tribe of Indians Water Quality Standards, *Technical Support Document* dated December 11, 2013 at 22 (December 9, 2013) (the criteria are based on a FCR of 865 g/day) (01020-1071).

[75] Ecology, Overview at 22. (00028)

[76] *Id.*

[77] *Id.; See also* Ecology, Draft Comments from Washington and Idaho on EPA 2013 FAQ (April 17, 2013)(04245-4256).

It is also noteworthy that EPA has not provided an opportunity for the scientific community to adequately evaluate and comment on these new bioaccumulation factors. Given the impact that these factors have on criteria values, and the potential implications for states and dischargers that may result, EPA should allow for substantive comment on the technical merits of EPA's choice of national default values and on the appropriateness of using those values in deriving HHWQC for specific states and water bodies. This is critically important given that many of the chemical-specific bioaccumulation factors in the 2015 EPA HHWQC revisions differ by orders of magnitude relative to prior EPA guidance values. For example, the BAF/BCF for butylbenzyl phthalate was revised from 414 to 19000 L/kg and for several PAH compounds such as benzo-a-pyrene the value increased from 30 to 3900 L/kg. Such dramatic changes illustrate the need for considerably more vetting in the scientific community before they are adopted as "national BAFs." Accordingly, Ecology was correct to continue using BCFs in deriving its HHWQC. The agency identified some of these issues in its documents supporting this rulemaking, as well as in its comments on EPA's proposed HHWQC for the state.

Comment No. 7: The proposed use of a fish consumption rate of 175 grams a day for the rule is arbitrary, capricious and not based on substantial evidence in the record.

The 175 g/day fish consumption rate used to derive the proposed human health criteria is not supported by technical information and is not necessary to protect the residents of Washington. It is also inconsistent with past EPA guidance and is in conflict with the Washington risk policy to protect the average consumption rate of the general population, including consumers and non-consumers, to a risk level of 10^{-6}.

Ecology should use a fish consumption rate that is less than 19 g/day. Ecology documented 18.8 g/day as the average consumption rate for consumers only for the general population in Washington.[78] Ecology has not provided a consumption rate that reflects both consumers and non-consumers but it must be substantially lower than 18.8 g/day given that Ecology estimated that between 25% and 70% of the general population in the state of Washington does not eat fish.[79]

The fish consumption rate used in the proposed rule exceeds the fish consumption rate used by any state to derive human health criteria, with the exception of the Oregon human health criteria adopted in 2012.[80] EPA guidance recommends for exposure to carcinogens that states use a fish consumption rate that protects the 90th percentile consumption of the general population while ensuring that subsistence fishers are protected at their average intake rate. EPA guidance recommends a default fish intake rate of 17.5 g/day to protect the general population.[81] The same guidance recommends that state criteria use an average intake rate of 142.4 g/day for

[78] Ecology, Fish Consumption Rate Technical Support Document Version 2.0, 40-44 at 95 (05514) (January 2013)(Ecology Publication No. 12-09-058)(05398-5591).

[79] *Id.*

[80] Ecology, Fish Consumption Rates & Risk Levels for Carcinogens Used in Human Health Criteria Calculations, (November 5, 2013)(00259-00267).

[81] Ecology, Overview at 15 (00021).

subsistence fishers. "EPA believes that the assumption of 142.4 grams/day is within the average consumption estimates for subsistence fishers based on studies reviewed."[82]

The rationale for this guidance is to ensure that human health criteria are protective within a broad range of consumption rates in a state from the general population at the 90th to the 99th percentile rates of consumption. EPA guidance describes the use of the general population consumption of 17.5 g/day at the 90th percentile as a baseline to ensure protection of the 99th percentile of the general population and average consumption rate for more exposed populations including subsistence fishers.[83] EPA confirmed this policy in a conference call with state regulators on April 17, 2013. EPA was asked during that conference call how EPA defines high exposure or high risk population for determining fish consumption rates. Beth Doyle, on behalf of EPA, responded that "EPA used the 99th percentile of the general population, as representing what they figured approximated the <u>median</u> consumption rate for subsistence fishers."[84] The fish consumption rate of 175 g/day used by Ecology is ten times the 90th percentile consumption rate established by EPA guidance for the general population. In response to these comments Ecology should acknowledge that 175 g/day is based on the 50th to 90th percentiles of tribal consumption rates. Oregon developed the 175 g/day fish consumption rate for its criteria using the same consumption studies relied on by Ecology in the 2015 Federal Register Notice and concluded that the value reflects the 95th percentile consumption rate in the Columbia River Inter-Tribal Fish Commission study and the 90th percentile consumption rates documented for Puget Sound Tribes.

> Consequently, the recommended rate [175 g/day] reflects consumption of salmon, and lamprey relative to rates documented in the CRITFC study (to protect at least 95% of fish consumers in Oregon), as well as marine fish and shellfish relative to the rates documented in the Puget Sound studies (to protect at least 90% of fish consumers in Oregon).[85]

The following table from the TSD summarizes the consumption rates from Tribal studies. The 175 g/day fish consumption rate exceeds the median (50th percentile) for all Tribes and the 90th percentile for all Tribes with the exception of the Tulalips, 206 g/day, and the Suquamish, 489 g/day. The Suquamish consumption rate shown in this table is heavily influenced by high consumption rates reported by a few individuals. Other studies, such as the Tulalip study, excluded similar high rates from the analysis as "outliers."[86] Oregon DEQ recognized that

[82]. EPA, 2000 Human Health Methodology at 4-27 (00186).

[83] EPA, Fish Consumption and Environmental Justice at 28 (November 2002). ("EPA's default value of 142.4 grams/day for subsistence fishers reflects the 99th percentile value of 142.41 grams/day for freshwater and estuarine ingestion by adults.")(00311).

[84] D. Essig, Email to S. Kirsch (April 5, 2013)(00453-454).

[85] Oregon DEQ, Oregon Human Health Criteria Issue Paper Toxics Rulemaking at 9 (May 24, 2011)(00476-0559).

[86] Oregon DEQ, Human Health Focus Group Report Oregon Fish and Shellfish Consumption Rate Project at 10-12 (June 2008)(00560-631).

"[w]ith no adjustments made for the high consumption rates, it was noted that the reported means may be highly influenced by the consumption of just a few individuals."[87]

Table 37. Summary of Fish Consumption Rates, All Finfish and Shellfish

Population	Source of Fish	Number of Adults Surveyed	Mean	Percentiles		
				50th	90th	95th
General population (consumers only)	All sources: EPA method	2,853	56	38	128	168
	All sources: NCI method	6,465	19	13	43	57
Columbia River Tribes	All sources	464	63	41	130	194
	Columbia River	–	56	36	114	171
Tulalip Tribes	All sources	73	82	45	193	268
	Puget Sound	71	60	30	139	237
Squaxin Island Tribe	All sources	117	84	45	206	280
	Puget Sound	–	56	30	139	189
Suquamish Tribe	All sources	92	214	132	489	797
	Puget Sound	91	165	58	397	767

See Polissar et al., 2012, Table E-1.

Ecology commissioned a report from the consultants who conducted the Tulalip, Squaxin and Suquamish studies. A report dated October 31, 2013, analyzed the data for a hypothetical combination of the Puget Sound Tribes.[88] This analysis calculated the median Tribal consumption rate to be 60.9 g/day for all fish.[89]

ARCADIS also developed a composite distribution of Washington Tribal consumption rates based on the TSD data.[90] The ARCADIS distribution set the median, 90th and 95th percentiles for Tribal consumption rates to be 55.05, 137.77 and 178.69 g/day.[91]

The Clean Water Act and EPA regulations require human health water quality criteria to protect exposures that may result from pollutants in state waters. EPA guidance accordingly does not require human health criteria to regulate pollutant levels in marine fish that do not accumulate pollutants in waters of the United States within the jurisdiction of a state. The default value of 17.5 g/day in EPA guidance thus reflects freshwater/estuarine fish and shellfish

[87] *Id.* at 12 (00577). Ecology, Fish Consumption Rate Technical Support Document Version 2.0 at 05514 (January 2013)(Ecology Publication No. 12-09-058)(05398-5591).

[88] Polissar and Hippe, Fish Consumption Rates for a Hypothetical Combination of Puget Sound Tribes (October 31, 2013)(00632-657).

[89] *Id.*, Table A at 2.

[90] ARCADIS, Derivation of Alternative Human Health Risk-Based Ambient Water Quality Criteria Using Probabilistic Methods for the State of Washington, Attachment A at 7 (February 4, 2014)(00658-0723).

[91] *Id.*

only.[92] The range of consumption rates in the 2000 EPA guidance similarly do not include marine fish.[93]

Salmon, as a marine species, should accordingly be excluded from the consumption rate used to derive Washington's criteria. The data on fish tissue samples from salmon in Puget Sound indicates that fish accumulate the predominant fraction of PCBs detected while in the ocean-phase of their life cycle.[94] Including all salmon in the fish consumption rate is not likely to benefit public health for contaminants accumulated in marine waters beyond the jurisdiction of the state.[95] Even for the small percentage of salmon that are resident for longer periods of time more stringent water quality standards are not likely to result in significant reductions in the body burden of contaminants.[96]

Excluding salmon from the fish consumption rate lowers the median consumption rate documented for Puget Sound Tribes to 32.2 g/day or less—less than half of the FCR used for the proposed criteria.[97] The ARCADIS analysis independently calculated the "non-salmon" median consumption rate for Washington Tribes at 29.73 g/day.[98] Even if Ecology apportioned consumption rates for those salmon that are found to accumulate pollutants and are resident in Puget Sound for a longer period in their life cycle, Ecology consultants estimated the median tribal consumption rate for all seafood and the portion of anadromous fish to be 49.0 g/day.[99] The ARCADIS analysis calculated a Washington tribal consumption rate with apportioned salmon at a median rate of consumption to be 37.78 g/day and of 122.63 g/day at the 95th percentile.[100]

Ecology should reject demands by EPA to base a FCR on "un-suppressed" fish consumption rates for northwest tribal members as claimed by EPA in its 2015 draft rule. 80 Federal Register at 55068. EPA did not cite to a single study, document or statistic of any kind to support its contention that there are suppressed consumption rates other than what it described

[92]. EPA, 2000 Human Health Methodology at 4-24 (EPA default fish consumption rates represent the ingestion of "freshwater and estuarine fish")(00184).

[93] *Id.* at 4-25; *see also* Ecology, Decision Factors in Development of Human Health Criteria (November 6, 2013)("Current federal guidelines do not use salmon in the fish consumption rate because most do not reside for their full life in water regulated by the Clean Water Act")(00726-727).

[94] National Council for Air and Stream Improvement (NCASI), Comments on Publication No. 11-09-050, Fish Consumption Rates Technical Support Document, Appendix A, page 11 (January 11, 2012) (00728-0740), *see also* NCASI, Comments on Proposed Human Health Criteria and Implementation Tools Rule Proposal, Attachment A at 2 (March 4, 2015) (00741-0767).

[95] *Id.*

[96] Hope, Acquisition of Polychlorinated Biphenyls (PCBs) by Pacific Chinook Salmon: An Exploration of Various Exposure Scenarios, 8 INTEGRATED ENVIRONMENTAL ASSESSMENT AND MANAGEMENT 553, 561 (January 2012)(05073-5082).

[97] Polissar and Hippe, Fish Consumption Rates for a Hypothetical Combination of Puget Sound Tribes at 2 (00633).

[98] ARCADIS, Derivation of Alternative Human Health Risk-Based Ambient Water Quality Criteria Using Probabilistic Methods for the State of Washington, Attachment A at 7 (00698).

[99] Polissar and Hippe, Fish Consumption Rates for a Hypothetical Combination of Puget Sound Tribes at 2 (00633).

[100] ARCADIS, Derivation of Alternative Human Health Risk-Based Ambient Water Quality Criteria Using Probabilistic Methods for the State of Washington, Attachment A at 7 (00698).

as “consultation with Washington tribes and Columbia River basin tribes.” *Id.* Reliance on meetings that are closed to the public and on proposals for which there is no documentation or scientific analysis is a facial violation of CWA and state APA requirements to provide a scientific basis for proposed standards and an opportunity for public participation.

The only regulatory authority cited by EPA in the Federal Register notice is a cross-reference to section II.B.c in the same notice that includes a representation that EPA “generally” recommends “selecting a FCR that reflects consumption that is not suppressed by fish availability or concerns about the safety of available fish.” 80 Fed. Reg. at 55065. The sole authority for this proposal is a “Frequently Asked Questions” document that EPA posted online in January 2013. *See* 80 Fed. Reg. 55065, n. 15. EPA has conceded that this posting was done improperly and previously assured state regulators that the document would be withdrawn.[101] EPA has also conceded that it is not sure how suppression should be factored into criteria.[102]

It is difficult to understand how EPA “generally” recommends consideration for suppressed consumption rates when there is no guidance on how EPA and the states are supposed to factor this into developing water quality criteria.[103] EPA has long advised states to use data to develop criteria (with a preference for local or regional data over national data).[104] EPA is now asserting that it is permissible for it to consider unknown impacts on consumption rates for which there are no data.

The Federal Register notice does not reference any evidence to support a contention that fish consumption in Washington is suppressed due to “concerns about the safety of available fish.” There is likewise a lack of any information in the proposed rule docket posted by EPA to support such a contention. An actual survey of potential consumers concerns in Idaho found only 3% of the population indicated that they limited fish consumption due to health concerns about pollution or contamination.[105]

It is also inappropriate to employ an alleged lack of availability of fish as a factor in setting human health criteria. Human health criteria do not impact fish availability. Imposing unattainable human health criteria on the state of Washington will in no way enhance fish runs or increase the availability of fish.

Even if it was appropriate to factor availability of fish in consideration of consumption rates, there is no evidence of a lack of availability of fish that would drive suppression. There is no documentation, for example, that tribal members lack access to fish. On the contrary, the tribal consumption studies document that at most two individual tribal members eat as much as

[101] S. Braley, Email to M. McCoy, C. Niemi and D. Essig (January 9, 2014); S. Braley, Email to D. Essig and C. Niemi (July 28, 2014)(06692-6693).

[102] D. Essig, Email to B. Burnell (September 30, 2014)(06691).

[103] D. Opalski, Letter to C. Niemi EPA Comment on Ecology Draft Rule (March 23, 2015)(07230-7249).

[104] EPA, 2000 Human Health Methodology at 2-2 (00108).

[105] Idaho Department of Environmental Quality, Considerations in Deciding Which Fish to Include in Idaho’s Fish Consumption Rate: Policy Summary at 7. (August 2015)(04792-4802).

1600 g/day of fish.[106] This is nearly twice the historic rate of consumption used in deriving the Spokane Tribe of Indians human health criteria.[107]

It appears, moreover, that tribal consumption fish rates have been growing and are not suppressed. In 1992, the Columbia River basin tribes claimed a fish consumption rate of 150 g/day.[108] By 2012, the Columbia River Inter-Tribal Fish Commission was claiming that the 95th percentile of tribal members were consuming 175 g/day.[109] In 2015 the Northwest Indian Fisheries Commission claimed that there are contemporary consumption rates of between 500 and 918 g/day.[110]

EPA itself has increased the fish consumption rate from 6.5 g/day in the NTR to 22 g/day in criteria included in the 2015 update to the Section 304 human health criteria. This trend is consistent with national data showing an increase in consumption of fish over time. The U.S. Department of Agriculture has reported that the per capita consumption of fish grew from 12.4 pounds to nearly 16 pounds from 1980 to 2009.[111] This indicates that consumption rates used in setting criteria are adjusting with increasing consumption rates. This is illustrated in the following figure from the Idaho negotiated rulemaking process:[112]

[106] EPA, Comment on Ecology Draft Rule; *see also* Polissar and Hippe, Fish Consumption Rates for a Hypothetical Combination of Puget Sound Tribes (October 31, 2013)(00632-657).

[107] EPA, Letter approving Spokane Tribe of Indians Water Quality Standards, *Technical Support Document* dated December 11, 2013 at 22 (December 9, 2013) (the criteria are based on a FCR of 865 g/day) (01020-1071).

[108] *Dioxin/Organochlorine Ctr. v. Clarke*, 57 F.3d 1517, 1524 (9th Cir. 1995)("In addition, the EPA argues that even assuming consumption of 150 grams of fully contaminated fish, as claimed by DOC, the risk level would still be only 23 in a million.").

[109] EPA, Technical Support Document for Action on the State of Oregon's New and Revised Human Health Water Quality Criteria and Associated Implementation Tools Submitted July 12 and 21, 2011 at 27 (October 17, 2011)(01908-2010).

[110] NWIFC, Comments on the State's Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards (March 23, 2015).

[111] U.S. Census Bureau, Statistical Abstract of the United States: 2012, Sec. 3, Table 217 (August 2011)(06986).

[112] Idaho Department of Environmental Quality, Considerations in Deciding Which Fish to Include in Idaho's Fish Consumption Rate: Policy Summary at 7. (August 2015)(04792-4802).

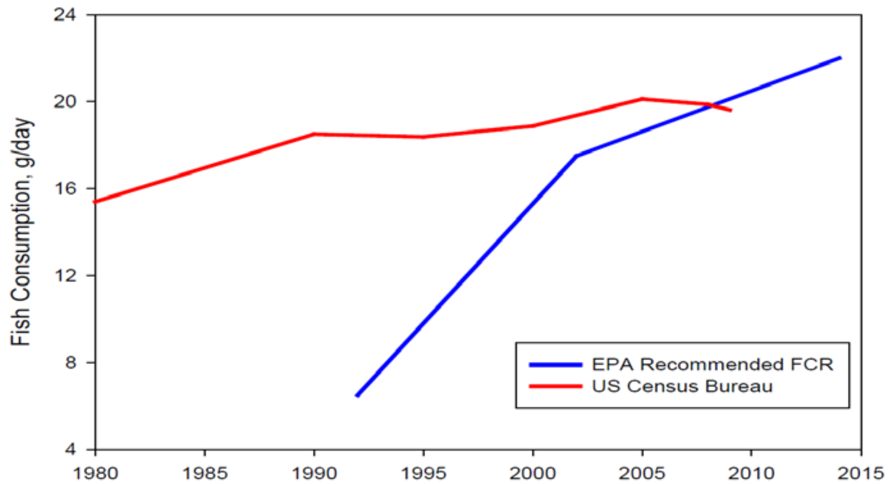


Figure 4. Per capita consumption of fish in the United States and EPA-recommended fish consumption rate (FCR), 1980–2014.

It is not appropriate to speculate on future consumption rates or restoration of consumption rates based on historic information. If fish consumption rates increase over time that information should inform future reviews by Ecology of the human health water quality criteria.

Comment No. 8: The proposed incremental excess cancer risk level factor used in the rule is arbitrary, capricious and not based on substantial evidence in the record.

Ecology has provided no justification for using a one in one million risk level coupled with a high fish consumption rate other than a policy decision by the Governor. It is a decision that succumbs to the pressure from EPA that lacks support under long-standing principles of the CWA, science and public health policy.

The current risk policy in Washington, WAC 173-201A-240(5), is intended to apply the one in one million (or 1 x 10^{-6}) risk level to the per capita consumption rate of the general population and not to more highly exposed subpopulations. EPA established this as a matter of law in *Dioxin/Organochlorine Center v. Clarke*, 57 F.3d 1517, 1524 (9th Cir. 1995).[113]

Ecology has interpreted and publicly stated that its risk policy for human health criteria in the state Water Quality Standards, WAC 173-201A-240(6), is intended to apply to the per capita consumption rate of the general population.[114] Washington adopted this risk level for application of the National Toxics Rule (NTR) in Washington. Through the NTR process, EPA offered states the option of human health criteria calculated based on either a 10^{-6} or 10^{-5} risk level for the general population. Washington opted to use a 10^{-6} risk level.[115] In the context of the NTR,

[113] EPA, Brief for the Defendant-Appellees, *Dioxin/Organochlorine Center v. Clarke,* Nos. 93-35973 & 93-36000 (May 31, 1994) (00899-0967).

[114] Ecology, Washington State Water Quality Standards: Human Health Criteria and Implementation Tools, Overview of Key Decisions in Rule Amendment, (January 2015)(Publication No. 14-10-058)(00001-0073).

[115] NTR, 57 Fed. Reg. 60848-01, 60868 (00768-847); 40 C.F.R. §131.36(b)(14)(iii)(00848-0860).

however, this risk level is applicable to the per capita consumption rate of the general population on the assumption that NTR criteria are protective of higher consuming subpopulations at a 10^{-4} risk level and is consistent with long-standing EPA policy.

EPA and Washington have never assumed that the 10^{-6} risk policy set forth in WAC 173-201A-240(6) would apply to all consumers of fish, including some sub-populations of high fish consumers. Otherwise, Washington would not have adopted, nor would EPA have approved, coverage under the NTR where the criteria are based on a range of acceptable risk levels from 10^{-6} to 10^{-4}.[116] EPA described this in its brief in the *Dioxin* case as a choice "to provide a high level of protection for the average population in order to provide what they [Washington and other states] deem adequate protection for more sensitive populations."[117]

The scope and intent of the 10^{-6} risk policy in WAC 173-201A-240(6) was a central issue in a challenge to a dioxin water quality improvement plan or Total Maximum Daily Load (TMDL) allocation developed by EPA for the Columbia River. The dioxin TMDL was based on the same assumptions for the dioxin criterion in the NTR, including a FCR of 6.5 g/day. The TMDL was challenged in federal court on the basis of evidence that actual FCRs on the Columbia River for recreational fishers and Tribes was as high as 150 g/day. The challengers contended that EPA should have applied WAC 173-201A-240(6) to derive a water quality criterion for dioxin that would protect all fish consumers to a level of 10^{-6} based on the higher FCR. In *Dioxin/Organochlorine Center v. Clarke*, 57 F.3d 1517, 1524 (9th Cir. 1995), the court concluded that Washington did not intend to mandate a 10^{-6} risk level for every fish consumer. The Ninth Circuit held that "the one-in-a-million risk level mandated by the state water quality standards for the general population does not necessarily reflect state legislative intent to provide the highest level of protection for *all* subpopulations but could reasonably be construed to allow for lower yet adequate protection of specific subpopulations." 57 F.3d at 1524 (emphasis in original).[118]

In *Dioxin/Organochlorine Center*, EPA successfully argued that the mere fact that actual fish consumption in Washington is greater than the FCR in the TMDL (the same as the NTR) does not mean that the national criteria violate the state risk policy to protect human health under WAC 173-201A-240(6). EPA argued that the FCR and risk levels in the federal criteria are based on consumption of maximally contaminated fish, and are not intended to reflect actual consumption rates.[119] EPA also argued that the 6.5 g/day fish consumption rate was not intended to accurately represent total consumption of fish, but instead the ingestion rate of a given contaminant.[120] According to EPA, the fish consumption rate used in the NTR was "intended to

[116] WAC 173-201A-240(6). EPA's "policy in the NTR [is] to select the risk level that reflect[s] the policies or preferences of CWA programs in the affected States." 65 Fed. Reg. 31682, 31699 (May 18, 2000)(00861-0898).

[117] EPA, Brief for the Defendant-Appellees, *Dioxin/Organochlorine Center v. Clarke*, Nos. 93-35973 & 93-36000 (May 31, 1994) (00899-0967)

[118] The risk policies in the NTR were also affirmed in *Natural Resources Defense Council v. EPA*, 16 F.3d 1395 (4th Cir. 1993)(rejecting argument that 6.5 grams per day FCR failed to protect subpopulations with higher than average fish consumption). EPA's range of acceptable risk levels was also upheld in other contexts. *E.g., Ohio v. EPA*, 997 F.2d 1520, 1533 (D.C. Cir. 1993)(describing range of 10^{-6} to 10^{-4} as adequately protective of human health).

[119] *Natural Resources Defense Council v. EPA*, 16 F.3d 1395, 1402 n.11 (4th Cir. 1993).

[120] EPA, Brief for the Defendant-Appellees.

represent only a subset of total fish consumption."[121] The FCR is the assumed amount of "maximum residue fish" consumed.[122] EPA further asserted that consuming anadromous fish, like salmon, is unlikely to cause ingestion of contaminants at a rate equal to consuming maximum residue fish.[123] EPA explained: "[T]he total fish consumption rate of various individuals is not determinative; the central question is whether the actual rate of ingestion [of a contaminant] is greater than that assumed by EPA."[124]

To understand Washington's risk policy, one must take into consideration the timing and sequence of the state's adoption of its risk policy and when the state was formally subject to the NTR. [125] The risk policy, WAC 173-201A-240(5), was promulgated as a state regulation in October 1992.[126] The promulgation of the regulation referencing the NTR was included with revisions to the state Water Quality Standards, WAC 173-201A-240(6), five years later in November 1997.[127] In addition to the fact that the NTR does not extend the 10^{-6} risk level to all consumers, there is the intervening ruling in *Dioxin/Organochlorine Center* that the state policy does not reflect any intent to protect high consumers to the 10^{-6} risk level. A basic rule of statutory construction provides that the failure to amend an act following a judicial construction indicates approval of the construction.[128] Thus, if Ecology believed that the risk policy was intended to more broadly apply in Washington it would have amended the regulation prior to incorporating a reference to the NTR in the state Water Quality Standards.

The risk levels used to develop the NTR are consistent with the EPA 2000 Human Health Methodology. That guidance provides for risk based criteria using a risk level of 10^{-6} or 10^{-5} for the 90th percentile consumption rate for the general population as long as the **median** consumption rate for highly exposed populations is protected to a level of 10^{-4}. [129] The 2000 Human Health Methodology is clear that EPA deems both 10^{-6} and 10^{-5} risk levels as acceptable, [130] so long as the selection provides at least a 10^{-4} risk level for the highest consumers of fish. "EPA generally regulates pollutants treated as carcinogens in the range of 10^{-6} to 10^{-4} to

[121] EPA, Brief for the Defendant-Appellees at 44 (00954).

[122] *Id.*

[123] 16 F.3d at 1403; *see also* EPA, Brief for the Defendant-Appellees at 44 (00954).

[124] EPA, Brief for the Defendant-Appellees at 45 (00955); EPA's water quality criteria guidance includes a margin of safety for water consumption. 65 Fed. Reg. 31682, 31693 (May 18, 2000) (00861-0898).

[125] Under controlling Washington law, the sequence of all statutes relating to the same subject matter should be considered. *Dep't of Labor and Industries v. Estate of MacMillan,* 117 Wn.2d 222, 229, 814 P.2d 194 (1991).

[126] WSR 92-24-037 (00968-0971).

[127] WSR 97-23-064. (00972-1019).

[128] *Hangman Ridge Training Stables, Inc. v. Safeco Title Ins. Co.*, 105 Wn.2d 778, 789, 719 P.2d 531 (1986).

[129]. NTR at 60855.

[130] EPA asked states covered by the NTR to tell EPA if they preferred the human health criteria for the state be applied at a risk level of 10^{-5}. NTR at 60864. In general, the NTR established AWQC for states based on a 10^{-6} risk level. *Id*. at 60860. A state could ask EPA to remove the state from the rule, and adopt human health criteria for a carcinogen at a 10^{-5} risk level. *Id*. If a state convinced EPA a 10^{-5} risk level was appropriate, public notice and comment would not be required "because the Agency has considered in this rule that criteria based on either 10^{-5} or 10^{-6} risk levels meet the requirements of the Act." *Id*.

protect average exposed individuals and more highly exposed populations."[131] "EPA also believes that criteria based on a 10^{-5} risk level are acceptable for the general population as long as States and authorized Tribes ensure that the risk to more highly exposed subgroups (sport fishers or subsistence fishers) does not exceed the 10^{-4} level."[132]

EPA guidance addresses the need to consider carefully the impact of criteria on sensitive and subsistence populations. This guidance is reflected in the preference for local data over EPA default values for fish consumption rates.[133] That does not mean, however, that a 10^{-6} risk level becomes a baseline for all population exposures. The EPA guidance directs that more specific information on consumption rates should be used to ensure that the criteria are within the protective range of EPA risk policy guidance:

> EPA understands that fish consumption rates vary considerably, especially among subsistence populations, and it is such great variation among these population groups that may make either 10^{-6} or 10^{-5} protective of those groups at a 10^{-4} risk level. Therefore, depending on the consumption patterns in a given State or Tribal jurisdiction, a 10^{-6} or 10^{-5} risk level could be appropriate. In cases where fish consumption among highly exposed population groups is of a magnitude that a 10^{-4} risk level would be exceeded, a more protective risk level should be chosen.[134]

EPA has erroneously suggested that the 2000 Human Health Methodology "did not consider how CWA decisions should account for applicable reserved fishing rights." This is simply a false statement. The Columbia River Inter-Tribal Fish Commission submitted a written comment on the draft 2000 guidance that raised treaty and trust obligations under the CWA.[135] As seen in the above quoted passage from the guidance, consumption patterns among subsistence populations and within a given tribal jurisdiction were considered in the document.

Moreover, EPA has updated and amended this guidance numerous times since its publication in 2002 as documented on the EPA web site.[136] EPA actively considered tribal fishing rights in parallel CWA proceedings in 2001 and 2002 that were nearly contemporaneous to the 2000 guidance and predate each of its updates.[137]

[131]. NTR at 60855; *see also* 65 FR 31682, 31699 (May 18, 2000) (00861-0898).

[132] EPA, Methodology for Deriving Ambient Water Quality Criteria for Protection of Human Health, EPA-822-B-00-004 at 1-12 (October 2000)(00074-0258); *see also* NTR at 60848, 60863 (describing 10^{-5} level as "adequately protective").

[133] *Id.* at 1-12, 4-25.

[134] *Id.* at 2-6.

[135] EPA, Fish Consumption and Environmental Justice, at 58 (November 2002)(referencing Columbia River Inter-Tribal Fish Commission, Comments to Administrator Browner on the Draft Revisions to the Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (1999))(00268-0452).

[136] http://water.epa.gov/scitech/swguidance/standards/criteria/health/methodology/index.cfm.

[137] EPA, Meeting Summary of the Executive Council of the National Environmental Justice Advisory Council December 3, 4, and 6, 2001 (06107-6157); *see also* EPA, Fish Consumption and Environmental Justice (00268-0452).

Ecology cannot rely on the statement by EPA that it "often uses 10^{-6} as a *de minimis* risk level" to justify a more stringent risk policy. EPA, across its environmental programs, the FDA and other federal agencies have consistently deemed 10^{-4} as a *de minimis* risk level when applied to a highly exposed subpopulation. EPA and FDA programs have in fact long considered any exposure within a range of 10^{-6} to 10^{-4} to be a *de minimis* risk and a level of risk that is acceptable and insignificant for setting human health standards including water quality standards.

This long standing policy is reflected in the scientific literature cited by EPA in its independent human health criteria rulemaking. EPA cites one scientific study in the Federal Register, 80 Fed. Reg. at 55068, n. 26:"Castorina, Rosemary and Tracey J. Woodruff (sic), *Assessment of Potential Risk Levels Associated with the U.S. EPA Reference Values*, ENVIRONMENTAL HEALTH PERSPECTIVES, Vol. 111, No. 10, page 1318." This article, which is about air quality and not water quality standards, does not support the implication in the Federal Register that EPA considers a 10^{-6} risk level to be a bright line standard for *de minimis* risk. The authors in fact state, "As a point of comparison, The U.S. EPA has defined 1 in 1,000,000 excess cancer risk as a *de minimis* risk level for cancer (Caldwell et al. 1998; Clean Air Act Amendments 1990; Fiori and Meyeroff, 2002; U.S. EPA 1991), **although regulatory actions are sometimes limited to instances where risk exceeds 1 in 100,000**." (Emphasis added.)

"Fiori and Meyeroff, 2002[138]," one of the references cited in support of the quoted statement in the Castorina article is a proposal for a risk management approach for exposure to mutagens that applies a *de minimis* risk standard. The article provides a short but instructive summary of "regulatory precedents for negligible carcinogenic risk":

> Acceptable risk is a concept that is required because of the adoption of the no threshold theory of carcinogenicity. Setting the acceptable risk level is a risk management decision….When EPA sets an acceptable risk for the general population (as for drinking water standards), the upper bound risk level of one excess cancer per 1 million people (i.e., 10^{-6}) is used. (EPA, 1991).[139]

The "EPA 1991" references in both articles are the same, the draft NTR.[140] EPA states in the draft NTR that its risk based criteria are consistent with EPA guidelines that assume carcinogenicity is a "non-threshold phenomenon" and that there is no "safe" or "no-effect levels" of exposure.[141] Consistent with this guidance, EPA elected to use a "relatively stringent" cancer risk level of 10^{-6} as applied to the general population and deemed protective of "subsistence fishermen" who are more exposed than the general population.[142] It was the position of EPA then, based on the law and best available science, that the use of a 10^{-6} risk level "is in part

[138] Fiori and Meyeroff, Extending the Threshold of Regulation Concept: *De Minimis* Limits for Carcinogens and Mutagens, 35, REGULATORY TOXICOLOGY AND PHARMACOLOGY, 209-16 (April 2002)(06355-6362).

[139] *Id.* at 210.

[140] EPA, Amendments to the Water Quality Standards Regulation to Establish the Numeric Criteria for Priority Toxic Pollutants Necessary to Bring All States into Compliance with Section 303(c)(2)(B), 56 Fed. Reg. 58420 (November 19, 1991) (06471-6529).

[141] *Id.* at 58434.

[142] *Id.* at 58435.

addressing the potential that highly exposed subpopulations exist by selecting a relatively stringent cancer risk level (10^{-6}) for use in deriving State-wide criteria for carcinogens."[143]

The EPA guidance also illustrates why protecting the highest subpopulation exposure at 10^{-6} would be over-protective of designated uses:

> It is important to understand that criteria for carcinogens are based on chosen risk levels that inherently reflect, in part, the exposure parameters used to derive those values. Therefore, changing the exposure parameters also changes the risk. Specifically, the incremental cancer risk levels are *relative*, meaning that any given criterion associated with a particular cancer risk level is also associated with specific exposure parameter assumptions (e.g., intake rates, body weights). When these exposure parameter values change, so does the relative risk. For a criterion derived on the basis of a cancer risk level of 10^{-6}, individuals consuming up to 10 times the assumed fish intake rate would not exceed a 10^{-5} risk level. Similarly, individuals consuming up to 100 times the assumed rate would not exceed a 10^{-4} risk level. Thus, for a criterion based on EPA's default fish intake rate (17.5 gm/day) and a risk level of 10^{-6}, those consuming a pound per day (i.e., 454 grams/day) would potentially experience between a 10^{-5} and a 10^{-4} risk level (closer to a 10^{-5} risk level). (Note: Fish consumers of up to 1,750 gm/day would not exceed the 10^{-4} risk level.) If a criterion were based on high-end intake rates and the relative risk of 10^{-6}, then an average fish consumer would be protected at a cancer risk level of approximately 10^{-8}. The point is that the risks for different population groups are not the same.[144]

EPA's 2000 Human Health Methodology clearly describes an "accepted risk range" of 10^{-4} to 10^{-6}, and provides that states may adopt a cancer risk level of either 10^{-5} or 10^{-6} for the general population, as long as "the risk to more highly exposed subgroups (sport fishers or subsistence fishers) does not exceed the 10^{-4} level."[145] Remarkably, the only reference in its proposed rule to this long held policy and practice of addressing the unique health risks to Indian tribes as a high consuming subpopulation is found in a footnote. 80 Fed. Reg. at 55065 n. 6. Rather than acknowledging that its proposed rule is a radical departure from the 2000 Guidance, EPA simply states that the 2000 Human Health Methodology "did not consider how CWA decisions should account for applicable reserved fishing rights, including treaty-reserved rights." *Id*. at 55068 (§IV.C.b).

The federal government has repeatedly deemed a 10^{-4} risk level to result in a *de minimis* risk when applied to more exposed subpopulations in deriving human health criteria under the CWA. Across EPA and FDA programs exposures at the level of risk between 10^{-6} and 10^{-4} are deemed acceptable because they represent an insignificant and essentially zero increased risk of cancer.[146]

[143] *Id.*

[144] *See*, EPA, 2000 Human Health Methodology at 2-7 (00113).

[145] *Id*. at 1-12.

[146] *See* Attachment A, at 12.

"De minimis" is a term of art taken from the principle in common law of *de minimis non curat lex* meaning roughly that the "the law does not concern itself about trifles."[147] Ecology should not disregard decades of scientific research and sound public policy by implying that highly exposed populations will not be as well protected if their exposure risk is at a risk level of 10^{-4}. On the contrary, it has been well understood that "if only a small population would be at greatest risk, the expected number of excess cancers corresponding to individual risks at the *de minimis* level of 10^{-4} would still be zero."[148] In actual practice, federal agencies across at least 132 regulatory decisions concluded that for small populations the *de minimis* lifetime risk was considered to be 10^{-4}.[149] These regulatory decisions include actions by the Consumer Product Safety Commission, the Food and Drug Administration, the Occupational Safety and Health Administration and EPA programs for water quality, air, pesticide use, drinking water, toxic substances and radiation.[150] A survey of these decisions concluded that "for small-population effects, regulatory action was never taken for individual risk levels below 10^{-4}.[151]

The accepted range of risk levels from 10^{-6} to 10^{-4} reflects a broader regulatory consensus that this range more than adequately protects human health to an insignificant level of risk that is essentially a zero increased risk of incurring cancer.[152] The abiding principle in the regulation of exposure to carcinogens was that there should be no exposure—that there is no safe level or threshold for exposure. An early expression of this principle is found in the 1954 Delaney Clause regulating chemicals in animal feed on the basis that there should be no toxins in toxic amounts.[153] It was apparent that health and environmental regulation would be impossible under the literal application of this concept. It is impossible to regulate to a zero standard.[154] This led to adoption by EPA and FDA of the Mantel-Bryan equation which is an early precursor to the current methodology for deriving risk based criteria under EPA guidance for human health criteria. Mantel-Bryan proposed using risk levels based at levels of insignificance that would reflect an essential zero risk of cancer at exposures considered in the resulting criteria.[155] As initially conceived, the risk levels were proposed in a range of one in one hundred million to one in a million—10^{-8} to 10^{-6}.[156]

The FDA through the 1970s and 1980s sought to establish amounts of carcinogenic compounds using an appropriate risk that when present as residue in human food would be

[147] BLACK'S LAW Dictionary 524 (2009).

[148] Attachment B, at 18 (*quoting* D. Kocher, Criteria for Establishing *de minimis* Level of Radionuclides and Hazardous Chemicals in the Environment (1996) (Report ES/ER/TM-187 prepared by the Oak Ridge National Laboratory for the U.S. Department of Energy).

[149] *See* Attachment B, at 18.

[150] Travis, Richter, Crouch, Wilson and Klema, Cancer Risk Management, 21 ENVIRON. SCI. TECHNOLOGY 415, Table 1 (1987).(05083-5088).

[151] *Id.* at 418.(05086).

[152] Ecology, Overview at 18. (00024).

[153] Calabrese, Edward J. "Origin of the Linearity No Threshold (LNT) Dose-Response Concept." ARCHIVES OF TOXICOLOGY at 7-8 (2013)(01097-1109).

[154] Graham, John D. "The Legacy of One in a Million" RISK IN PERSPECTIVE (1993)(01110-1111).

[155] Hutt, Peter B. "A Brief History of Risk Assessment," FDA ORAL HISTORY (November 2000)(01112-1132).

[156] 33 Fed. Reg. 19226, 19226 (July 19, 1973)(01133-1137).

consistent with "a zero tolerance (no residue)" policy.[157] To achieve this goal FDA made an early proposal based on the one in one-hundred-million risk level.[158] In its final rule, however, the FDA determined that the proposal was too conservative and offered no additional benefit to public health. As a result, the FDA determined that a one in one million risk was "essentially zero."[159]

The trajectory of FDA regulations was to deem a 10^{-8} risk level as too conservative "after considering that and listening to both the industry and to the scientists in FDA, the final regulation as the sensitivity of the methods and the level chosen by FDA ever since then was reduced to 1 in a million."[160] FDA has explained that the 10^{-6} risk means no carcinogenic risk at all, that while there is a mathematical possibility, it is not a real risk in the actual practical world.[161]

EPA engaged in a similar public discussion as the FDA in the 1970s and 1980s.[162] EPA recognized that absolute criteria for carcinogens could not be established given uncertainties

[157] *Id.*

[158] *Id*. at 19227.

[159] FDA, Compounds used in Food-Producing Animals, 38 Fed. Reg. 19227 (July 19, 1973). 37 Fed. Reg. 15747 (Aug. 4, 1972) (FDA adopts the Mantel-Bryan equation and its probit dose-response model as the tool used for quantitative risk assessment. Through Mantel-Bryan, one in 100,000,000 (10^{-8}) becomes a guide for determining safe doses of carcinogenic substances). FDA, Criteria and Procedures for Evaluating Assays for Carcinogenic Residues in Edible Products of Animals, 42 Fed. Reg. 10412 (Feb 22, 1977) (Following public response, industry critique, regulator reevaluation and economic considerations the one in 100,000,000 (10^{-8}) safe dose level is increased to a more lenient one in 1,000,000 (10^{-6})). FDA, Criteria and Procedure for Evaluating Assays for Carcinogenic Residues 44 Fed. Reg. 17070 (Mar. 20, 1979) (The Mantel-Bryan Equation is again adjusted; one in 1,000,000 is maintained). FDA, D&C Green No. 5, 47 Fed. Reg. 24278 (June 4, 1982) (Color additive D&C Green No. 6 permanently listed as acceptable for human consumption by FDA). FDA, Sponsored Compounds in Food-Producing Animals; Criteria and Procedures for Evaluating the Safety of Carcinogenic Residues, 50 Fed. Reg. 45530, 44541 (Oct. 31, 1985) (Responding to the Delaney clause, the FDA argues that one in a million risk level represents a truly insignificant degree of risk but that the agency can't confidently assert a one in one-hundred thousand risk level would adequately protect the general public). FDA, Cosmetics; Proposed Ban on the Use of Methylene Chloride as an Ingredient of Aerosol Cosmetic Products, 50 Fed. Reg. 51551 (Dec. 18, 1985) (FDA claims one in a million risk level represents a "*de minimis*" level of risk). (01138-1280).

[160] Hutt, "A Brief History of Risk Assessment," FDA ORAL HISTORY, at 17 (November 2000)(01112-1132).

[161] *Id.*

[162] EPA, Health Risk and Economic Impact Assessments of Suspected Carcinogens: Interim Procedures & Guidelines 41 Fed. Reg. 21402 (May 25, 1976) (EPA proposes "a balancing of risks and benefits as the basis for final regulatory action" regarding carcinogenic pesticides). EPA, Water Quality Criteria Documents; Availability, 45 Fed. Reg. 79323 (Nov. 28, 1980) (The EPA presents a range of acceptable risk levels in regard to Superfund (CERCLA) cleanup). EPA, National Emission Standards for Hazardous Air Pollutants: Regulations of Radionuclides, 49 Fed. Reg. 43906-43911 (Oct. 31 1984) (EPA prescribes different levels of protection for those who have carrying levels of exposure; distinguishes between individual risk and population risk). EPA, Regulations of Pesticides in Food: Addressing the Delaney Paradox Policy Statement, 53 Fed. Reg. 41104 (Oct. 19, 1988). (EPA proposes using one in a million as a definitive acceptable risk level in an effort to supersede the Delaney clause). EPA, Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions, 55 Fed. Reg. 11798 (Mar. 29, 1990) (EPA opts to use a one in one-hundred-thousand carcinogenic risk level for hazardous waste cleanup). EPA, Guidelines for Exposure Assessment, 57 Fed. Reg. 22888-22938 (May 29, 1992) (Discussion of individual and general population risks). EPA, Final Water Quality Guidelines for the Great Lakes System, 60 Fed. Reg. 15366-01 (March 23, 1995) (EPA approves a one in one-

including variances of sensitivities and exposure levels.[163] Instead, EPA presented a range of concentrations associated with risk levels of 10^{-5}, 10^{-6} and 10^{-7}.[164] EPA's objective in deriving these water quality criteria was to estimate concentrations "which do not represent a significant risk to the public."[165]

As discussed above, the EPA risk policy was affirmed in *Dioxin/Organochlorine Center v. Clarke*, 57 F.3d 1517, 1524 (9th Cir. 1995). The same risk policy as applied under CERCLA was affirmed in *State of Ohio v. EPA,* 997 F.2d 1520, 1533 (D.C. Cir. 1993). At issue was whether EPA can allow a lower, one in ten thousand, risk level for the protection of populations near a Superfund site. Washington filed an amicus brief in this proceeding. 997 F.2d at 1524 n.1. The court rejected this contention:

> The States next challenge EPA's use of a cancer risk range between 10^{-6} and 10^{-4} in the NCP, arguing that an exposure level greater than 10^{-6} is never appropriate. A 10^{-4} risk subjects the surrounding population to an increased lifetime cancer risk of 1 in 10,000. A 10^{-6} risk subjects the surrounding population to an increased lifetime cancer risk of 1 in 1,000,000. When EPA develops objectives for a remedial action at a site, it selects a remediation goal that "establish[es] acceptable exposure levels that are protective of human health." 40 C.F.R. § 300.430(e)(2)(i). EPA attempts to use health-based ARARs to set the goal, but if ARARs are nonexistent or unsuitable for use, EPA establishes the goal based on criteria in the NCP. 55 Fed. Reg. 8712 (1990). "For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-6} and 10^{-4}...." 40 C.F.R. § 300.430(e)(2)(i)(A)(2). The NCP expresses a preference for remedial actions that achieve a level of 10^{-6} however, the ultimate decision depends on a balancing of nine criteria, including cost. *Id.;* 55 Fed. Reg. 8718 (1990).
>
> The States contend that by permitting cost to play a role in determining the level of exposure, the cancer risk range fails to meet the requirement in § 9621 that remedial actions be "protective of human health." 42 U.S.C. § 9621(b)(1); *see also* 42 U.S.C. § 9621(d)(1). The States' argument necessarily depends, though, on the notion that an exposure level greater than 10^{-6} is not protective of human health. CERCLA requires the selection of remedial actions "that are protective of human health," not as protective as conceivably possible. A "risk range of 10^{-4} to 10^{-6} represents EPA's opinion on what are generally acceptable levels." 55 Fed. Reg. 8716 (1990). Although cost cannot be used to justify the selection of a remedy that is not protective of human health and the environment, it can be considered in selecting from options that are adequately protective.

hundred-thousand risk level for the general population of the Great Lakes region because the most exposed populations would still be protected at a one in ten-thousand level, which is deemed adequate). (01281-1742).

[163] 45 Fed. Reg. 79318, 79347 (Nov. 28, 1980)(01743-1767).

[164] *Id.* at 79348.

[165] *Id.* at 79348.

> The States also argue that the actual risk range selected is not adequately protective. EPA concluded, though, that all levels of exposure within the risk range are protective of human health. *Id.* EPA has used 10^{-4} as an upper bound for establishing risk levels in the past, *see* 53 Fed. Reg. 51,394, 51,426 (1988), and "[m]any ARARs, which Congress specifically intended be used as cleanup standards at Superfund sites, are set at risk levels less stringent than 10^{-6}," 55 Fed. Reg. 8717 (1990). The States offer no evidence challenging EPA's position that 10^{-4} represents a safe level of exposure, and in any event, we give EPA's findings on this point significant deference. *See New York v. EPA*, 852 F.2d 574, 580 (D.C.Cir.1988), *cert. denied*, 489 U.S. 1065, 109 S.Ct. 1338, 103 L.Ed.2d 809 (1989).
>
> The States also argue that EPA failed to justify the use of a range, instead of a single point. But EPA explained its decision to use a range. While "[t]he use of 10^{-6} expresses EPA's preference for remedial actions that result in risks at the more protective end of the risk range," 55 Fed. Reg. 8718 (1990), the Agency is also required to consider other factors in selecting an appropriate remedy. "Factors related to exposure, uncertainty and technical limitations may justify modifications of initial cleanup levels that are based on the 10^{-6} risk level." *Id.* A flexible approach to developing remedial goals is justified by the multiple statutory mandates of CERCLA, so long as EPA meets the statutory requirement of protectiveness.

997 F.2d 1520, 1533.

The national policy on acceptable risk is based on an extended scientific evaluation and has withstood legal challenges.[166] The risk policy for human health water quality criteria was resolved in the NTR. The NTR and subsequent EPA guidance documents have consistently articulated a policy to accept human health water quality criteria protecting the general population at a risk level of 10^{-6} or 10^{-5} as long as higher exposed populations are protected to at least a level of 10^{-4}.[167] "Adoption of a 10^{-6} or 10^{-5} risk level, both of which States and authorized Tribes have chosen in adopting water quality standards to date, represents a generally acceptable risk management decision, and EPA intends to continue providing this flexibility to States and Tribes."[168]

A long line of EPA decisions have affirmed the existing risk policy in human health criteria approvals for states on the Great Lakes[169], the California Toxic Rule, 40 C.F.R. § 131.38, and the state of Oregon human health criteria. The 2011 Technical Support Document for the Oregon criteria unequivocally states:

[166] *See* Attachment A at 11-12.

[167] NTR at 60855; *see also*, EPA, 2000 Human Health Methodology at 1-12 (October 2000)(00104).

[168] EPA, 2000 Human Health Methodology at 2-6 (00112); *see also* Attachment A at 13-14.

[169] EPA, Final Water Quality Guidelines for the Great Lakes System, 60 Fed. Reg. 15366-01 (March 23, 1995) (01775-1907)

> EPA has identified a risk level range of 1 x 10^{-6} (1:1,000,000) to 1 x 10^{-5} (1:100,000) to be an acceptable risk management goal for the general population….
>
> EPA's 2000 Methodology states that criteria based on a 10^{-5} risk level are acceptable for the general population as long as States and authorized Tribes ensure that the risk to more highly exposed subgroups (sport fishers or subsistence fishers) does not exceed the 10^{-4} risk policy.[170]

Under the proposed risk policy, compared to the current state risk policy, the general population consumption rate, results in criteria that will be protective to a level more stringent than 10^{-7}. The 100th percentile of tribal consumption will be protected to 10^{-6}. Ecology concluded that the mean consumption rate for the general population in Washington is 18.8 g/day including all fish.[171] The effective rate for deriving human health water quality criteria is substantially less than this value, as it includes both fish that are store bought and anadromous fish that do not spend sufficient time in Washington waters to bio accumulate toxics. As such, the proposed criteria would protect the general population at a risk level of 10^{-8}, and median tribal consumption rates at a risk level of 10^{-6}.

Criteria based on the existing state risk policy would be fully protective of tribal consumption without this dramatic change in risk policy. If Ecology used 17.5 g/day as the consumption rate for the general population in Washington, at a risk level of 10^{-6}, the resulting criteria would be protective to a consumption rate of 175 g/day at a 10^{-5} risk level and for a consumption rate of 1,750 g/day at a risk of 10^{-4}. The Washington Office of Financial Management estimates that there are 104,000 American Indian and Alaska natives in Washington.[172] If Ecology followed established guidance and science and applied a 10^{-6} risk level for the general population the resulting exposures at risk levels of 10^{-5} and 10^{-4} would not predict a single excess cancer risk for this population—a result that is more stringent than EPA guidance which calls for no excess cancer risk at the median consumption rate for high consuming populations at 10^{-4}.

ARCADIS, Summary of Health Risk Assessment Decisions in Environmental Regulations (March 6, 2015), Attachment A, explains in detail why tribal consumers would have the equivalent of a zero increased risk of cancer if Ecology complied with EPA guidance in setting criteria based on the general population consumption rate. The risk of cancer from all causes far outweighs the possible risk of cancer from exposure to chemicals in the environment. *Id.* at 2. To add some meaning to these risks, the excess cancer risk that may occur as a result of exposure to a carcinogen in the environment in Washington on an annual basis is 0.54% while the lifetime risk of cancer based on a risk level of 10^{-4} used to set water quality criteria is 0.00014%. *Id.* at 8-9. A 10^{-4} risk level is clearly an acceptable and protective upper bound risk level to use in deriving water quality criteria as there is no real increase in the overall risk of

[170] EPA, Technical Support Document for Action on the State of Oregon's New and Revised Human Health Water Quality Criteria and Associated Implementation Tools Submitted July 12 and 21, 2011, at 27 (October 17, 2011)(01908-2010).

[171] Ecology, Fish Consumption Rate Technical Support Document Version 2.0, 40-44 (January 2013)(Ecology Publication No. 12-09-058)(05398-5591).

[172] *Id.* at 18.

incurring cancer. This is especially true when comparing an **annual** risk to a risk level based on a **lifetime** exposure every day for 70 years. In theory only, a 10^{-4} risk level would predict one excess cancer in Washington. *Id*. at 2. This is only theoretical as risk managers across EPA and other federal programs have long considered this level of risk insignificant and, in fact, the absence of any real risk. *Id.* at 9-21. It is inexplicable why Ecology is proposing to ignore and in some sense misrepresent the best available science and policy in risk management.

The risk level proposed by Ecology far exceeds what is required by a principled consideration of environmental justice. This undoubtedly explains why EPA abandoned environmental justice as the basis for its demands on the state of Washington that it adopt EPA's preferred risk policy. In 2013 and 2014 Dennis McLerran made the improbable claims that "everyone deserves to be protected to the same level" and that "10^{-6} is a baseline for environmental justice."[173] It is notable that there is virtually no mention of environmental justice in the EPA March 23, 2015 comment letter on Washington's proposed rule and in the Federal Register notice for EPA's own September 2015 proposed rule. This is not surprising since EPA guidance on environmental justice, including consideration of tribal consumption rates, in fact supports the rule proposed by Washington in January 2015.

In May 2015 EPA published formal guidance on considering environmental justice in agency actions, including rulemaking.[174] The guidance document does not reference and therefore implicitly endorses EPA's long-standing policy on the acceptable range of risk levels. The following discussion from the guidance document exemplifies how the agency will determine whether there is a disproportionate impact from an agency action:

> It is important to note that the role of the analyst is to assess and present differences in anticipated impacts across population groups of concern to the decision-maker and the public. The determination of whether there is a potential disproportionate impact that may merit Agency action is ultimately a policy judgment informed by analysis, and is the responsibility of the decision-maker. These analyses will depend on the availability of the scientific and technical data. As noted in the *Draft Technical Guidance for Assessing Environmental Justice in Regulatory Analysis* (U.S. EPA 2013), examples of the type of information that may be useful to provide to decision-makers for considering whether or not effects are disproportionate include: the severity and nature of health consequences; the magnitude of the estimated differences in impacts between population groups; **mean or median exposures or risks to relevant population groups**; distributions of exposures or risk to relevant population groups; characterization of the uncertainty; and a discussion of factors that may make population groups more vulnerable.[175]

[173] D. McLerran, Pers. Communication to NWPPA Members (April 9, 2013); *see also* K. Susewind, Email to D. Opalski (March 11, 2014)(00459-0461).

[174] EPA, Guidance on Considering Environmental Justice During the Development of Regulatory Actions (May 2015)(available at http://www3.epa.gov/environmentaljustice/resources/policy) (05991-6046).

[175] *Id.* at 6-7 (emphasis added) (06002-6003).

Thus, the EPA 2015 environmental justice guidance focuses on the mean or median consumption or exposure rate of a more highly exposed subpopulation in the same manner as the 2000 EPA guidance focuses on the range of acceptable risk levels.

EPA has consistently defended this range as protective of the entire population under the principles of environmental justice. This was addressed in the response to comments for the 1995 Final Water Quality Guidelines for the Great Lakes System where EPA approved the use of a one in one hundred thousand risk level:

> Commentators argued that a 15 gram per day assumption in the methodology would not adequately protect populations that consume greater than this amount (e.g. low-income minority anglers and Native Americans). And that such an approach therefore would be inconsistent with Executive Order 12898 regarding environmental justice (February 16, 1994, 59 Fed. Reg. 7629). **EPA believes that the human health criteria methodology, including the fish consumption rate, will provide adequate health protection for the public, including more highly exposed sub-populations.** In carrying out our regulatory actions under a variety of statutory authorities, including the CWA, EPA has generally viewed an upper bound incremental cancer risk in the range of 10^{-4} to 10^{-6} as adequately protective of public health. As discussed above, the human health criteria methodology is based on a risk level of 10^{-5}. Therefore, if fish are contaminated at the level permitted by the criteria derived under the final Guidance, individuals eating up to 10 times (i.e., 150 grams per day) the assumed fish consumption rate would still be protected to 10^{-4} risk level.[176]

In promulgating the California Toxics Rule in 2000 EPA specifically rejected several comments that the 10^{-6} to 10^{-4} risk policy offended notions of environmental justice.

> EPA believes that this rule is consistent with the terms of the Executive Order (E.O.) on Environmental Justice. EPA rejects the notion that the rule is, in any respect, discriminatory against persons or populations because of their race, color, or national origin. The final rule establishes criteria that are designed to ensure protection of the public, including highly exposed populations. While some groups and individuals, including some low income and minority persons and populations, may face a greater risk of adverse health effects than the general population due to their particular fish consumption patterns, EPA believes that these groups will nonetheless receive a level of public health protection within the range that EPA has long considered to be appropriate in its environmental programs (e.g., 10^{-4} to 10^{-6} incremental cancer risk). **Obviously, as long as there is variability in fish consumption patterns among various segments of the population, it would be impossible for EPA to ensure that all groups would face identical risk from consuming fish. Therefore, EPA has sought to ensure that, after attainment of water quality criteria in ambient waters, no group is subject to increased cancer risks greater than the risk range that the EPA has long considered protective**. EPA disagrees that individuals who consume up to a pound of fish per day would face a 10^{-3} cancer risk. Given that

[176] EPA, Final Water Quality Guidelines for the Great Lakes System at 15 (emphasis added)(01789).

the basis of the criteria are a 6.5 gm/day assumption at a 10^{-6} risk level, individuals who consume a pound of fish per day would be protected within the established acceptable range of 10^{-4} to 10^{-6}, consistent throughout current EPA program office guidance and regulatory actions.[177]

EPA engaged in extensive consultations and considerations of tribal concerns and treaty interests in developing the 2015 guidance. Trust responsibilities and treaty rights were specifically addressed at a meeting of the EPA National Environmental Justice Advisory Council in December 2001 in Seattle, Washington.[178] Treaty rights are also discussed in a 2002 EPA report on fish consumption and environmental justice.[179] The 2002 document had been part of the EPA "EJ" tool kit documents including the "Plan EJ 2014."[180]

In June 2015 EPA published final updated ambient water quality criteria for the protection of public health in accordance with section 304(a)(1) of the Clean Water Act.[181] The risk-based criteria were updated based on the application of a 10^{-6} risk level to a general population consumption rate. EPA did not suggest that its risk management decision placed high consuming populations at risk and certainly did not consider whether there was any scientific basis for protecting those populations at a risk of 10^{-6}. The criteria are in fact based on the same understanding of the range of acceptable risk levels used in developing the NTR and the 2000 Human Health Criteria Guidance. [182] EPA proclaimed, based on this approach, that its recommended criteria "are scientifically derived numeric values that EPA determines will generally protect aquatic life or human health from adverse effects of pollutants in ambient water."[183]

From the inception of rulemaking in early 2013 by Ecology through publication of EPA's proposed rule in September 2015, EPA has taken a hardened position on two key factors—fish consumption rates and acceptable risk levels—and refused to engage in any discussion on the merits or basis for its demands. Ecology can and should choose a risk factor of 10^{-5}. There is no justification to stray from Ecology's 2015 risk management decision based on EPA demands.

EPA declared their position on these issues with the regulated community in Washington at a meeting on April 9, 2013. That meeting took place in the offices of EPA Region 10 in Seattle, Washington and was attended by EPA Regional Administrator Dennis McLerran and Daniel Opalski, the manager of the Region 10 Office of Water and Watersheds, representatives of Northwest Pulp & Paper Association, the Association of Washington Business, the

[177] EPA, California Toxics Rule Response to Comments Report, CTR-002-005a (Dec. 1999) (emphasis added)(02311-3812).

[178] EPA, Meeting Summary of the Executive Council of the National Environmental Justice Council.

[179] EPA, Fish Consumption and Environmental Justice at 8 ("[t]he tribes have fought too hard for too long to let the salmon and their treaty rights to harvest salmon to go extinct")(00291).

[180] EPA, Plan EJ 2014 Legal Tools (December 2011)(03813-3932).

[181] EPA, Final Updated Ambient Water Quality Criteria for the Protection of Public Health, 80 Fed. Reg. 36986 (June 29, 2015)(04807-4810).

[182] EPA, Human Health Ambient Water Quality Criteria: Draft 2014 Update, EPA-820-F-14-003 at 2 (May 2014)(01772-1774).

[183] EPA, Final Updated Ambient Water Quality Criteria at 36987.

Association of Washington Cities, the City of Everett, Weyerhaeuser and Inland Empire Paper Company. Mr. McLerran commenced the meeting by stating that the criteria in Washington should be based on a 175 grams per day (g/day) fish consumption rate and risk policy of one in one million (1 x 10^{-6} or 10^{-6}). Mr. McLerran explained that this was so because "everyone should be protected to the same level."[184] Mr. McLerran further stated that there had to be regional, meaning EPA regional, consistency on the toxic criteria. Mr. McLerran further stated that he was unwilling to discuss these factors with the regulated community.

EPA has been equally opaque in its dealings with the state of Washington. Ecology presented the risk level policy issue to EPA Region 10 on numerous occasions over the past three years. The origins and basis for the one in one million risk policy were the subjects of several emails to EPA regional staff in January and February 2013.[185] We believe that EPA staff attended the February 8, 2013, and March 28, 2013 Ecology Policy Forum meetings where the current risk policy in Washington and EPA guidance on risk policy were discussed.[186] EPA staff never indicated in response to these emails or at the meetings that there has been any change in EPA policy—or any circumstances that require toxic criteria in Washington to vary from national guidance.

Ecology specifically raised the risk policy issue to EPA national and regional staff at a meeting on March 20, 2013. The regional staff included Lisa Macchio, Mary Lou Soscia, Matthew Szelag, Lon Kissinger and Angela Chung.[187] The following questions and answers were recorded regarding EPA guidance on risk policy:

> Question: Does EPA agree that [the Washington] risk level applies to [the] general population?
>
> Angela Chung: EPA can't answer that now.
>
> Question: Would EPA disapprove a standard based on 10^{-6} for general population as long as 10^{-4} is max for highly exposed?
>
> Angela Chung: EPA can't answer that now.[188]

Ecology raised this issue with EPA staff again in emails and meetings in October and November 2013.[189] At these meetings between agency staff, the risk policy was listed as a topic for discussion. Ecology also presented its range of policy options at a public meeting on November 6, 2013.[190] EPA staff were present for the meeting but made no comment on national

[184] D. McLerran, Pers. Communication to NWPPA Members (April 9, 2013).

[185] C. Niemi, Email to L. Kissinger (January 2, 2013)(03933-3934).

[186] *See* Attendance Lists for Meetings on June 24, 2013, November 6, 2013, and July 2014 (03935-3943).

[187] C. Niemi, Handwritten Notes (March 20, 2013)("Dennis [EPA Region 10 Administrator] thinks the OR outcome was the right outcome, regionally wants to explore that position.")(00455-0458).

[188] *Id.*

[189] M. Gildersleeve, Email to A. Chung and M. Szelag (October 1, 2013)(03944).

[190] Ecology, Preliminary Draft – HHC Tools Summary, Water Quality Standards Rule Making, Human Health Criteria, Summary, (November 6, 2013)(03945).

guidance for setting risk policy and there is no record of any comments from EPA regarding the policy options presented at this meeting. In meeting after meeting EPA staff remained silent on this issue. This included two public meetings held in 2013 and 2014, at seven delegate table meetings in 2012, 2013 and 2014, and at five Policy Forum meetings in 2013.

The issue was most pointedly raised in a meeting with EPA regional staff on March 11, 2014. After months of silence, Mr. McLerran apparently stated "175 grams a day at 10^{-6} is a baseline for environmental justice."[191] Mr. McLerran reportedly represented that this assertion was based on EPA guidance. In a follow-up email, Ecology requested that Region 10 verify the existence of that guidance. Ecology specifically asked:

> I have a copy of the document: "EPA Policy on Environmental Justice for Tribes and Indigenous Peoples." It is a pre-decisional working draft dated November 14, 2012.
>
> Is that the document Dennis referred to?
>
> …
>
> As we discussed, tribal members, and anyone eating high amounts of fish, are at higher risk. They are at a risk exactly proportionate to the consumption rate and will be at the same ratio (proportion) regardless of where the rule lands. Interpreting this section of the policy to mean that they can't be at a higher risk would frustrate the entire system the HHC equations are based on and make it impossible to comply. **Is there a statement somewhere that one in a million risk rate is the baseline to establish environment justice?**[192]

Mr. Opalski responded to this email and confirmed that there is no such statement. In an email dated March 11, 2014, he conceded: "Regarding the environmental justice concern, you are right that there isn't anything that will/does call out particular risk levels."[193]

EPA Region 10 provided an additional comment on the Washington proposal in a letter dated July 1, 2014. This letter was in response to two letters from Washington State Senator Doug Ericksen. Sen. Ericksen, in his first letter on April 3, 2014, asked the EPA Regional Administrator, "I specifically would like to know what your agency considers to be an appropriate cancer risk level for the state of Washington."[194] Three weeks later Mr. McLerran responded with a letter that was not responsive to this question.[195] Sen. Ericksen sent a second letter to Mr. McLerran on May 28, 2014, pointing out that "I asked a specific question relating to a very important issue that will affect Washington's economy and public health, but you did not

[191] K. Susewind, Email to D. Opalski (March 11, 2014)(00459-0461).

[192] *Id.* (emphasis added).

[193] D. Opalski, Email to K. Susewind (March 11, 2014)(03946).

[194] D. Ericksen, Letter to D. McLerran (April 3, 2014)(03947-3948).

[195] D. McLerran, Letter to D. Ericksen (April 24, 2014)(03949).

provide me with a specific answer."[196] Sen. Ericksen requested an answer to his question and rephrased it as follows:

(1) Have you or your staff indicated to the Washington Department of Ecology that there is a threshold cancer risk level that must be proposed for the state's criteria to receive approval?
(2) Have you or your staff indicated to Ecology that a cancer risk level of 10^{-6} is required or that it is a level you want the state to propose?
(3) Have you or your staff provided any specific directives to Ecology outlining what you will accept for a cancer risk level for Washington?[197]

Mr. McLerran, in a letter dated July 1, 2014, responded that certain "groups could be provided less protection than they have now" if Washington uses a one in one hundred thousand risk policy.[198] There is no merit to this contention where the state was proposing to increase the consumption rates protected within the long accepted range of insignificant risk at 10^{-4} from 650 grams per day under the National Toxics Rule (NTR) to 1750 grams per day under the draft criteria and where the state was proposing criteria that would have been no less stringent than the current NTR criteria.

By the summer of 2014 it was clear that EPA was struggling to find some post-hoc rationalization for its demands. In some instances EPA staff would abandon any pretense of what is required under the CWA and simply assert its policy preferences are appropriate because "Dennis is concerned" or "Dennis feels."[199] At other times EPA would assert grounds for its demands that later disappeared. In March and July 2014, EPA claimed that its preferred fish consumption rate and risk level was required as a matter of environmental justice. This argument is notably absent from both the EPA comment letter on the Ecology proposed rule and the Federal Register explanation for the basis of the EPA proposed rule.[200]

On March 23, 2015, EPA submitted a formal comment letter on the Ecology proposed rule. The letter was signed by Mr. Opalski, who participated in many of the meetings and telephone conversations and emails discussed above. EPA's letter asserted an entirely new basis for EPA's demands, stating that a one in one million risk level applied to tribal consumption rates is a "compromise position" of Washington tribes.[201] NWPPA submitted a Freedom of Information Act request to EPA for any documents that reflect the claim in the EPA comment letter. Matthew Szelag and Andre Szalay, EPA Region 10 staff, initially responded in a telephone conference that there were no public records to support the statement by EPA. EPA nonetheless produced twenty-six pages of heavily redacted emails and publicly available documents, not one of which includes a communication from or on behalf of any tribe stating

[196] D. Ericksen, Letter to D. McLerran (May 28, 2014)(03950-3951).

[197] *Id.*

[198] D. McLerran Letter to D. Ericksen (July 1, 2014)(03952-3953).

[199] C. Niemi, Handwritten Notes (00455-8) and A. Chung, Pers. Communication, NWPPA Annual Meeting (June 6, 2013).

[200] D. Opalski, Letter to C. Niemi EPA Comment on Ecology Draft Rule (March 23, 2015)(07230-7249).

[201] *Id.*

that a one in one million risk level is a "compromise position of the tribes."[202] In any event, even if it were a compromise position of the tribes, this is not a basis under the CWA for EPA to depart from long-standing CWA policies, procedures, and requirements to mandate its preferred position on a state as it develops its criteria.

The March 23, 2015, comment letter is also noteworthy as being the first time EPA asserted that tribal treaty rights require the application of a particular risk level to tribal consumption rates. EPA had never before cited this rationale in prior meetings with the regulated community or in communications or meetings EPA had with Ecology staff. Having asserted this claim, however, EPA has consistently refused to explain how a treaty right to take fish dictates any particular risk management decision. This question was specifically posed to EPA by Ecology on July 15, 2015:

> Does EPA have an OGC [Office of General Counsel] or other legal opinion or rationale on how risk level and treaty tribal rights are connected, and why 10-6 is looked upon by EPA as fulfilling the rights, and 10-5 is not? Could you send me a copy of the opinion/rationale document?[203]

This becomes one of the central questions in the EPA demand that Washington derive criteria using a high consumption rate and 10^{-6} risk level—what exactly is the legal and scientific connection between a tribal treaty right and the use of a particular risk level as a factor in the equation that derives water quality criteria. Consistent with its now long-standing refusal to provide a legal, scientific and policy basis for its demands or engage in any meaningful public process, the EPA general counsel in an internal email directed EPA Region 10 to respond to Ecology by referring Ecology back to EPA's March 23, 2015 comment letter and EPA's February 2, 2015 decision to disapprove in part human health water criteria developed by the State of Maine.[204] It is not surprising that Ecology's subsequent July 2015 draft responses to comments on the proposed Washington State rule concluded that there is no legal basis for requiring criteria based on tribal consumption rates using a 10^{-6} risk level.[205]

Ecology has not provided an adequate basis in the record for its decision to change course on this issue.

Comment No. 9: Ecology should ensure that implementation of the criteria will be based on approved test methods in effect at the time of rule adoption.

The preliminary cost benefit analysis is limited in scope due to absence of data that effluent and receiving waters are above the proposed criteria. This is due in large part to the fact the criteria are in many cases far below the detection levels in EPA approved test methods. Ecology should acknowledge in response to these comments that test methods approved after the

[202] M. Szelag, Email to J. Edgell (July 14, 2015)(06440-2); K. Brown, Email to B. Duncan (June 5, 2015)(06466-6467); M. Szelag, Email to P. Ford (March 17, 2015)(06464-6465), EPA FOIA Response, EPA-R10-2015-008998 (August 2015).

[203] *Id.*, M. Szelag, Email (06442).

[204] *Id.*, M. Szelag, Email (06440).

[205] Ecology, Draft Responses to Comments on Proposed State Rule (July 2015) (04758).

adoption of a final rule cannot be used for the human health criteria until they are approved through an amendment to the state water quality standards.

The state water quality standards currently limit test methods for numeric criteria to EPA approved methods. This is expressly provided in WAC 173-201A-260(3)(h): "The analytical methods for these numeric criteria must be in accordance with the 'Guidelines Establishing Test Procedures for the Analysis of Pollutants.' (40 CFR Part 136)…" The Clean Water Act regulations, at 40 CFR Part 136, require the use of approved test methods for compliance monitoring in NPDES permits. The Pollution Control Hearings Board, in *Puget Soundkeeper Alliance v. Ecology and Seattle Iron and Metals*, PCHB No. 13-137c, Final Findings of Fact, Conclusion of Law and Order (July 23, 2015), held that Ecology is limited to use of approved test methods for NPDES permit compliance monitoring.

Under Washington law Ecology is further constrained to use only those test methods that are approved at the time the water quality standards are adopted. In a parallel provision of the state water quality standards Ecology has concluded that it can only use EPA guidance on deriving numeric limits that was in effect at the time of rule adoption. That provision, WAC 173-201A-240(4), states that "USEPA Quality Criteria for Water, 1986, as revised shall be used in the interpretation of values listed in subsection (3) of this section." Ecology has specifically interpreted this provision to mean, in the case of copper criteria, that it cannot use the biotic ligand model (BLM) to derive permit limits since the BLM was not part of the EPA guidance document at the time Ecology adopt its copper criteria. This interpretation was affirmed by the PCHB in *Copper Development Association v. Ecology*, PCHB 10-142, Order of Summary Judgment (December 12, 2011).

The same rationale should apply to approved test methods. This is a critical issue to ensure that no test method will be applicable to the new and significantly more stringent human health criteria without a full understanding of how the criteria will be implemented relying on the new test methods, including the costs and benefits of the proposed changes.

Comment No. 10: Submitting the rule package for EPA approval containing both numeric criteria and implementation tools is appropriate under the law and consistent with Ecology's prior commitments.

Ecology has reiterated its intent to submit a rule package containing both numeric and narrative criteria and implementation tools for water permits on numerous occasions in the 2015 and 2016 public processes. It is extremely helpful for all parties to see a path toward implementation as the rule proposal moves through the state and federal approval processes. Under no circumstances should the rule proposal components be divided up and moved separately through the federal approval process. Appropriate rule language should be included to ensure all components remain together similar to "the numeric criteria in Table 240 for human health protection become effective when the water quality standards implementation policies in revised WAC 173-201A-420 *Variances*, -460 *Intake Credits*, and -510(4) *General Allowance for Compliance Schedule*, are approved by EPA." If Ecology's 2016 proposal is not approved by EPA, then Ecology should still immediately adopt these state implementation policies.

Comment No. 11: The rule implementation plan must take into account evolution of the regulatory framework over time.

Ecology's support documents should be designed to implement the proposal considering the evolution over time of regulations and laws and science. Nothing will remain static as this rule proposal is implemented across Washington. We provide a list of factors that will change over time and no one issue is more important than others. First, analytical test methodologies will likely advance and have lower quantification levels leading to more stringent water quality based effluent limits as allowed for by WAC 173-201A-260(3)(h). Second, water permit holders will likely change as populations shift and manufacturing changes. Third, Section 303(d) lists of waters impaired by pollutants under the Clean Water Act will likely change. Fourth, additional large and complex TMDLs will need to be developed in populous areas of Washington. Fifth, applications and drafting water quality permits will become more complex and require additional Ecology staff-time and scientific support activities. Sixth, large-scale treatment technology is likely to advance beyond 2016 technology limitations. Seventh, case law and also legal precedents from the Pollution Control Hearings Board (PCHB) will change, for example, the practical implications of PCHB No. 11-184 for future water permits. Finally, when all is said and done, the situation will likely be chaotic and factors surrounding water permitting will not evolve at the same pace.

As a result the questions for Ecology are at what pace will the evolution in each sector occur; and, how will Ecology respond to the challenge of developing appropriate implementation policies? We encourage Ecology to build a plan based on realistic assessments of available data, implementation tools and science while building in flexibility to meet these evolving challenges.

Comment No.12: Preliminary Cost-Benefit and Least-Burdensome Alternative Analyses are incomplete in key areas and fail to adequately quantify the true costs of the proposed rule.

Ecology's Preliminary Cost-Benefit Analysis inadequately addresses the complex and evolving nature of regulatory costs of the more stringent 2016 proposal which will be phased in over time. The Analysis fails to quantify all regulatory costs across sectors for "prospectively impacted entities." While the February 2016 Analysis is an improvement over the 2015 Analysis—it still fails to identify and quantify all regulatory cost drivers for the private and public sectors and provide information to the public. The analysis should address future federal actions on analytical test methodologies; future PCHB decisions; an increased number of impaired water listings under Section 303(d) of the CWA; Ecology staff costs for preparation and implementation of additional complex TMDLs; incrementally higher remediation costs as the complete program is implemented; and, lost economic opportunities for the public due to increased compliance costs and regulatory uncertainty.

Comment No. 13: Intake credits are necessary and appropriate implementation tools for the rule proposal in WAC 173-201A-460 and allowed by the Clean Water Act.

Intake credits are essential tools for implementing the rule proposal in water permits for point source dischargers and the proposal in WAC 173-201A-460 should be adopted along with numeric criteria. The revised 2016 intake credit rule language is an improvement over the 2015 proposed language as it expands on the 2015 concept and provides additional details on the intent and functions of intake credits. While an intake credit will not be available in all situations to a discharger, nevertheless it can be a useful tool for permitting when a facility is found not to have the reasonable potential to cause or contribute to an exceedance of the applicable water quality standard but the pollutant is found in intake water.

Comment No. 14: Variances are necessary and appropriate implementation tools for the rule proposal in WAC 173-201A-420 and allowed by the Clean Water Act.

Variances are essential tools for implementing the rule proposal and the proposed language in WAC 173-201A-420 should be adopted along with numeric criteria. A variance is an undesirable but likely necessary implementation tool for the human health rule package. It is a serious tool that modifies a water quality standard and undergoes rigorous evaluation by both the state and EPA and includes public comment. Regulated entities will absolutely require the option of a variance to provide regulatory certainty and a path forward to compliance in certain water permitting situations.

Comment No. 15: Ecology must carefully consider any additional changes to variance rule language and the rule implementation plan to ensure successful implementation of variances for public and private entities.

The variances application process should be a defined path with clear expectations for both the regulated entities and the public. Ecology must develop and disseminate information to assist in applying for a variance with defined steps and timelines to reduce regulatory uncertainty and build trust with the public.

Recent federal guidance on variances should be incorporated into Ecology's rules. Any changes to the proposed variance language should be carefully analyzed to ensure a fair and balanced process with checks and balances. A variance should not be a regulatory roadblock to achieving water quality improvements rather it should be a path to compliance. Ecology should assess whether decisions to initially grant a variance can be adopted through RCW 34.05.350 *Emergency Rule* procedures to allow compliance in specific water permitting situations rather than wait for 12 to 24 months in a typical rule process.

Comment No. 16: Water body and multidischarger variance language is essential and must be retained in WAC 173-201A-420(2).

Water body specific and multidischarger variances are essential types of variances for implementing the rule proposal and the proposal in WAC 173-201A-420(2) should be adopted along with numeric criteria. Ecology must adopt and implement these important types of variances. Ecology should start planning and implementation work for water body and multidischarger variances to mitigate regulatory compliance costs and also provide certainty to regulated entities and the public. A water body variance could establish a framework for improving water quality in a geographical area. It could provide benefits beyond initial compliance with standards as the variance overlay could attract further study, evaluation, and actions by all sectors associated with the waterbody.

Comment No. 17: Compliance schedule language is essential and must be retained in WAC 173-201A-510(4).

Compliance schedule language is essential for implementing the rule proposal and the proposal in WAC 173-201A-510(4) and should be adopted along with numeric criteria. The continued availability and usefulness of compliance schedules is a key part of implementing the rule proposal. Specifically, the proposal acknowledges and allows for additional time to come into compliance with applicable standards in certain circumstances in WAC 173-201A-510(4)(d) and (e). Ecology must adopt these concepts as they provide regulatory certainty for dischargers while working towards improved water quality.

Respectfully submitted this 22nd day of April, 2016.

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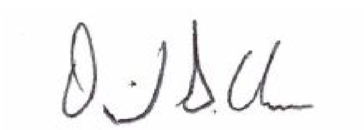

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Northwest Pulp and Paper Association

Summary of Health Risk Assessment Decisions in Environmental Regulations

March 6, 2015

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Acronyms and Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
DBCP	dibromochloropropane
FFDCA	Federal Food, Drug and Cosmetic Act
g/day	grams per day
HHWQC	Human Health Water Quality Criteria
HQ	hazard quotient
LFC	lowest feasible concentration
LoREX	low release and exposure
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/L	milligrams per liter
mg/yr	milligrams per year
MTCA	Model Toxics Control Act
NCEL	New Chemical Exposure Limit
NIOSH	National Institute of Occupational Safety and Health

NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyls
PEL	Permissible Exposure Limit
REL	Recommended Exposure Limit
RfD	reference dose
SDWA	Safe Drinking Water Act
THM	trihalomethane
TSCA	Toxic Substances Control Act
TWA	time weighted average
USEPA	United States Environmental Protection Agency
USFDA	United States Food and Drug Administration

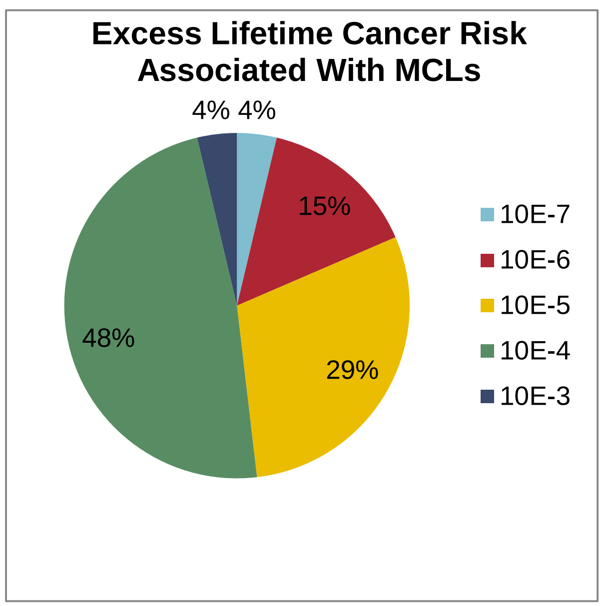
Executive Summary

This white paper provides perspective on how we protect human health through the choices reflected in environmental regulations. Limits on the concentrations of chemicals in the environment reflect a combination of science and policy. Regulators estimate the risks to human health from exposure to chemicals and then decide, as a matter of policy, what level of risk is acceptable. Those decisions are multi-faceted and reflect many smaller choices about both how to apply scientific knowledge and our values as a society. Wise choices must consider such decisions within the broader context of all the sources of risks to our health and the consequences of over-regulation.

Laying the groundwork: risk assessment concepts

Regulators estimate the potential risks to human health from exposure to chemicals in the environment by considering two factors: toxicity and exposure. The amount of a chemical to which people are exposed depends on how much of the chemical is in the air, water, soil, or food. It also depends on the amount of contact that people have with those media. The degree of contact – for example, the amount water that people drink or the amount of fish that people eat – can vary widely between people. Whether assessing the possible risks from environmental exposure or in setting limits on the acceptable concentrations in environmental media, regulators must decide what assumptions to make about the degree of exposure.

The risk of getting cancer from a lifetime of exposure to a chemical is expressed as a probability of developing cancer above and beyond the background risk that already exists, also known as the excess lifetime cancer risk. A $1x10^{-4}$ risk (or 1E-04) is a one in ten thousand chance of getting cancer over and above the background risk assuming a lifetime of exposure; a $1x10^{-6}$ risk (or 1E-06) is a one in a million chance. These risk levels represent the upper bound probability that an individual exposed to the chemical in the environment will develop cancer as a result of that exposure.



Putting risks into perspective

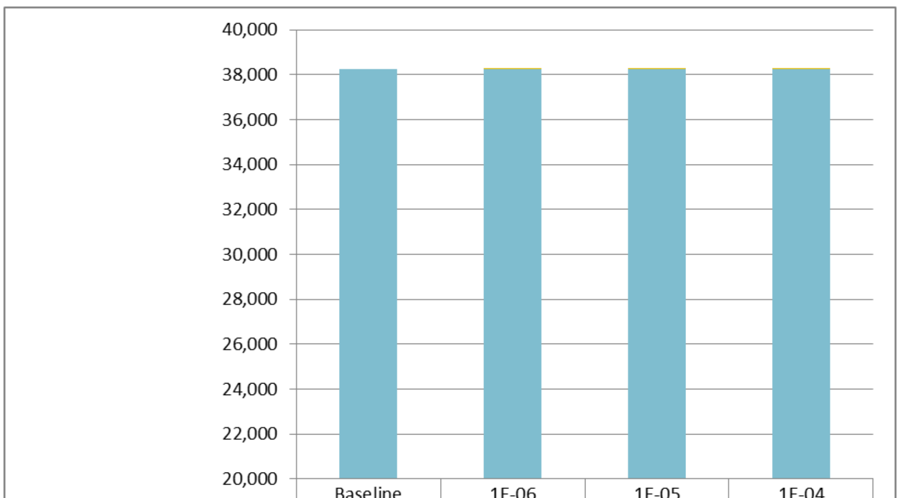
The debate over Human Health Water Quality Criteria (HHWQC) in Washington concerns in part the level of acceptable risk. This white paper discusses three factors that bear on this debate.

1. Acceptable risk from exposure to chemicals in the environment

Various statutes and associated regulations define acceptable risks differently. Standards set under the Occupational Safety and Health Act to protect workers on the job reflect an excess lifetime cancer risk on the order of 1x10^{-3}. The limits on the concentrations of chemicals in our drinking water at the Maximum Contaminant Levels (MCLs) allowed reflect a range of excess lifetime cancer risks as depicted in the pie chart. Regarding HHWQC, the United States Environmental Protection Agency (USEPA) says this (USEPA 2000):

> *EPA also believes that criteria based on a 10^{-5} risk level are acceptable for the general population as long as States and authorized Tribes ensure that the risk to more highly exposed subgroups (sportfishers or subsistence fishers) does not exceed the 10^{-4} level.*

2. Comparison between risk of cancer from environmental exposure to regulated chemicals and risk of cancer from all causes



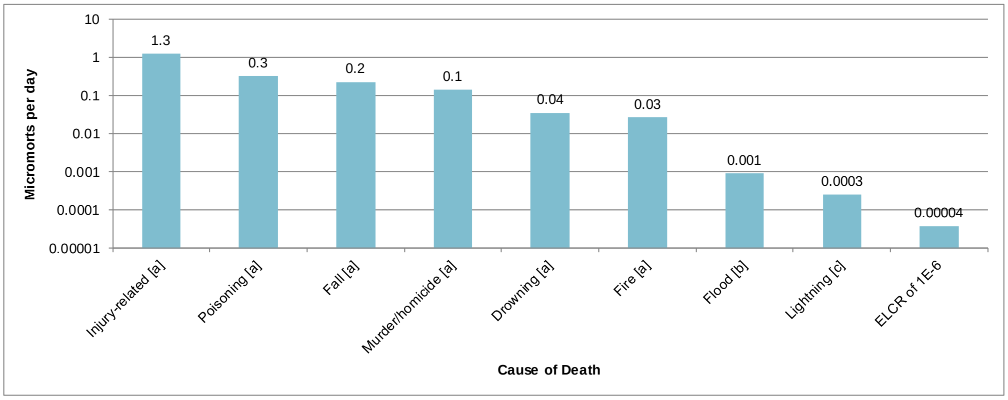
	Baseline	1E-06	1E-05	1E-04
Hypothetical Excess Cancers	0	<1	<1	1
Total Cancers	38,230	38,230	38,230	38,231

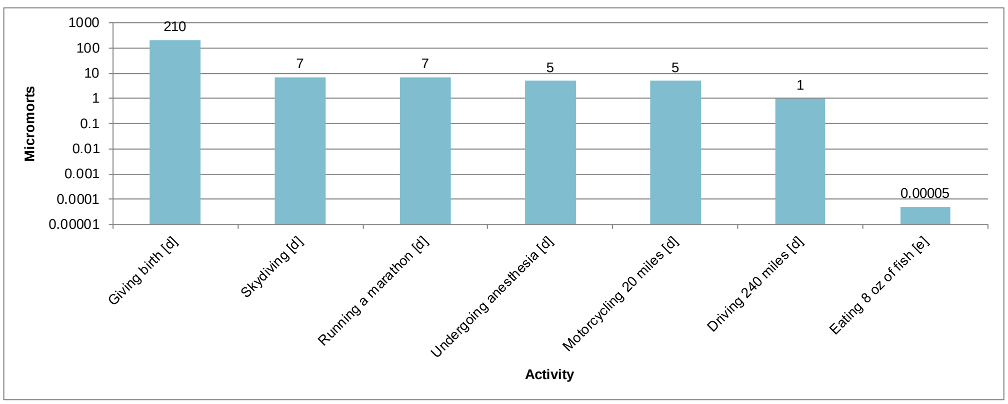
The risk of cancer from all causes far outweighs the possible risk of cancer from exposure to chemicals in the environment. The figure to the right shows how these risks translate to an estimated number of cancer occurrences per year in Washington State[1]. Compared to total cancer incidence in Washington, the increase in cancers associated with the excess lifetime cancer risks between 1x10^{-4} and 1x10^{-6} are far smaller (on the order of a thousandth of percent at an allowable excess lifetime cancer risk of 1x10^{-4} or less) than other causes of cancer. This finding is consistent with the comparisons of mortality risk associated with various allowable risk levels to mortality risk from various activities that are part of everyday life, as discussed below.

[1] Note that the in order to make the hypothetical excess cancers visible on the bar graph, the Y axis was set to start at 20,000 rather than 0.

3. Comparison between risk of cancer from environmental exposure and everyday risks

We face risks every day. When risk assessors want to be able to compare the relative risks from various activities they sometimes describe those risks in terms of “micromorts”. A micromort is an activity that typically occurs over time or distance which presents a risk of $1x10^{-6}$ (one in one million). As illustrated below, we routinely accept – whether we realize it or not – risks that far exceed an excess lifetime cancer risk of $1x10^{-4}$ to $1x10^{-6}$. The average American faced an unintentional injury-related mortality risk of approximately 467 micromorts per year in 2010, or 1.3 micromorts per day. In the U.S. population of 318 million people, the unit of 1.3 micromorts per day means that about 413 people die each day from an unintentional injury. This means that every day, every American has a risk of slightly greater than $1x10^{-6}$ of dying from unintentional injury. This every day, accepted risk provides context for discussions about protecting the general population and highly exposed subgroups.





Notes:

[a] Murphy et al. (2013)

[b] NOAA (2015a)

[c] NOAA (2015b)

[d] Blastland and Spiegelhalter (2014)

[e] Assuming organism-only AWQC are based on a fish consumption rate of 175 grams per day and risk level of $1x10^{-6}$.

Assumptions underlying risk characterization

Risk assessors must make many assumptions to estimate the possible risks from exposure to chemicals in the environment. These include assumptions about the degree of exposure. Assumptions about the amount of fish Washingtonians eat each day are particularly critical to the discussion about HHWQC though many other assumptions are important as well.

Water quality criteria based on the mean fish consumption rate in Washington and an excess lifetime cancer risk of $1x10^{-5}$ present a risk that, even to the most highly exposed populations, is within the acceptable range as defined by USEPA (2000). The default fish consumption rate does not need to be raised to 175 grams per day to protect the people of Washington State from unreasonable risk. Why? Because conservative assumptions add up. If a decision maker chooses a conservative value for every variable in a risk calculation, the results will be far more protective than intended. Consider the hypothetical example of a risk assessment that is based on three independent and log-normally distributed parameters. In the case of a fish consumption calculation, those parameters might be the amount of fish eaten each day, the source of the fish, and the number of years over the course of a lifetime that people live in a certain place and eat fish from a local source. Each value represents the 95^{th} percentile, or in other words that 9,500 out of 10,000 people have a lower exposure: they eat less fish, do not only eat fish from local waters, or do not eat local fish for their entire life, for example. Combining those three variables would result in a risk estimate that would fall at the 99.78^{th} percentile of the resulting distribution. The risk to 9,978 out of 10,000 people would be lower than the allowable risk level used to establish the standard. So, if $1x10^{-5}$ was selected as the allowable risk level for a criterion based on those assumptions, 9,978 people would have a risk less than $1x10^{-5}$ and only 22 would have a risk greater than $1x10^{-5}$. Decisions made on the basis of this hypothetical calculation, which compounds conservative factors, are far more protective than intended if the goal was to protect the average member of the population (or the 90^{th} percentile or even the 95^{th} percentile of the population) at the selected allowable risk level.

This may look like an academic calculation. Some readers may think that overestimating risks is a good thing because it allows us to be extra-cautious, and that regulatory decisions based on risk estimates should be as conservative and protective as possible. But the consequences of such choices also need to be considered. There's a cost to reducing the levels of chemicals in the environment to meet more-stringent limits, a cost that may be measured in dollars, energy usage, or the risk of injury to workers who have the job of reducing the levels of those chemicals. Chemicals may be used to treat wastewater to meet lower standards, for example, and the sludge that results has to be trucked to a landfill or incinerated. Generating the power used to operate the wastewater treatment plant uses natural resources and creates air emissions. Each of these aspects of the life cycle of wastewater treatment operations, and their related risks, should be weighed against the value of regulatory decisions based on the combination of several conservative assumptions, referred to as compounded conservatism.

Compounding conservative values for multiple variables (including a high fish consumption rate, long duration of residence, and upper percentile drinking water rate) to estimate risks with a low target excess lifetime cancer risk will have an unintended consequence. It will result in HHWQC that are far more protective of the vast majority of the population than reflected by the target excess lifetime cancer risk. That additional degree of protection must be weighed against the risks and environmental impacts that would result from the additional treatment needed to meet such criteria.

1. Risk assessment concepts

This section provides some background information relevant to the topics discussed in this white paper. It begins with a general discussion of how both cancer and non-cancer risks are evaluated by the United States Environmental Protection Agency (USEPA) (Section 1.1). It then puts those risks into perspective by describing what risk assessment conclusions mean with respect to an individual or a larger group of people, and how cancers resulting from exposure to chemicals in the environment, if they occur, compare to the general incidence of cancer (Section 1.2).

1.1 Evaluation of cancer and noncancer health endpoints

Risk generally depends on the following factors (USEPA 2012A):

- Amount of exposure, which depends on
  - How much of a chemical is present in an environmental medium, such as soil, water, air, or fish;
  - How much contact (exposure) a person has with the environmental medium, containing the chemical; and
  - The toxicity of the chemical.

Scientists consider two types of toxic effects, cancer and noncancer, when they assess the possible risks to human health from exposure to chemicals in the environment. The ways in which most United States regulatory agencies evaluate these risks differ because of one fundamental assumption, that the human body can tolerate some low dose of a chemical that causes harm other than cancer but that no dose of a carcinogen (a chemical that may cause cancer) is entirely safe.

Chemicals that may cause cancer – or, in scientific terminology, those with a carcinogenic endpoint – are, with a very few exceptions, conservatively assumed to have some probability of causing an adverse health effect (cancer) at any dose, by typical regulatory risk assessment practice. There is no safe dose. Thus, *any* exposure to a chemical believed to cause cancer has associated with it a risk.

> **Scientific Notation**
> One in a million is the same as…
> 1 in 1,000,000 or
> 1/1,000,000, or
> 0.000001, or
> $1x10^{-6}$, or
> 1E-6, or
> 0.0001%

Carcinogenic risk is expressed as a probability of developing cancer as a result of a given level of exposure over a lifetime (USEPA 1989) above and beyond the background risk that already exists. This additional risk of getting cancer associated with exposure to chemicals is often referred to as the excess lifetime cancer risk. The excess lifetime cancer risk is usually described in scientific notation. A $1x10^{-4}$ risk (or 1E-04) is a one in ten thousand chance of getting cancer over and above the background risk assuming a lifetime of exposure; a $1x10^{-6}$ risk (or 1E-06) is a one in a million chance. These risk levels represent the upper bound probability that an individual exposed to the chemical in the environment will develop cancer as a result of that exposure. It's important to note that the probability pertains to the risk of getting cancer, not the risk of dying from cancer. These probabilities apply only to people who are exposed to the chemicals under the conditions and to the extent that was assumed in estimating the risk. (Typically, these risk levels correspond to 70 years of exposure and represent the risk over an entire lifetime.) It is also important to recognize that these are upper-bound estimates of risk that depend on numerous assumptions. The actual risks are expected to be lower and may be even be zero (USEPA 1986). Public health policy makers must choose some "acceptable" excess lifetime cancer risk (also referred to in this white paper as an allowable risk) when developing limits for chemicals in the environment.

Chemicals that cause non-cancer adverse health effects are assumed to have some threshold dose below which no adverse health effects are expected to occur. In other words, test data show that there is a safe (or allowable) dose. Scientists use the hazard quotient (HQ) to indicate the degree of risk from exposure to a noncarcinogenic chemical:

HQ = (estimated exposure or dose) / (allowable dose).

An HQ of less than or equal to one indicates that the estimated exposure is less than or equal to the allowable dose (referred to by the USEPA as a reference dose or RfD) and that no adverse health effects are expected, even over a lifetime of continuous exposure. In other words, such exposures are considered safe. An HQ of greater than one indicates that estimated exposure is greater than the RfD. An exceedance of the RfD indicates that the potential exists for an adverse health effect to occur. However, because of the multiple conservative assumptions used to estimate exposures and to derive RfDs, an HQ somewhat greater than one is generally not considered to represent a substantial public health threat. The USEPA has offered this perspective (USEPA 1996):

> *Because many reference [doses] incorporate protective assumptions designed to provide a margin of safety, a hazard quotient greater than one does not necessarily suggest a likelihood of adverse effects. A hazard quotient less than one, however, suggests that exposures are likely to be without an*

appreciable risk of noncancer effects during a lifetime. Furthermore, the hazard quotient cannot be translated into a probability that an adverse effects [sic] will occur, and is not likely to be proportional to risk. A hazard quotient greater than one can be best described as only indicating that a potential may exist for adverse health effects.

The United States Department of Health and Human Services (2013) provides further perspective:

If the hazard quotient exceeds unity, the toxicant may produce an adverse effect but normally this will require a hazard quotient of several times unity; a hazard quotient of less than one indicates that no adverse effects are likely over a lifetime of exposure.

In short, while an HQ less than one provides substantial certainty that exposure will not result in a risk, exposure that results in an HQ of somewhat greater than one (even up to several times one) is also unlikely to result in an adverse effect.

1.2 Perspective on cancer risks

The excess lifetime cancer risk that may occur as a result of exposure to a carcinogen in the environment, as described above, is the excess risk above and beyond the background risks that we all face. The American Cancer Society provides perspective on background risks. It estimates that in 2014, 1,665,540 new cancer cases were diagnosed in the United States and 585,720 people died of cancer. These numbers include 38,230 new diagnoses and 12,550 deaths in the state of Washington. **Table 1** summarizes the incidence of cancer in the United States and in the state of Washington in 2014.

Table 1 Incidence of Cancer in 2014, from all causes

Geography	Cancer Cases Diagnosed in 2014*	Estimated Population in 2014**	Annual Cancer Incidence Rate
U.S. (national)	1,665,540	318,857,056	5.22×10^{-3}
Washington State	38,230	7,061,530	5.41×10^{-3}

* American Cancer Society 2014.

** U.S. Census Bureau 2014.

As the data in Table 1 show, a person living in the United States has about a 5/1,000 chance, *per year*, equal to about a 3.7 in 10 chance (37%) over a 70-year lifetime, of being diagnosed with cancer. In contrast, many regulatory agencies believe that an "acceptable" excess lifetime cancer risk that should be used to set limits on chemicals in the environment should correspond to a risk of 1/10,000 (1×10^{-4}) to 1/1,000,000 (1×10^{-6}) over the course of a *lifetime*. **Table 2** shows how the annual risk of cancer from all causes, based on the 2014 data shown in Table 1, compares to the annual cancer risk that would result from exposure to compounds in the environment that met environmental standards based on a lifetime cancer risk of $1x10^{-4}$ to $1x10^{-6}$. The cancer risk from exposures to environmental pollutants at or below their environmental standards is a tiny fraction (0.028% to 0.00028%) of the background cancer risk we all face.

Table 2 Incidence of Cancer in 2014 Compared to Acceptable Risk under Environmental Regulations

Geography	Annual Cancer Incidence Rate based on 2014 Data	Annual Risk of Cancer associated with Lifetime Excess Lifetime Cancer Risk $1x10^{-4}$	Annual Risk of Cancer associated with Lifetime Excess Lifetime Cancer Risk $1x10^{-6}$
United States (national)	$5.2x10^{-3}$ (0.52%)	$1.4x10^{-6}$ (0.00014%)	$1.4x10^{-8}$ (0.0000014%)
Washington State	$5.4x10^{-3}$ (0.54%)	$1.4x10^{-6}$ (0.00014%)	$1.4x10^{-8}$ (0.0000014%)

2. Risk assessment choices in federal regulatory programs

We've been assessing the risks from exposure to chemicals in the United States for just over half a century. In 1958, scientists knew of just four human carcinogens; by 1978, they knew of 37 human carcinogens and over 500 animal carcinogens (Wilson 1978). The National Toxicology Program (NTP) currently lists 243 agents, substances, mixtures, and exposure circumstances that *are* known or reasonably anticipated *to* cause cancer in humans (NTP 2014). Environmental legislation that developed in the United States in parallel to the study of what could cause cancer reflected both our scientific understanding of the hazards of chemical exposure and the socioeconomic factors of the times. Much of the legislation requiring assessment of risks of exposure to chemicals in the environment originated between 1972 and 1980[2].

This perspective is important when considering the risk assessment choices expressed in federal regulatory programs. Congress and regulators had to articulate their thinking about risk and what levels of risk were acceptable over a relatively short period of time. We had little time to test and debate ideas, as a society, about how what levels of risk are acceptable to us. It is useful, then, to take the "big picture" view of acceptable risk as we discuss risk based water quality criteria in Washington State.

Various federal laws and regulations define 'acceptable risk' in different ways. These definitions typically fall into one or more of the general categories shown in **Table 3** (Schroeder 1990).

[2] Includes: Clean Water Act (1972), Clean Air Act (1972), Safe Drinking Water Act (1974), Resource Conservation and Recovery Act (1976), Comprehensive Environmental Response, Compensation, and Liability Act (1980).

Table 3 Ways of Reflecting Risk Considerations in Environmental Laws

Type of standard	Variation	Premise
Health based standards	Zero risk	Risk should be reduced to zero or to some other level that is acceptable to society
	Significant risk	
Balancing standards	Cost-benefit	Possible risks must be balanced against the economic benefits of using a chemical or the costs of controlling risks
Technology based standards	Feasibility analysis	Limits are set based on the levels achievable by the best available treatment technology that the regulated industry can afford to install.

As a result of the different ways of thinking about acceptable risk and the factors that must be taken into account when regulating exposure to chemicals, regulators have defined goals for limiting cancer risks in different ways in various regulatory programs. **Table 4** summarizes benchmark criteria. Those criteria and some of the striking differences between programs are described below.

Table 4 Benchmarks for "Acceptable" Risk

Law / Regulation	Focus	Risk Standard	Criterion for Carcinogens
Clean Water Act	Surface water	Adverse health impacts	$1x10^{-4}$ to $1x10^{-6}$
Safe Drinking Water Act	Public drinking water	Any adverse effect	Goal: 0 Enforceable standard: $1x10^{-4}$ to $1x10^{-7}$
Toxic Substances Control Act	Chemicals manufactured or imported into the United States	Unreasonable risk	$1x10^{-4}$ (inferred, absent clear policy)
Occupational Safety and Health Act	Worker protection	Significant risk over 45-year working life	$1x10^{-3}$
Comprehensive Environmental Response, Compensation, and Liability Act, or Superfund	Uncontrolled hazardous waste sites	No significant risk	$1x10^{-4}$ to $1x10^{-6}$

2.1 The beginning of "minimal risk" discussions: the Delaney Clause

Delaney Clause – 1958	
Health based standards	✓
Balancing standards	
Technology based standards	

The debate over what level of exposure to a carcinogen could be considered safe began in the United States when people became concerned about pesticide residues in processed foods. This debate produced the 1958 Food Additives Amendment (section 409) to the 1954 Federal Food, Drug and Cosmetic Act (FFDCA), which said:

> *…no additive shall be deemed to be safe if it is found to induce cancer when ingested by man or animal, or if it is found, after tests which are appropriate for the evaluation of the safety of food additives, to induce cancer in man or animal…*

This "zero risk" clause, named for Congressman James Delaney, was a landmark decision in the regulation of compounds that might cause cancer. The Delaney Clause sounds simple enough, but soon ran into practical limitations: How low of a dose do we need to test to assure ourselves that a chemical does not cause cancer? And how, given the limits of analytical chemistry, do we know when a chemical that can induce cancer is present in a food product?

The United States Food and Drug Administration (USFDA) faced this challenge in regulations proposed in 1973 (USFDA 1973), saying:

> *If the results of the test for carcinogenicity establish that the compound or its metabolites will induce cancer in test animals, the required sensitivity of the regulatory assay method will be determined based on the Mantel-Bryan procedure ….*
>
> *Absolute safety can never be conclusively demonstrated experimentally. The level defined by the Mantel-Bryan procedure is an arbitrary but conservative level of maximum exposure resulting in a minimal probability of risk to an individual (e.g., 1/100,000,000), under those exposure conditions of the basic animal studies.*

In describing the benchmark (1/100,000,000 or 10^{-8}) provided as an example of minimal probability of risk to an individual, the USFDA cited a groundbreaking paper by Mantel and Bryan (1961) that said:

> *We may, for example, assume that a risk of 1/100 million is so low as to constitute "virtual safety." Other arbitrary definitions of "virtual safety" may be employed as conditions require.*

Many of the comments on the regulation proposed in 1973 pertained to how the proposed regulation dealt with the risk of cancer and the 1/100,000,000 benchmark. After considering those comments the USFDA promulgated a final regulation in 1977. In doing so it re-defined the benchmark risk level. The preamble to the final rule explains that tests for carcinogens must be able to measure the concentration corresponding to the 1/1,000,000 (or 10^{-6}) risk level, which the USFDA described as an "insignificant public health concern". (USFDA 1977)

In this rulemaking, the USFDA was careful to point out that it was not making an explicit judgment on an acceptable level of risk, simply seeking to set a practical benchmark that could be used to design animal experiments:

> *[10^{-6}] does not represent a level of residues "approved" for introduction into the human diet. The purpose of these regulations is to establish criteria for the evaluation of assays for the measurement of carcinogenic animal drugs. These criteria must include some lowest level of reliable measurement that an assay is required to meet. In defining a level of potential residues that can be considered "safe", therefore, the Commissioner is establishing a criterion of assay measurement that, if it can be met for a compound, will ensure that any undetected residues resulting from the compound's use will not increase the risk of human cancer.*

Despite this caution, many people took this regulatory action as a precedent for defining an "acceptable" level of risk as $1x10^{-6}$. In fact, the Delaney Clause was replaced in 1996 by legislation that specifies 10^{-6} as an acceptable level of risk[3] (Moran 1977).

2.2 Clean Water Act

CWA – 1972	
Health based standards	✓
Balancing standards	
Technology based standards	

Under the Clean Water Act (CWA), States and authorized Native American tribes set water quality standards for the surface water bodies under their jurisdiction. A water quality standard has two parts: the designated uses of a body of water, and the criteria (or concentration limits for specific chemical compounds) necessary to protect those uses. The USEPA develops Human Health Water Quality

[3] The Delaney Clause is no longer in effect. The Food Quality Protection Act of 1996 changed the standard for the residues of carcinogens in foods from the "zero risk" criterion implicit in the Delaney Clause to a standard of "reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue." The law allows for chemical residues if the risk of causing cancer in less than one-in-a-million people over the course of a typical life-span. The USEPA must consider the benefits of pesticides in supporting an adequate, wholesome, and economical food supply in determining an acceptable level of risk.

Criteria (HHWQC) that States and Native American tribes can use to set those concentration limits (USEPA 2000). In general (USEPA 2000),

> *Water quality criteria are derived to establish ambient concentrations of pollutants which, if not exceeded, will protect the general population from adverse health impacts from those pollutants due to consumption of aquatic organisms and water, including incidental water consumption related to recreational activities.*

For compounds that may cause cancer in people exposed to surface water, those criteria must correspond to some level of risk that is thought to be acceptable.

The USEPA's 1980 HHWQC National Guidelines simply represented a range of risks. In other words, the guidance presented a range of chemical concentrations corresponding to incremental cancer risks of 10^{-7} to 10^{-5}. Revised guidelines published in 2000 corresponded to the 10^{-6} risk level, with this explanation (USEPA 2000):

> *With [HHWQC] derived for carcinogens based on a linear low-dose extrapolation, the Agency will publish recommended criteria values at a 10^{-6} risk level. States and authorized Tribes can always choose a more stringent risk level, such as 10^{-7}. EPA also believes that criteria based on a 10^{-5} risk level are acceptable for the general population as long as States and authorized Tribes ensure that the risk to more highly exposed subgroups (sportfishers or subsistence fishers) does not exceed the 10^{-4} level.*

The Agency elaborated on this policy with respect to more highly exposed people, saying

> *EPA understands that highly exposed populations may be widely distributed geographically throughout a given State or Tribal area. EPA recommends that priority be given to identifying and adequately protecting the most highly exposed population. Thus, if the State or Tribe determines that a highly exposed population is at greater risk and would not be adequately protected by criteria based on the general population, and by the national … criteria in particular, EPA recommends that the State or Tribe adopt more stringent criteria using alternative exposure assumptions….*
>
> *EPA understands that fish consumption rates vary considerably, especially among subsistence populations, and it is such great variation among these population groups that may make either 10^{-6} or 10^{-5} protective of those groups at a 10^{-4} risk level. Therefore, depending on the consumption patterns in a given State or Tribal jurisdiction, a 10^{-6} or 10^{-5} risk level could be appropriate. In cases where fish consumption among highly exposed population groups is of a magnitude that a 10^{-4} risk level would be exceeded, a more protective risk level should be chosen.*

…changing the exposure parameters also changes the risk. Specifically, the incremental cancer risk levels are relative, meaning that any given criterion associated with a particular cancer risk level is also associated with specific exposure parameter assumptions (e.g., intake rates, body weights). When these exposure parameter values change, so does the relative risk. For a criterion derived on the basis of a cancer risk level of 10^{-6}, individuals consuming up to 10 times the assumed fish intake rate would not exceed a 10^{-5} risk level. Similarly, individuals consuming up to 100 times the assumed rate would not exceed a 10^{-4} risk level. Thus, for a criterion based on EPA's default fish intake rate (17.5 gm/day) and a risk level of 10^{-6}, those consuming a pound per day (i.e., 454 grams/day) would potentially experience between a 10^{-5} and a 10^{-4} risk level (closer to a 10^{-5} risk level).

In other words, the USEPA generally sets HHWQC at the 10^{-5} to 10^{-6} risk level, but allows states and tribes flexibility in setting enforceable criteria. In regions where some groups may eat more fish than is typical and by doing so perhaps increase their exposure to chemicals in fish, the Agency advises that the criterion set for the general population should not result in a risk to those who eat more fish that is greater than 10^{-4}.

2.3 Safe Drinking Water Act

The USEPA sets two kinds of criteria for chemicals in public water supplies, Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Levels (MCLs). Here's how the Agency describes the process of determining those criteria (USEPA 2013A):

If there is evidence that a chemical may cause cancer, and there is no dose below which the chemical is considered safe, the MCLG is set at zero. If a chemical is carcinogenic and a safe dose can be determined, the MCLG is set at a level above zero that is safe….

Once the MCLG is determined, EPA sets an enforceable standard. In most cases, the standard is a Maximum Contaminant Level (MCL), the maximum permissible level of a contaminant in water which is delivered to any user of a public water system. …The MCL is set as close to the MCLG as feasible….. EPA may adjust the MCL for a particular class or group of systems to a level that maximizes health risk reduction benefits at a cost that is justified by the benefits.

The USEPA also determines non-enforceable Drinking Water Specific Risk Level Concentrations. It has described the Drinking Water Specific Risk Level Concentration as being based on the $1x10^{-4}$ excess lifetime cancer risk (USEPA 2012B). In some cases, as illustrated in **Table 5**, adjustments to the MCL have resulted in a concentration limit that corresponds to a higher risk. In other cases, the MCL for a chemical is lower than the concentration corresponding to the 10^{-4} risk level and therefore represents a lower risk level.

SDWA – 1972	
Health based standards	✓
Balancing standards	✓
Technology based standards	✓

Table 5 Comparison of Drinking Water MCLs and Cancer Risk Levels for Potential Carcinogens

Compound	MCL* (mg/L)	Concentration (mg/L) at 10^{-4} Cancer Risk*	Approximate Risk Level of MCL
Arsenic	0.01	0.002	$5x10^{-4}$
Benzene	0.005	1 to 10	$5x10^{-7}$ to $5x10^{-6}$
Benzo(a)pyrene	0.0002	0.0005	$4x10^{-5}$
Bromodichloromethane (THM**)	0.1	0.08	10^{-4}
Bromate	0.01	0.005	$2x10^{-4}$
Bromoform (THM**)	0.08	0.08	10^{-4}
Carbon tetrachloride	0.005	0.05	10^{-5}
Chlordane	0.002	0.01	$2x10^{-5}$
Di(2-ethylhexyl)adipate	0.4	3	10^{-5}
Dibromochloromethane (THM**)	0.08	0.08	10^{-4}
Dibromochloropropane (DBCP)	0.0002	0.003	$7x10^{-6}$
Dichloroacetic acid^{+}	0.06	0.07	10^{-4}
Dichloroethane (1,2-)	0.005	0.04	10^{-5}
Dichloroethylene (1,1-)	0.007	0.006	10^{-4}
Dichloromethane	0.005	0.5	10^{-6}
Dichloropropane (1,2-)	0.005	0.06	10^{-5}
Epichlorohydrin	TT^{++}	0.3	$7x10^{-7}$
Ethylene dibromide	0.00005	0.002	$2.5x10^{-6}$
Heptachlor	0.0004	0.0008	$5x10^{-5}$
Heptachlor epoxide	0.0002	0.0004	$5x10^{-5}$
Hexachlorobenzene	0.001	0.002	$5x10^{-5}$
Pentachlorophenol	0.001	0.009	10^{-5}
Polychlorinated biphenyls (PCBs)	0.005	0.01	$5x10^{-5}$
2,3,7,8-TCDD (dioxin)	$3x10^{-8}$	$2x10^{-8}$	10^{-4}
Toxaphene	0.003	0.003	10^{-4}
Trichloroethylene	0.005	0.3	10^{-6}
Vinyl chloride	0.002	0.002	10^{-4}

* USEPA 2012B.

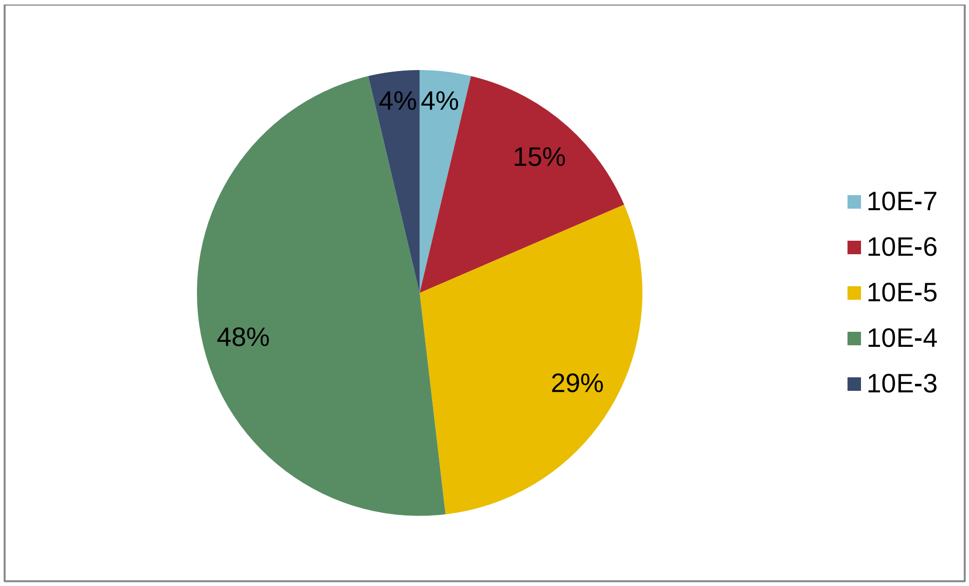
** Total trihalomethane (THM) concentration should not exceed 0.08 mg/L.

$^{+}$ The total for five haloacetic acids is 0.06.

$^{++}$ When epichlorohydrin is used in drinking water systems, the combination (or product) of dose and monomer level shall not exceed that equivalent to an epichlorohydrin-based polymer containing 0.01% monomer dosed at 20 mg/L. (0.01/100 * 20 mg/L = 0.002 mg/L)

As these examples show and as illustrated in **Figure 1**, the excess lifetime cancer risks associated with a single drinking water contaminant present in a water supply at its MCL may fall within a range of several orders of magnitude. Forty-eight percent of MCLs correspond to an estimated lifetime risk of $1x10^{-4}$ to $1x10^{-3}$; 29% of MCLs represent a potential risk of cancer after a lifetime of exposure of $1x10^{-5}$ to $1x10^{-4}$. While the USEPA may consider the benchmark excess lifetime cancer risk of 10^{-4} in setting a standard, the requirement to set the MCL as close to the MCLG as feasible or to adjust the MCL to a level that "maximizes health risk reduction benefits at a cost that is justified by the benefits" may result in a MCL that represents a very different risk level for that compound. And the combined risks of exposure to multiple chemicals, if they are present in the water supply, may increase the potential risk further.

Figure 1 Approximate Risk Levels associated with MCLs in Drinking Water



2.4 Occupational Safety and Health Act

The United States Occupational Safety and Health Administration (OSHA) develops standards to protect workers under the Occupational Safety and Health Act of 1970. OSHA first promulgated standards in 1974 to regulate the industrial use of 13 chemicals identified as potential occupational carcinogens. Those standards did not set limits on exposure, simply mandated the use of engineering controls, work practices, and personal protective equipment to limit exposure.

OSHA has since promulgated standards for certain carcinogens, including the regulations at 1910 Subpart Z, Toxic and Hazardous Substances. Those standards reflect a landmark decision by the Supreme Court known as the “Benzene Decision”, more formally known as *Industrial Union Department v. American*

Petroleum Institute, 448 U.S. 607, in 1980, At issue was whether setting worker protection standards for carcinogens such as benzene at the lowest technologically feasible level that would not impair the viability of the industries regulated conformed to the statutory requirement that such standards be "reasonably necessary or appropriate to provide safe and healthful employment". The decision read, in part,

> *… "safe" is not the equivalent of "risk-free." A workplace can hardly be considered "unsafe" unless it threatens the workers with a significant risk of harm…. [T]he requirement that a "significant" risk be identified is not a mathematical straitjacket. It is the Agency's responsibility to determine, in the first instance, what it considers to be a "significant" risk. Some risks are plainly acceptable and others are plainly unacceptable. If, for example, the odds are one in a billion that a person will die from cancer by taking a drink of chlorinated water, the risk clearly could not be considered significant. On the other hand, if the odds are one in a thousand that regular inhalation of gasoline vapors that are 2% benzene will be fatal, a reasonable person might well consider the risk significant and take appropriate steps to decrease or eliminate it. Although the Agency has no duty to calculate the exact probability of harm, it does have an obligation to find that a significant risk is present before it can characterize a place of employment as "unsafe."*

The Supreme Court essentially stated that a risk of fatality of 1×10^{-3} in an occupational setting was unacceptable. OSHA applied this benchmark to excess lifetime cancer risk. (Again, it is worth noting that not all cancers are fatal: an excess lifetime cancer risk of 1×10^{-3} corresponds to a far lower risk of cancer-related death.) For example, when OSHA set the Permissible Exposure Limit (PEL) for methylene chloride as a time weighted average (TWA) concentration, it offered an explanation that indicated how it thought about acceptable risk and acknowledged the level of risk associated with the standard being replaced (OSHA 1997):

> *OSHA's final estimate of excess cancer risks at the current PEL of 500 [parts per million] ppm (8-hour TWA) is 126 per 1000. The risk at the new PEL of 25 ppm is 3.62 per 1000. The risk at 25 ppm is similar to the risk estimated in OSHA's preliminary quantitative risk assessment based on applied dose of [methylene chloride] on a mg/kg/day basis (2.3 per 1000 workers) and clearly supports a PEL of 25 ppm. Risks greater than or equal to 10(-3) are clearly significant and the Agency deems them unacceptably high. However, OSHA did not collect the data necessary to document the feasibility of a PEL below 25 ppm across all affected industry sectors, and so the Agency has set the PEL at 25 ppm in the final rule.*
>
> *Further guidance for the Agency in evaluating significant risk and narrowing the million-fold range provided in the "Benzene decision" is provided by an examination of occupational risk rates, legislative intent, and the academic literature on "acceptable risk" issues. For example, in the high risk occupations of mining and quarrying, the average risk of death from an occupational injury or an acute occupationally-related illness over a lifetime of employment (45 years) is 15.1 per 1,000*

workers. The typical occupational risk of deaths for all manufacturing industries is 1.98 per 1,000. Typical lifetime occupational risk of death in an occupation of relatively low risk, like retail trade, is 0.82 per 1,000. (These rates are averages derived from 1984-1986 Bureau of Labor Statistics data for employers with 11 or more employees, adjusted to 45 years of employment, for 50 weeks per year).

The National Institute of Occupational Safety and Health, or NIOSH, is the research and development counterpart to OSHA. Part of the organization's mission is to develop recommendations for health and safety standards. Their work provides guidance on limits for occupational exposures that supplements and informs OSHA rulemaking.

In 1976, NIOSH published its first guidelines on carcinogens in the workplace. Those guidelines called for "no detectable exposure levels for proven carcinogenic substances" (NIOSH 2014). NIOSH set Recommended Exposure Limits (RELs) for most carcinogens at the "lowest feasible concentration (LFC)." In 1995, NIOSH revised its policy (NIOSH 2010):

NIOSH recommended exposure limits (RELs) will be based on risk evaluations using human or animal health effects data, and on an assessment of what levels can be feasibly achieved by engineering controls and measured by analytical techniques. To the extent feasible, NIOSH will project not only a no-effect exposure, but also exposure levels at which there may be residual risks.

The effect of this new policy will be the development, whenever possible, of quantitative RELs that are based on human and/or animal data, as well as on the consideration of technological feasibility for controlling workplace exposures to the REL..

In 2013, NIOSH issued a new carcinogen policy for public comment. This policy explicitly addresses the acceptable level of risk from exposure to carcinogens in the workplace. In a document titled *NIOSH Current Intelligence Bulletin: Update of NIOSH Carcinogen Classification and Target Risk Level Policy for Chemical Hazards in the Workplace*, NIOSH proposed the following (NIOSH 2013).

NIOSH will set RELs to keep exposures below the 95% lower confidence limit estimate of the dose expected to produce 1 in 1,000 excess risk of cancer as a result of a 45-year working lifetime exposure (section 6). Although NIOSH recommends keeping occupational carcinogen exposures below the concentrations that produce a working lifetime risk of 1 in 1,000, this should be considered the minimum level of protection. Controlling exposures to lessen risk is always warranted….

The 1 in 1,000 risk level comes from interpreting the 1980 U.S. Supreme Court "benzene" decision, which determined a 1 in 1,000 excess risk to be significant.

In summary, the levels of risk considered to be acceptable for workers have varied over time at OSHA and at NIOSH. In the latest evolution of policy, an excess risk of 1/1000 ($1x10^{-3}$) over a working lifetime of 45 years of exposure has been proposed as the basis for workplace standards, although some standards, former and current, have exceeded that limit. By comparison to the other definitions of acceptable risk described in this white paper, this risk equates to an annual risk of $2x10^{-5}$ or an excess lifetime cancer risk (70 years) of approximately $2x10^{-3}$.

2.5 Toxic Substances Control Act

The Toxic Substances Control Act, abbreviated TSCA, regulates most chemical substances manufactured or imported into the United States. Under this law the USEPA can require reporting, record-keeping and testing of chemical substances, and may impose restrictions on their manufacture or use. The law defines the conditions under which the USEPA can take action. If an "unreasonable risk of injury to health or the environment" from a chemical substance has been proven, for example, the Agency can require risk-abatement action such as labeling chemical substances, regulating uses, restrictions on disposal, and prohibiting or limiting manufacture. But neither the law nor the regulations that implement the law define "unreasonable risk" clearly.

The USEPA has not published explicit guidance on how it reaches a finding of "unreasonable risk" but has described it generally as follows (USEPA 2013B):

> *EPA's determination that manufacture, processing, use, distribution in commerce, or disposal of an individual substance which has been the subject of a notice under section 5 of the TSCA may present an unreasonable risk of injury to human health or the environment is based on consideration of (i) the size of the risks identified by EPA; (ii) limitations on risk that would result from specific safeguards (generally, exposure and release controls) sought based on Agency review and (iii) the benefits to industry and the public expected to be provided by new chemical substances intended to be manufactured after Agency review. In considering risk, EPA considers factors including environmental effects, distribution, and fate of the chemical substance in the environment, disposal methods, waste water treatment, use of protective equipment and engineering controls, use patterns, and market potential of the chemical substance.*

What does this mean with respect to the acceptable level of cancer risk for workers manufacturing a new chemical or consumers who might be exposed to it? The USEPA has not published a clear statement on acceptable risk under TSCA, but the cases described

TSCA – 1976	
Health based standards	✓
Balancing standards	✓
Technology based standards	✓

below shed some light on the question[4]. The first is a publication by an Agency official early in the TSCA program regarding the determination of acceptable risks under TSCA, and the second, the USEPA's explanation of how it derives limits for worker exposure to new chemicals under TSCA.

In 1983, a USEPA official indicated that the objective is to reduce risks to an "insignificant" level but that the USEPA did "not employ any predetermined statistical risk level since this will vary depending on a variety of factors." (Todhunter 1983). In other words, at that time "unreasonable risk" did not correspond to a benchmark level or range (such as 10^{-4} to 10^{-6}). The USEPA has not apparently published anything since that time to suggest that a benchmark level exists under TSCA, with one exception.

The Agency sometimes sets New Chemical Exposure Limits (NCELs) for new chemicals regulated under TSCA. An NCEL is the concentration that a worker who makes or uses a chemical can be exposed to safely. To derive an NCEL for a potential carcinogen, the USEPA reportedly begins with the policy that a cancer risk of 10^{-4} is acceptable (USEPA 1995). But in some cases the Agency finds that the calculated NCEL may be difficult to attain or monitor. In such cases the risks to workers may be higher than 10^{-4} (Sellers 2015).

2.6 Superfund

CERCLA/ SARA – 1980 / 1986	
Health based standards	✓
Balancing standards	
Technology based standards	

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, defines the significant risks at uncontrolled hazardous waste sites that must be cleaned up. The regulations at 40 CFR 300.430(e)(2)(i)(A) specify that remediation goals shall consider the following:

> *For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response. The 10^{-6} risk level shall be used as the point of departure for determining remediation goals ….*

[4] This discussion is adapted from: Sellers, K., 2015 (in press). *Product Stewardship, Life Cycle Analysis, and the Environment*. (Taylor & Francis/ CRC Press)

2.7 Inconsistent results

The different benchmarks for acceptable risks have led to some striking inconsistencies in the ways in which some chemicals are regulated in the United States Consider the example below, which contrasts risk management decisions under TSCA and the Safe Drinking Water Act (SDWA).

While the USEPA has not published a direct statement under TSCA on what level of risk is acceptable, it is interesting to compare risk-related benchmarks under TSCA to those under the SDWA[5].

When the exposure to a new chemical will be quite limited – or more specifically 'low release and exposure' (LoREX) – the manufacturer or importer can be exempt from TSCA regulations. Regulations at 40 CFR 723.50(2) specify the criteria for the LoREX exemption. They include the case where no exposure in drinking water would exceed a 1 milligram per year (mg/yr) estimated average dosage. While this exemption does not define serious human health effects or significant environmental effects to a degree that helps to explain the concept of "unacceptable risk" under TSCA, it does provide a point of reference: the risks from exposure to any compound at 1 mg/yr in drinking water are anticipated to be acceptable.

The USEPA has also considered the possible risk from chemicals in drinking water under the SDWA. A risk assessor working under USEPA guidelines has typically assumed that an adult drinks 2 liters of water per day (USEPA 2011). An adult drinking 2 liters of water per day for an entire year could drink water containing up to 0.0014 milligrams per liter (mg/L) of a chemical before reaching the LoREX criterion of 1 mg/yr of exposure:

2 liters water / day * 365 days/year * 1 year * 0.0014 milligrams / liter * = 1 mg/yr

The MCLs for 10 chemical (nonradionuclide) substances are below 0.0014 mg/L (USEPA 2013C). Put another way, for 13% of the chemicals regulated under the SDWA (that is, 10/76) the USEPA has found that exposure to 1 mg/yr in drinking water – which is considered to be a negligible exposure under the TSCA New Chemicals program – was not acceptable. If such chemicals were brought onto the market now, they could be exempted from regulation under TSCA.

[5] This discussion is adapted from: Sellers, K., 2015 (in press). *Product Stewardship, Life Cycle Analysis, and the Environment*. (Taylor & Francis/ CRC Press)

2.8 Summary

The level of risk considered to be acceptable varies widely between different federal regulatory programs. The risks we experience at work or by drinking from a public water supply can be on the order of $1x10^{-4}$ or even higher. Under other programs, such as the cleanup of hazardous waste sites, a risk level of $1x10^{-6}$ is the point of departure for determining the goals for cleanup though as long as excess lifetime cancer risk is equal to or less than $1x10^{-4}$ a site generally does not require cleanup. Perhaps most relevant to this discussion are the risk goals set under the Clean Water Act. Federal water quality criteria are typically based on a risk of $1x10^{-6}$; the USEPA has noted that criteria based on a 1/100,000 risk are acceptable for the general population as long as groups of people who may be more highly exposed (such as subsistence anglers) would encounter a risk less than or equal to $1x10^{-4}$.

3. Estimating risks: importance of underlying assumptions

The preceding paragraphs described the variation in one important assumption, the level of acceptable risk. That value may vary from 10^{-7} to more than 10^{-3}, depending upon the regulatory program and the context of the decision. Risk assessors must make other assumptions to estimate the possible risks from exposure to chemicals in the environment. These include assumptions about the degree of exposure. To illustrate the range of assumptions that can be factored into calculations of risks, Section 3.1 describes fish consumption estimates. Section 3.2 describes the effects of compounding a series of assumptions, if the assessor selects the most conservative value for each.

3.1 A closer look at one critical assumption: fish consumption

Calculations of the risk from eating fish containing chemicals in the environment typically reflect a simple assumption about the amount of fish eaten by each person per day or per year. But such values represent some complicated variables. Different people eat different amounts of fish. Those fish may come from different places, some very far from the area being considered in the risk assessment. The ways in which fish are cooked can decrease the amount of chemicals in the fish. The assumptions that are made to account for these variables and simplify the calculations can have a big effect on the calculated risk.

> **95th Percentile Values**
> The 95th percentile value for a variable like fish consumption means that 95 out of 100 people eat less fish than that amount.

The amount of fish a person eats every day depends in part on geographic region, age, gender, and body size (USEPA 2011), as well as cultural or taste preferences. Estimates of fish consumption can also vary based on the way in which the fish consumption rate is estimated. A detailed discussion of all of those factors and their effect on fish consumption is beyond the scope of this white paper. But consider the values listed in **Table 6** (Washington State Department of Ecology 2013) for illustration.

Table 6 Variations in fish ingestion rates

Population	Key Variable	Fish	Mean fish ingestion (g/day)	95% Percentile (g/day)
Washington's Model Toxics Control Act (MTCA) Cleanup Regulation	Default fish consumption rate	All	54	
General population, Washington State, consumers only	NCI estimation method	All	19	57
Columbia River Tribes	All sources of fish	All	63	194
Tulalip Tribes	All sources of fish	All	82	268
Squaxin Island Tribe	All sources of fish	All	84	280
Suquamish Tribe	All sources of fish	All	214	797
Recreational Fishers, Washington State	Freshwater	All	6.0 to 22	42 to 67

How do we account for such varying rates of fish consumption in estimating risk and setting protective environmental standards? One way is to incorporate the range of values into risk calculations in a method known as probabilistic risk assessment. Another way is to pick a value for fish consumption that protects the majority of the population at the target excess lifetime cancer risk in order to set a criterion, and then to make sure that the standard represents a reasonable level of risk for more highly exposed groups of people. **Table 7** illustrates the results of a series of hypothetical calculations. It shows how the calculated risk varies with the amount of fish eaten, as described below.

Table 7 Excess Lifetime Cancer Risk versus Fish Consumption Rates

	MTCA Default	Washington State, mean	Washington State, 95th Percentile	Proposed regulation	Suquamish Tribe, 95th percentile
Fish consumption rate (grams per day)	54	19	57	175	797
Excess Lifetime Cancer Risk	1E-05	4E-06	1E-05	3E-05	1E-04
	3E-05	1E-05	3E-05	9E-05	4E-04
	9E-06	3E-06	1E-05	3E-05	1E-04
	3E-06	1E-06	3E-06	1E-05	5E-05
	7E-07	2E-07	7E-07	2E-06	1E-05

Five values are shown for fish consumption rate. These five values for the amount of fish that people in Washington might eat every day cover the range of values shown previously in Table 6. Included in Table 7 are the amounts eaten by fish consumers throughout Washington as represented by the MTCA default value, fish consumers throughout Washington as represented by the mean rate of consumption and the 95th percentile, and the value of fish consumption included in the proposed criteria. The table also includes the amount eaten by members of the Suquamish tribe at the 95th percentile, who eat the largest amounts of fish of all the people in Washington State (Washington State Department of Ecology 2013).

The rows labelled excess lifetime cancer risk in Table 7 show how the calculated risk varies with the amount of fish eaten. In each row, the shaded box shows the group that was “assigned” a $1x10^{-5}$ (or 1E-05) risk. For example, calculations summarized in the first excess lifetime cancer risk row started with the assumption that the risk to people eating 54 grams per day of fish (Washington State MTCA default value) should be no more than $1x10^{-5}$ or 1E-05. The risk to the group that eats the most fish (Suquamish Tribe, 95th percentile) would then be no more than $1x10^{-4}$ or 1E-04 if all of the other variables in the calculation remained the same. Similarly, the last row in the table shows that if one were to base a standard on a $1x10^{-5}$ (or 1E-05) risk level to the most highly exposed people in the Suquamish Tribe (95th percentile) then the general population of fish eaters would be protected at the $7x10^{-7}$ level.

What do these calculations mean with respect to public policy? Water quality criteria based on the mean fish consumption rate in Washington and an excess lifetime cancer risk of 1E-05 present a risk that, even to the most highly exposed populations, is within the acceptable range as defined by USEPA (2000). The default fish consumption rate does not need to be raised to 175 grams per day to protect the people of Washington State from unreasonable risk.

3.2 Compounded conservatism

Conservative assumptions add up. If a decision maker chooses a conservative value for every variable in a risk calculation, the results will be far more protective than intended. Consider the hypothetical example of a risk assessment that is based on three independent and log-normally distributed parameters (Burmaster and Harris 1993). In the case of a fish consumption calculation, those parameters might be the amount of fish eaten each day, body weight, and the number of years over the course of a lifetime that people live in a certain place and eat fish from a local source. Each value represents the 95th percentile, or in other words that 9,500 out of 10,000 people have a lower exposure: they eat less fish, or do not eat fish from a stream for as many years, for example. Combining those three variables would result in a risk estimate that would fall at the 99.78th percentile of the resulting distribution. The risk to 9,978 out of 10,000 people would be lower than the allowable risk level used to establish the standard. Decisions made on the basis of this hypothetical calculation, which compounds conservative factors, would be far more protective than perhaps originally planned by the decision maker who intended to protect the average member of the population (or the 90th percentile or even the 95th percentile of the population) at the selected allowable risk level.

This may look like an academic calculation. Some readers may think that overestimating risks is a good thing because it allows us to be extra-cautious, and that regulatory decisions based on risk estimates should be as conservative and protective as possible. But the consequences of such choices also need to be considered. There's a cost to reducing the levels of chemicals in the environment to meet more-stringent limits, a cost that may be measured in dollars, energy usage, or the risk of injury to workers who have the job of reducing the levels of those chemicals. Chemicals may be used to treat wastewater to meet lower standards, for example, and the sludge that results has to be trucked to a landfill or incinerated. Generating the power used to operate the wastewater treatment plant uses natural resources and creates air emissions. Each of these aspects of the life cycle of wastewater treatment operations, and their related risks, should be weighed against the value of regulatory decisions based on compounded conservatism.

Compounding the use of a high fish consumption rate, long duration of residence, upper percentile drinking water rate, and other high-end assumptions to estimate risks with a low target excess lifetime cancer risk will result in a water quality standard that is far more protective of the vast majority of the population than reflected by the target excess lifetime cancer risk. That additional degree of protection must be weighed against the risks and environmental impacts that would result from the additional treatment needed to meet such a standard.

4. Environmental Justice considerations

Environmental justice is, in the words of USEPA (2014),

> *… the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. …. It will be achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work.*

But how do we know what's fair treatment? The USEPA (2006) has developed guidelines relevant to risk-based decision-making. After defining the problem to be solved and collecting relevant information, we are to assess the potential for "adverse" environmental and human health effects or impacts, and to assess the potential for "disproportionately high and adverse" effects or impacts before deciding on a course of action.

Within the context of setting HHWQC within the State of Washington and the discussion in this white paper, the adverse human health effect of particular concern is cancer. At issue is whether the higher rates of fish consumption by Native Americans could lead to a disproportionate and unfair risk. The proposed criteria reflect two key assumptions: that citizens in Washington State consume 175 g/day of fish, and that $1x10^{-5}$ is the maximum acceptable level of risk. These two assumptions are each conservative and they need not be compounded in order to achieve environmental justice.

As demonstrated in Table 7, a standard based on the premise that those eating an average amount of fish each day would be protected to $1x10^{-5}$ risk level would assure that even the most highly exposed population, represented by the 95th percentile of the Suquamish Tribe, would encounter a risk of $1x10^{-4}$. Such a risk would not be "disproportionately high and adverse". As indicated in Section 2.2,

> *EPA also believes that criteria based on a 10^{-5} risk level are acceptable for the general population as long as States and authorized Tribes ensure that the risk to more highly exposed subgroups (sportfishers or subsistence fishers) does not exceed the 10^{-4} level.*

Further, the 10^{-4} risk level is embedded in many other standards, including drinking water; our standards for protecting workers on the job reflect the judgment that a 10^{-3} risk is acceptable. As a society, we accept that level of risk as reasonable.

Increasing the assumed amount of fish consumption or capping the acceptable level of risk is not necessary to develop standards that correspond to risks within acceptable bounds. Nor is it necessary to achieve environmental justice.

5. Putting environmental risks in perspective: every day risks

Consider how a $1x10^{-6}$ lifetime risk of developing cancer compares to risks we face in our daily lives. For ease of discussion, we can refer to mortality risks in terms of micromorts[6], units representing a one in one million chance of death. For example, one micromort is the risk incurred by the average person driving 240 miles in the United States. The micromort allows different kinds of risk to be compared on a similar scale. Motorcycling 20 miles or undergoing anesthesia are equivalent to 5 micromorts apiece, skydiving or running a marathon are equivalent to 7 micromorts apiece, and giving birth in the United States is equivalent to 210 micromorts (Blastland and Spiegelhalter 2014). When we compare a lifetime risk of developing cancer to such micromorts, we need to keep two important distinctions in mind. Not all cancers are fatal. And many of the micromort statistics described below represent the risk of death *each year*, not over the course of a lifetime.

In 2010, approximately 140,000 people died in the United States from unintentional injury-related deaths (e.g., poisoning, motor vehicle traffic, firearms, falls) (Murphy et al. 2013). This means that given a total population of 300 million people, the average American faced an unintentional injury-related mortality risk of approximately 467 micromorts per year in 2010, or 1.3 micromorts per day. In other words, about 413

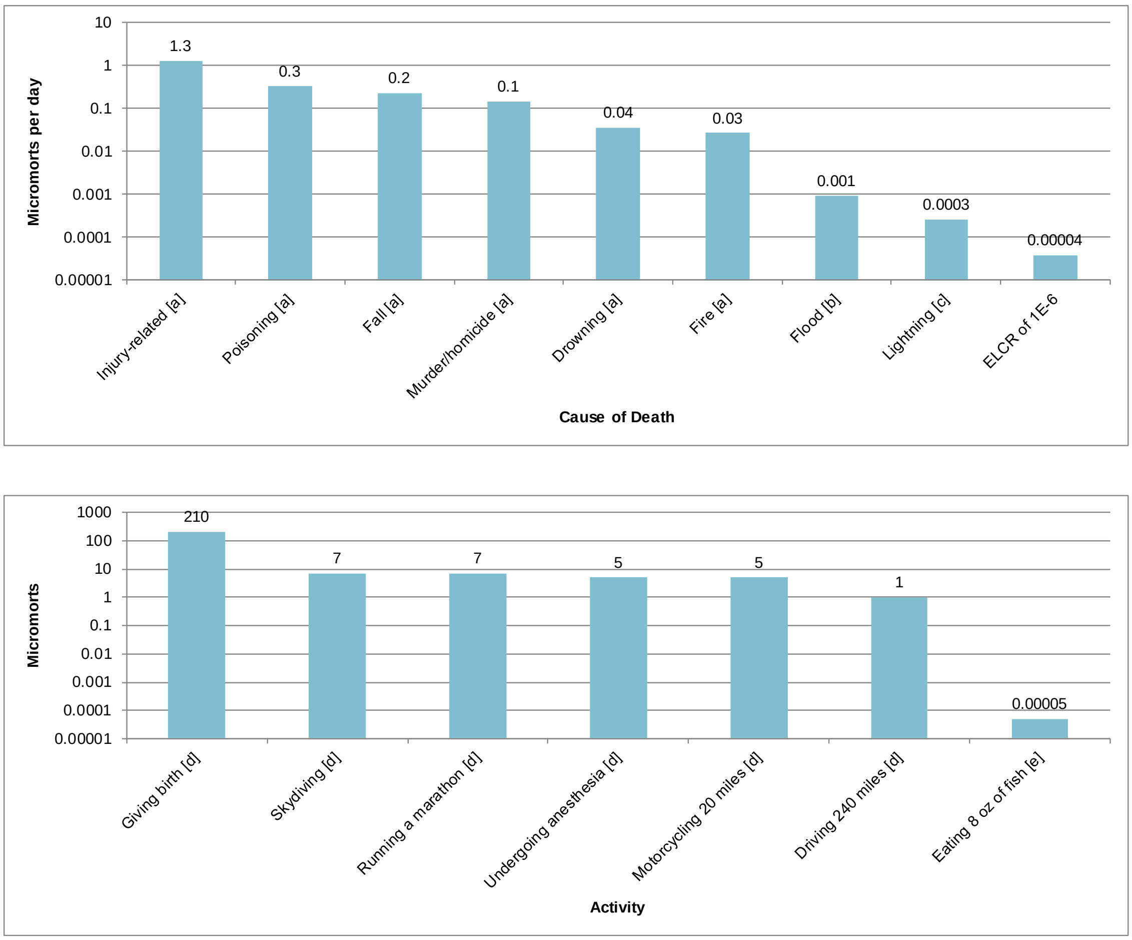
[6] A micromort is a unit of risk that represents a one-in-a-million ($1x10^{-6}$) probability of death. Risk assessors use micromorts to characterize and compare the riskiness of various day-to-day activities.

people die each day from an unintentional injury. This means that *every day*, *every American* has a risk of slightly greater than $1x10^{-6}$ of dying from unintentional injury.

Compare this to an excess lifetime cancer risk of $1x10^{-6}$, which (if we assume a lifetime corresponds to 70 years as does USEPA) translates to a worse-case 0.01 micromorts per year or 0.00004 micromorts per day; this is worse case from the perspective that not all cancers are fatal and the risks estimated by risk assessments are *upper bound estimates* of risk and *do not* represent *actual* risks. Thus, USEPA's definition of "acceptable" risk is several orders of magnitude below the average American's daily risk of dying from an unintentional injury; it is also approximately 3,500 times lower than the 2010 risk of dying from a murder/homicide (16,259 deaths or 0.1 micromorts per day), 20 times lower than the 2010 risk of dying from a flood (103 deaths or 0.001 micromorts per day) and 10 times lower than the 2010 risk of dying from a lightning strike (29 deaths or 0.0003 micromorts per day) in the United States (Murphy et al. 2013; NOAA 2014a,b) (**Figure 2**). This is consistent with the concept of $1x10^{-6}$ being a *de minimus* level of risk, because risks within this range are not risks that most members of the general public are concerned with and attempt to actively avoid.

Consider next that many regulatory agencies employ the USEPA-recommended $1x10^{-6}$ risk level to deriving HHWQC that relies on conservative upper-end values to estimate exposure. If one were to derive organism-only HHWQC by selecting a fish consumption rate of 175 g/day and targeting a risk level of $1x10^{-6}$, this means that a person would need to consume approximately 4,500 kilograms of locally-caught fish in his or her lifetime just to reach this *de minimus* level of risk, assuming ambient water always contains chemicals present at the resulting HHWQC. This also means that the risk associated with a single meal of fish would be $5x10^{-11}$, or 0.00005 micromorts, which for perspective should be noted is 20,000 times lower than the risk an average person faces when driving 250 miles in the United States (1 micromort) (**Figure 2**). Given that 175 g/day is an upper-end consumption rate estimate, the average member of the population would have an excess lifetime cancer risk lower than $1x10^{-6}$. For example, if we assume the average member of the population eats 8 g/day of fish, he or she would have an excess lifetime cancer risk of $5x10^{-8}$, roughly 20 times lower than the high-end consumer. If, on the other hand, one were to derive organism-only HHWQC by selecting an average fish consumption rate of 8 g/day and targeting a risk level of $1x10^{-6}$, the high-end consumer eating 175 g/day would have an excess lifetime cancer risk of $2x10^{-5}$, higher than $1x10^{-6}$ but still nearly an order of magnitude below the level USEPA (2000) recommends for highly exposed populations. Risk managers must make decisions such as these, recognizing that if highly exposed individuals are protected at $1x10^{-6}$, the average member of the population – and in fact the majority of the population itself – will have risks well below this *de minimus* level.

Figure 2 Common Risks Expressed as Micromorts



Notes:

[a] Murphy et al. (2013)

[b] NOAA (2015a)

[c] NOAA (2015b)

[d] Blastland and Spiegelhalter (2014)

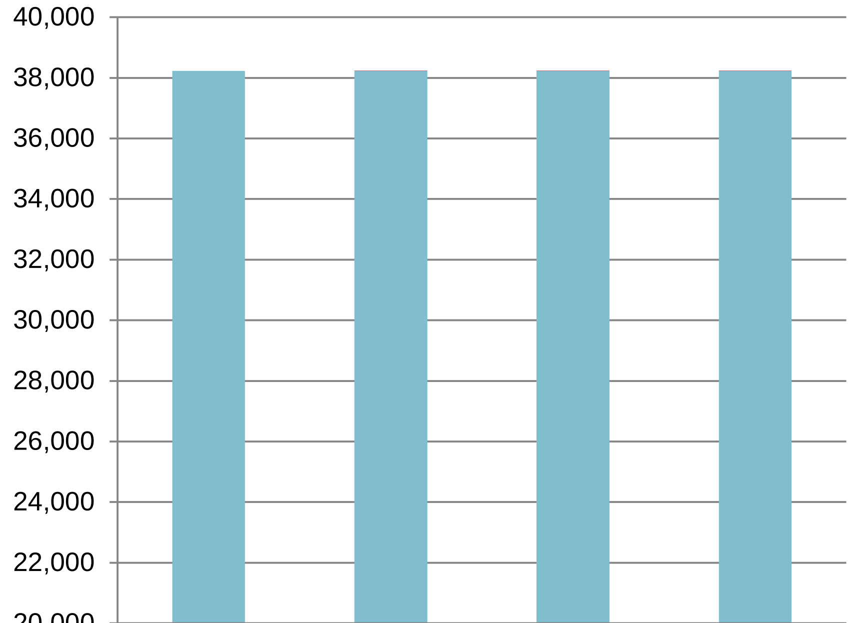
[e] Assuming organism-only AWQC are based on a fish consumption rate of 175 grams per day and risk level of $1x10^{-6}$.

Another perspective when thinking about allowable risk is to consider the reduction or change in cancers associated with a particular allowable risk level. Allowable risk levels that result in large reductions in expected cancers clearly have a greater public health benefit than allowable risk levels that result in little change. The average excess lifetime cancer risk can be combined with the estimated size of the population of Washington (7,061,530 in 2014) and the cancer rate in Washington in 2014 (38,230 new cancers) to see how large of a change in incidence is associated with using various allowable risk levels to set regulatory standards such as water quality criteria[7]. **Figure 3** shows that comparison.

The comparison illustrated in Figure 3 demonstrates that the annual increased incidence of cancer in the state of Washington associated with various alternative allowable cancer risks is very small when compared to the baseline incidence of cancer. This is true even at an allowable lifetime risk of $1x10^{-4}$ where 1 (and for the reasons described above, almost certainly less than 1) additional cancer may occur in the State compared to the 38,230 cased diagnosed in 2014. The change is two thousandths of a percent in overall incidence. Clearly, compared to total cancer incidence, the increases in cancers associated with the above allowable risk levels are small and are swamped by other causes of cancer. This finding is consistent with the comparisons of mortality risk associated with various allowable risk levels to mortality risk from various activities that are part of everyday life shown above.

[7] Assumptions used when deriving most criteria represent an upper percentile of the exposed population, not the average person in the population. To estimate the increased state-wide cancer incidence an average excess lifetime cancer risk needs to be used otherwise increased state-wide incidence will be overestimated. Based on the work we have completed using probabilistic approaches, criteria derived using the typical deterministic approach may overestimate the potential risk to an average member of the population by 10, 100, or more fold. Because a probabilistic evaluation of the proposed Washington criteria is beyond the scope of this paper an exact estimate of the excess lifetime cancer risk for an average Washingtonian could not be developed. However, we do know that the average Washingtonian eats about 19 grams of fish per day, not 175 as assumed by the proposed criteria. Therefore, that assumption ***by itself***, results in a nearly 10-fold overestimate of excess lifetime cancer risk for the average Washingtonian. Use of other conservative assumptions in the derivation of the proposed criteria means that the excess lifetime cancer risk for the average Washingtonian is more than 10-fold lower than the allowable excess lifetime cancer risk used to derive the proposed criteria. Based on the difference between the average fish consumption rate and the 175 grams per day assumed by proposed criteria, the increased incidence of cancers associated with different excess lifetime cancer risks was estimated by multiplying the expected annual cancer incidence associated with each of the excess lifetime cancer risks by the ratio of consumption rates (19 g/d/175 g/d = 0.109). The adjusted incidence of cancers based on a conservative estimate of excess lifetime cancer risk for the average Washingtonian are shown in Figure 3.

Figure 3 Comparison between Total Cancer Incidence and the Hypothetical Excess Annual Cancer Incidence Associated with Various Allowable Risk Levels



	Baseline	1E-06	1E-05	1E-04
Hypothetical Excess Cancers	0	<1	<1	1
Total Cancers	38,230	38,230	38,230	38,231

6. Health benefits of fish consumption

Finally, risk managers should also consider how the risks incurred from eating fish compare to the benefits gained. Researchers and public health officials have been aware for several decades that consumption of fish has associated with it many benefits. Early comparisons of those benefits to the potential risks associated with exposure to possible chemicals in the environment suggested that the benefits (specifically the reduced risk of mortality from coronary heart disease) far outweighed any increased cancer risks that might be associated with the allowable risk levels used in the derivation of HHWQC (e.g., $1x10^{-6}$, $1x10^{-5}$, and $1x10^{-4}$) (Anderson and Weiner 1995, Patterson 2002, Daviglus et al. 2002, Dourson et al. 2002, Anderson et al. 2002). A great deal of research continues on the health benefits and risks of consuming fish with measurable levels of chemicals. A literature search of publications since 2005 revealed over 400 citations, including three recent reviews by expert panels or recommendations by regulatory agencies (Nesheim and Yaktine 2007, WHO 2011, EFSA 2014). All of those recent expert reviews and regulatory agency recommendations continue to urge that people regularly consume fish. In fact, in the recommendation is that the general population eat 1 to 2 meals per week and that pregnant women eat 2 to 4 meals per week because of the benefits to the infants they are carrying (EFSA 2014). Such benefits almost always outweigh the possible risks of chemical exposure.

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A REVIEW OF METHODS FOR DERIVING HUMAN HEALTH-BASED WATER QUALITY CRITERIA WITH CONSIDERATION OF PROTECTIVENESS

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CONTENTS

APPENDICES

TABLES

AN OVERVIEW OF PARAMETERS USED IN THE DERIVATION OF EPA HUMAN HEALTH AMBIENT WATER QUALITY CRITERIA

1.0 EXECUTIVE SUMMARY

Consistent with the requirements of the Clean Water Act, states are obligated to establish numeric water quality criteria for toxic substances and to periodically consider the need for revisions to those criteria. Toxics criteria are designed to protect both resident aquatic life and humans exposed via drinking water, consumption of fish, and/or dermal contact. Criteria for the protection of human health (i.e., Human Health Ambient Water Quality Criteria, or HHAWQC) are traditionally derived using EPA-recommended equations that include parameters for risk, toxicity, and exposure. The values used for these parameters are revisited and adjusted periodically in response to the availability of new science and shifts in policy.

The material presented in this paper includes an overview of the derivation procedures for HHAWQC, focusing especially on the selection of values for the parametric components in the HHAWQC derivation equations. Particular attention is given to the use of conservative (i.e., over-protective) choices for multiple parameter values and the overall effect of compounded conservatism on the resulting criteria relative to health protection targets established by state and federal agencies.

1.1 Parameters Used in HHAWQC Derivation and Frequently Used Values

The equations used to derive HHAWQC are composed of explicit parameters (i.e., those that are listed and defined), and implicit parameters (i.e., those that are embodied with the application of the explicit parameters). The equations and rationales for selection of specific parameter values were developed by EPA more than twenty years ago and while updates in parameter values have been made periodically, the basic methodology remains unchanged. **Table 1.1** lists the explicit and implicit parameters used in the HHAWQC derivation. Also shown are typical parameter values recommended by EPA. The third column in the table provides an indication regarding whether the typical value reflects a central, upper-end, or maximum in the range of values that could be chosen for each parameter. It is clear from the table that, in nearly every case, the typical values used for explicit and implicit parameters are selected from the upper end of the range of possible values.

It is well-known, and mathematically intuitive, that the practice of selecting "upper end of range" values for multiple parameters in a risk equation will lead to over-conservative estimates of risk or, in the case of HHAWQC, overly restrictive criteria. Indeed, EPA's Risk Assessment Task Force has suggested that "when several parameters are assessed, upper-end values and/or central tendency values are generally combined to generate a risk estimate that falls within the higher end of the population risk range" and "an exposure estimate that lies between the 90^{th} percentile and the maximum exposure in the exposed population [should] be constructed by using maximum or near-maximum values for one or more of the most sensitive variables, leaving others at their mean values" (EPA 2004). This concept, however, has not been embraced in the current practice for deriving HHAWQC.

Table 1.1 Parameter Values used in HHAWQC Derivation and Location in the Range of Possible Values

Parameter	Typical Value	Location in Range of Possible Values[1] (maximum possible, upper-end, or central tendency)
Explicit Parameters		
substance toxicity	substance-specific	upper-end
body weight of a person	70 kg (actual mean is 80kg)	central tendency
drinking water intake	2 L/day (86th percentile), but assumes drinking water is untreated surface water	(extreme) upper-end
fish ingestion/consumption rate	17.5 g/day (90th percentile of sport fishers)	upper-end
substance exposure from other sources	80%	upper-end
Implicit Parameters		
cooking loss	0% (no loss due to cooking)	maximum possible
duration of exposure	70 years	(extreme) upper end
exposure concentration	at HHAWQC 100% of the time	maximum possible
relative bioavailability	1	maximum possible
bioaccumulation/concentration factor of fish	substance-specific	substance-specific (not evaluated)

[1]"maximum possible" would be the most conservative (over protective) choice possible, "upper-end" a very conservative choice, and "central tendency" a typical or average value for a population. "Extreme" denotes a value that is very near maximum.

1.2 Degree of Conservatism in HHAWQC

Section 6 of this report details the degree of protectiveness, conservatism, and the combined effect of conservative parameter value choices in the derivation of HHAWQC. The information provided shows that the values commonly used for each parameter can have the effect of lowering the calculated HHAWQC by large factors. For example:

- substance toxicity values are commonly reduced by 10 to 3000 times below demonstrated toxicity thresholds as a means of ensuring protection of human health
- assumptions about chemical exposure via drinking water results in some criteria being as much as 30 times lower than needed to afford the degree of protection targeted by most states and EPA

- the assumption that a person lives in the same place and is exposed to the same level of contamination for a 70 year lifetime results in criteria that are up to 8 times more stringent than if a median exposure period were assumed
- the assumption that waters would exist at the allowable HHAWQC for 70 years is in opposition to water management policies in virtually all states and results in criteria values that are 1.5 to 6 times more stringent than would be the case if actual water quality management practices were considered

Each of the factors listed above, and several others discussed in more detail in the following sections, can combine (i.e., compound) when applied in the same calculation, such as that used for deriving HHAWQC. The result is criteria that are many times lower than would be the case if the advice of the Risk Assessment Task Force regarding use of upper range values for one or more sensitive values and leaving others at their mean values (EPA 2004) were followed.

1.3 Comparison of HHAWQC with other Regulatory Mechanisms for Human Health Protection

The summary above, and supporting sections of this report, offer observations suggesting that HHAWQC are considerably more protective (i.e., lower in concentration, or over-protective) than are necessary to achieve the health protection targets described by EPA and many state environmental agencies. Section 7 of this report considers other evidence that might confirm or refute this observation. It contains a comparison of fish tissue concentrations corresponding to EPA recommended HHAWQC with (a) existing fish tissue concentration data, (b) concentrations found in other foods, and (c) allowable concentrations (such as fish consumption advisory “trigger levels”) set by other US and international health agencies.

Findings from this comparison support the observation that HHAWQC are over-protective. Specifically:

- For higher assumed fish consumption rates and based on EPA fish tissue data, virtually all surface waters in the US would exceed the HHAWQC for PCB, mercury, and likely a number of other substances. In contrast, for example, health agencies have established fish consumption advisories for PCBs on only about 15% of water bodies (Appendix C) indicating that assumptions used by EPA are more conservative than the assumptions used by state agencies to derive fish consumption advisories.
- A comparison of the daily intake of several example substances for which HHAWQC exist, showed that intakes from other foodstuffs was greater than from fish and was already exceeding the allowable intakes used to establish HHAWQC. Thus, establishment and enforcement of more stringent HHAWQC may not provide a measureable public health benefit.
- Various federal and international agencies have established concentration limits for fish as a food in commerce. Levels set by these agencies (whose goal is to insure the safety of edible fish) show that EPA HHAWQC are limiting fish tissue concentrations to levels substantially (10s to 1000s of times) below those considered to be without significant risk.

1.4 Other Observations

Other observations from this review are noted as follows.

- Target cancer risk levels between 10^{-6} and 10^{-4} have become widely accepted among the different EPA programs, including the derivation of HHAWQC. The HHAWQC methodology document states that a risk level of 10^{-4} for highly exposed populations is acceptable (EPA 2000a). This is sometimes interpreted as meaning that highly exposed populations are not as well protected by the HHAWQC. However, as noted by Kocher (1996) "if only a small population would be at greatest risk, the expected number of excess cancers corresponding to individual risks at the *de minimis* level of 10^{-4} would still be [essentially] zero."

- The fish consumption rates used in calculating HHAWQC can have a significant impact on the resulting HHAWQC. This is because the HHAWQC are proportional to the fish consumption rates - as the rate increases, the HHAWQC decreases, and the decrease is particularly pronounced for high BAF/BCF substances. Potential exposure through the fish consumption pathway is dependent upon a number of different variables including the types of fish consumed, the sources of those fish (particularly anadromous fish such as salmon, see Appendix B), and the rates at which they are consumed, all of which vary widely among the population. The quantification of fish consumption rates is complicated by the methods used to collect consumption information, the interpretation of such data (particularly extremes in the distribution of individual consumption rates obtained from survey data), the availability of fish from regulated sources, and the habits of the targeted population of fish consumers. Without extreme diligence in data interpretation, most of these complications are likely to manifest in overestimations of fish consumption rates.
- The selection of some exposure parameters are unrealistic because, as a practical matter, other environmental management programs would ensure that such conditions did not occur (or would not persist for a person's lifetime). Assumptions concerning ambient water column concentrations (and related fish tissue concentrations) and drinking water concentrations are examples.

Finally, it is noteworthy that the values used for parameters in a health risk equation like that for deriving HHAWQC involve a combination of science and policy choices. And, while evolving science and policy may sometimes indicate that revisiting these choices is warranted, responsible evaluation of risk (and thus protection of health) is best considered in total rather than by simple alteration of a single parameter value without due consideration of the others. The information presented herein suggests that the degree of protection embodied in the current HHAWQC derivation method, using typically applied values for each parameter, exceeds by a large margin the health protection targets expressed by EPA and many states.

2.0 INTRODUCTION

Section 304(a) (1) of the Clean Water Act (CWA) requires the United States Environmental Protection Agency (EPA) to develop and publish recommended numeric ambient water quality criteria (AWQC) for limiting the impact of pollutants on human health and aquatic life. These recommended human health-based AWQC (HHAWQC) are intended to provide guidance for states and tribes to use in adopting their own water quality standards and are meant to "minimize the risk of adverse effects occurring to humans from chronic (lifetime) exposures to substances through the ingestion of drinking water and consumption of fish obtained from surface waters" (EPA 2000a). Water quality criteria recommendations are derived by EPA using equations that express a risk analysis. The value of each parametric component of the criteria equations represents policy choices made by the Agency, though several of those choices are derived from scientific data (EPA 2011a).

In a staff policy paper from the Office of the Science Advisor, EPA discussed the bases for these policy choices (EPA, 2004). They noted that "Congress establishes legal requirements that generally describe the level of protectiveness that EPA regulations must achieve" and that individual statutes identify the risks that should be evaluated and protected against and also mandate the required levels of protection (EPA 2004). The Clean Water Act, which mandates the development of AWQC, simply requires that AWQC must "protect the public health or welfare, enhance the quality of water and serve the purposes of this Act" and "be adequate to protect public health and the environment from any reasonably anticipated adverse effects of each pollutant." In order to meet these requirements, EPA "attempts to protect individuals who represent high-end exposures (typically around the 90th percentile and above) or those who have some underlying biological sensitivity" (but not hypersensitive individuals) (EPA 2004). EPA (2004) notes that "[p]rograms may approach the problem semi-quantitatively (e.g., selecting individual parameter values at specified percentiles of a distribution) or qualitatively (e.g., making conservative assumptions to ensure protection for most individuals), though no overall degree of protection can be explicitly stated."

While EPA is obligated to develop and publish AWQC guidance, adoption and implementation of criteria for most fresh waters in the U.S. is an activity mandated to states. Many states choose to adopt EPA's AWQC guidance values but states are free to depart from EPA's criteria guidance provided that there is a scientifically valid rationale for doing so. Departure from the EPA AWQC guidance values is commonly accomplished by altering one or more of the values used to represent the parametric components of the risk analysis equation used to derive the criteria guidance values.

This document contains a discussion of each parametric component of the risk analysis equation that is used to derive HHAWQC. As noted earlier, selection of parameter values for risk analyses is primarily a policy choice and it is typical that such choices are conservative in favor of protecting public health. The combined degree of conservatism embodied in the final AWQC guidance is not usually expressed quantitatively by EPA. The primary purpose of this document is to provide an exploration of the combined conservatism that may be embodied in AWQC calculated using typically chosen values for the explicit parametric components of the HHAWQC equation and use of implicit assumptions also embodied in the criteria derivation.

3.0 EQUATIONS USED FOR THE DERIVATION OF HHAWQC

In calculating HHAWQC, EPA differentiates between carcinogenic and noncarcinogenic effects. Three risk analysis equations are used, the first for noncarcinogenic effects, the second for carcinogenic effects that are assumed to have a nonlinear dose-response, and the third for carcinogenic effects that are assumed to have a linear dose-response. These are shown in Table 3.1.

Table 3.1 Equations for Deriving Human Health Water Quality Criteria

Substance Category	HHAWQC Equation	Eq. #
Noncarcinogenic effects	$RfD*RSC*(BW/(DI + (\Sigma FI_i*BAF_i)))$	**Eq. 3.1**
Carcinogenic effects (non-linear)	$(POD/UF)*RSC*(BW/(DI + (\Sigma FI_i*BAF_i)))$	**Eq. 3.2**
Carcinogenic effects (linear)	$RSD*(BW/(DI + (\Sigma FI_i*BAF_i)))$	**Eq. 3.3**

where:

HHAWQC = human health ambient water quality criterion (mg/L);

RfD = reference dose for noncancer effect (mg/kg-day);

RSC = relative source contribution factor to account for non-water sources of exposure (typically expressed as a fraction of the total exposure);

POD = point of departure for carcinogenic effects based on a nonlinear low-dose extrapolation (mg/kg-day), usually a LOAEL, NOAEL, or LED_{10};

UF = uncertainty factor for carcinogenic effects based on a nonlinear low-dose extrapolation (unitless);

RSD = Risk-specific dose for carcinogenic effects based on a linear low-dose extrapolation (mg/kg-day) and on the selected target risk level;

BW = human body weight (kg);

DI = drinking water intake (L/day);

FI_i = fish intake at trophic level (TL) i (i = 2, 3, and 4); this is the fish consumption rate (kg/d); and

BAF_i = bioaccumulation factor at trophic level i, lipid normalized (L/kg)

The first portion of each equation in Table 3.1 contains parameters that represent a measure of the toxicity of a substance and are unique to each equation. The latter portion of each equation is common for the three substance categories and describes assumed human exposure to a substance. Implicit, and not obvious, with the practice of using these equations are other assumptions concerning exposure (i.e., a duration of exposure equal to a full lifetime, an average ambient water concentration equal to the HHAWQC, and bioavailability of chemicals from fish and water equal to that observed in the toxicity experiment). Finally, and also not obvious, is that an assumed incremental risk of illness is also part of the overall algorithms. Taken collectively, these explicit and implicit elements yield a risk analysis in the form of an acceptable water column concentration for a substance.

Although the parameters in the risk equations used for deriving a HHAWQC are most accurately represented by a range or distribution of values, it has been typical for EPA to select a single value for each parameter. EPA has recognized that there are elements of both variability and uncertainty in each parametric value but has generally not implemented specific procedures to account for variability and uncertainty. However in some cases, EPA has intentionally chosen parametric values that are conservative (i.e., over-, rather than under-, protective of human health) with respect to the general population.

The sections below discuss the parametric components of the toxicity portion (Section 4) and the exposure portion (Section 5) of each equation in Table 3.1. Section 6 includes discussion of variability and uncertainty in parameter values and, where evident, conservatism embodied in typical choices made for parameter values. Also in Section 6, consideration is given to the combined effect on conservatism of typical parameter value choices in HHAWQC derivation.

4.0 TOXICITY PARAMETERS USED FOR DERIVATION OF HHAWQC

Each of the three equations used to develop HHAWQC contains a factor that represents the toxicity of the substance of concern. Equation 3.1 (Table 3.1), which is used for non-carcinogenic effects, employs the reference dose (RfD), the derivation of which incorporates various uncertainty factors (UFs) and sometimes an additional modifying factor (MF). Equation 3.2 (Table 3.1), which is used for carcinogenic effects that have a nonlinear dose-response curve (i.e., there exists some level of exposure below which no carcinogenic response is expected to occur), employs a factor calculated by dividing the "point of departure" (POD) by UFs. Equation 3.3 (Table 3.1), which is used for substances that are assumed to have a linear dose-response (i.e., some probability of a carcinogenic response is presumed to exist at any level of exposure), employs a Risk-Specific Dose (RSD). It is EPA's policy to assume that all carcinogenic effects can be described using a linear dose response unless non-linearity has been clearly demonstrated. Typically, if a compound is considered to have both carcinogenic and non-carcinogenic health effects, HHAWQC are calculated for both the cancer and noncancer endpoints and the lower of the two concentrations is selected as the HHAWQC. The derivation of these components is described in the "Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (EPA 2000a) (hereafter referred to as the "HHAWQC methodology document") and its Technical Support Document Volume 1: Risk Assessment" (EPA 2000b).

4.1 Reference Dose (RfD)

A reference dose (RfD) is defined as "an estimate (with uncertainty spanning approximately an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects over a lifetime" (EPA 2000b).

The development of an RfD begins with a review of all available toxicological data. Relevant studies are evaluated for quality and a "critical effect" is identified. The critical effect is defined as "the first adverse effect, or its known precursor, that occurs to the most sensitive species as the dose rate of an agent increases" (EPA 2002a). The underlying assumption is that if the RfD is derived to prevent the critical effect from occurring, then no other effects of concern will occur (EPA 2002a).

The next step is the identification of a POD based on the study in which the selected critical effect has been identified. The POD may be derived from a No Observed Adverse Effect Level (NOAEL), a Lowest Observed Adverse Effect Level (LOAEL) or Benchmark Dose Lower Confidence Level (BMDL). The NOAEL is defined by USEPA as "the highest exposure level at which there are no biologically significant increases in the frequency or severity of an adverse effect between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered adverse or precursors of adverse effects."[1] If a NOAEL cannot be identified, a LOAEL may be used instead. The LOAEL is defined by USEPA as "the lowest exposure level at which there are biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group."[2]

When study data are suitable, the Benchmark Dose BMD approach is sometimes used as an alternative to the NOAEL/LOAEL approach. The BMD is the dose at which the critical effect occurs at a rate 5-10% above the rate observed in the control group (other rates could possibly be used, but 5% or 10% are most common). The BMDL, which is typically the lower 95% confidence limit of the BMD, is used as the POD when the BMD approach is used.

Once the POD is identified, the RfD is derived according to equation 4.1:

$$RfD = POD/(UF_i * MF) \qquad \textbf{Eq. 4.1}$$

where:

RfD = reference dose for noncancer effect (mg/kg-day);

POD = NOAEL, LOAEL, or BMDL (mg/kg-day);

UF_i = uncertainty factors for various circumstances (see Table 4.1) (unitless) ; and

MF = modifying factor (unitless)

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[1] Taken from USEPA's online IRIS glossary (http://www.epa.gov/iris/help_gloss.htm#n)
[2] Taken from USEPA's online IRIS glossary (http://www.epa.gov/iris/help_gloss.htm#n)

Uncertainty factors are used to reduce the dose in order to account for areas of scientific uncertainty in the supporting toxicity databases (EPA 2000b). The standard UFs are 1, 3, and 10. A modifying factor further adjusts the dose in order to provide for additional uncertainty not explicitly included in the UFs, such as the completeness of the overall database (EPA 2000b). The MF is a matter of professional judgment and ranges between 0 and 10, with the standard values being 0.3, 1, 3, and 10 and the default value being 1 (EPA 2000b). Table 4.1 defines the various UFs.

Table 4.1 Uncertainty Factors (adapted from EPA 2000b)

Uncertainty Factor	Description
Intraspecies variation (UF_H)	Accounts for uncertainty associated with variations in sensitivity among members of the same species (e.g., differences in age, disease status, susceptibility to disease due to genetic differences)
Interspecies variation (UF_A)	Accounts for uncertainty involved in extrapolating from animal data to humans; used when the POD is derived from an animal study
Subchronic-to-chronic (UF_S)	Accounts for uncertainty involved in extrapolating from studies with a less-than-chronic[1] duration of exposure; used when the POD is derived from a study in which exposures did not occur over a significant fraction of the animal's or the individual's lifetime
LOAEL-to-NOAEL (UF_L)	Accounts for uncertainty associated with the use of a POD derived from a LOAEL rather than a NOAEL or BMDL
Incomplete database (UF_D)	Accounts for uncertainty associated with the use of an incomplete database to derive the POD, for example, the lack of a study of reproductive toxicity

[1] Chronic Exposure: Repeated exposure for more than approximately 10% of the life span in humans (more than approximately 90 days to 2 years in typically used laboratory animal species).

In application, the various UFs and any MF are multiplied to obtain the final factor by which the POD is to be divided. In general, EPA follows a policy that a final factor greater than 3000 indicates that the existing toxicity database is inadequate to support the derivation of an RfD. In this case, no RfD is calculated (EPA 2002a).

Although instructions for calculating an RfD are provided in the documentation for HHAWQC, in actual practice, the RfD is typically obtained from EPA's IRIS database (http://www.epa.gov/iris/).

4.2 Cancer Effects: Nonlinear Low-Dose Extrapolation

In deriving a HHAWQC, a nonlinear low-dose extrapolation may be used for carcinogenic effects when there are sufficient data available to understand the mode of action (MOA) and conclude that it is nonlinear at low doses (EPA 2005). In practical application, this is interpreted to mean that a threshold of exposure exists below which no carcinogenic response will occur.

For nonlinear carcinogenic effects, the factor representing toxicity in Equation 3.2 is calculated by dividing the POD by UFs. The recommended POD is the Lower Limit on Effective Dose$_{10}$, or LED$_{10}$, which is determined by calculating the lower 95 percent confidence limit on a dose associated with an estimated 10 percent increased tumor or tumor precursor response (EPA 2000b). A NOAEL or LOAEL value from a precursor response may also be used in some cases (EPA 2000b). When animal data are used to determine the POD, the selected dose is converted to a human equivalent dose using a default interspecies dose adjustment factor or a toxicokinetic model. However, as noted above, it is EPA's policy to assume that all carcinogenic effects have a linear dose response unless non-linearity has been clearly demonstrated. Thus, the non-linear low dose extrapolation procedure is rarely used.

The HHAWQC methodology document provides no specific guidance on the selection of UFs (EPA 2000a). Instead, it defers to the "upcoming cancer risk assessment guidelines," which were subsequently released in 2005.

The 2005 Cancer Risk Assessment Guidelines took a somewhat different approach than anticipated by EPA in 2000 when the HHAWQC methodology guidelines were developed. The 2005 guidelines instead recommended that for nonlinear carcinogenic effects, "an oral reference dose…should be developed in accordance with EPA's established practice for developing such values" (EPA 2005). This does not have much practical impact on HHAWQC calculation, as comparison of equations 3.2 and 4.1 reveals that the process for calculating the factor that represents the toxicity of nonlinear carcinogenic effects in HHAWQC derivations is essentially the same as that for calculating an RfD.

Given that (1) the documentation for HHAWQC derivation does not provide complete guidance on the calculation of the POD/UF factor, and (2) the 2005 Cancer Risk Assessment Guidelines took a somewhat different approach than anticipated by the HHAWQC methodology guidelines, in actual practice, the POD/UF factor will be typically be replaced by an RfD for some noncancer endpoint (e.g., a cancer precursor event) obtained from EPA's IRIS database (http://www.epa.gov/iris/).

4.3 Cancer Effects: Linear Low-Dose Extrapolation

In deriving a HHAWQC, a linear low-dose extrapolation is used for compounds that are believed to have carcinogenic potential when the chemical has direct effects on DNA, the MOA analysis indicates that the dose-response relationship will be linear, human exposures or body burdens are already near the doses associated with key events in the carcinogenic process, or there is an absence of sufficient data to elucidate the MOA.

The RSD, which is used in Equation 3.3 (Table 3.1), is derived according to Equation 4.2:

RSD = Target Incremental Cancer Risk/m **Eq. 4.2**

where:

RSD = Risk-Specific dose (mg/kg-day);

Target Incremental Cancer Risk = Typically a value ranging from10^{-6} to 10^{-4}; and

m = cancer potency factor $(mg/kg\text{-}day)^{-1}$

The HHAWQC methodology document (EPA 2000a) states that the Agency will calculate recommended HHAWQC using at a Target Incremental Cancer Risk level of 10^{-6}. However, in deriving their own HHAWQC, states and authorized tribes may choose a risk level as low as 10^{-7} or as high as 10^{-5}, as long as the risk to more highly exposed subgroups (e.g., sport or subsistence anglers) does not exceed 10^{-4}. (The rationale for this is discussed further in Section 6.1.3.)

The cancer potency factor may be calculated by first modeling the relationship between tumor incidence and dose and then selecting a POD (generally the LED$_{10}$). When animal data are used to determine the POD, the selected dose is converted to a human equivalent dose using a default interspecies dose adjustment factor or a toxicokinetic model. Finally, a straight line is drawn between the POD and the origin (zero). The slope of that line, which will be "m" in Equation 4.2, is calculated. If the LED_{10} is used as the POD, m is equal to $0.10/LED_{10}$ (EPA 2000b).

Instructions for calculating m are provided in the documentation for HHAWQC. In actual practice, however, the value of m is typically obtained from EPA's IRIS database (http://www.epa.gov/iris/). Note that EPA terminology has changed somewhat since the HHAWQC methodology document was released and what was referred to as "m" or "cancer potency factor" in the methodology document is more commonly identified as "slope factor" in the IRIS database.

5.0 EXPOSURE PARAMETERS USED FOR DERIVATION OF HHAWQC

As noted above, both explicit and implicit elements are used to yield a risk analysis in the form of an acceptable water column concentration for a substance. This section summarizes each of these elements and the manner in which they are used for deriving HHAWQC.

5.1 Relative Source Contribution (RSC)

When deriving a HHAWQC for noncarcinogenic or nonlinear carcinogenic effects, a factor is included in the equation to account for non-water sources of exposure to a substance. For example, a particular chemical may be found not only in water sources, but also in some food items or in ambient air (from which it could be inhaled). This factor is known as the Relative Source Contribution (RSC) and it acts to reduce the amount of the RfD that is apportioned to water and fish consumption. The rationale for using the RSC factor in calculating a HHAWQC is to ensure that an individual's total exposure does not exceed the threshold level (EPA 2000a).

The HHAWQC methodology document (EPA 2000a) creates an "Exposure Decision Tree" procedure to be used in the selection of an RSC. In the absence of sufficient data to support the use of the Exposure Decision Tree, EPA uses 20% as a default RSC (EPA 2000a). The methodology also sets 80% as the maximum allowable RSC and 20% as the minimum (EPA 2000a). EPA encourages states and authorized tribes to develop alternate RSC values based on local data (EPA 2000a). Although the Exposure Decision Tree approach does theoretically allow for the use of an RSC other than the 20% default, in actual practice, use of values other than the default is very rare.

Note that while the methodology (EPA 2000a) specifies that the RSC value must be between 20 and 80% and states that "EPA intends to use 20 percent of the RfD (or POD/UF), which has also been used in past water program regulations, as the default value," the current EPA HHAWQC are calculated using RSCs ranging from 20 to 100%. This is because many of the HHAWQC remain unchanged from earlier years or have been updated to reflect changes in fish consumption rates or RfD, but were not recalculated using the 2000 methodology.

The RSC factor is not used in the derivation of HHAWQC for carcinogenic effects with linear low-dose extrapolation. For these substances, the only sources considered are drinking water and fish ingestion. This is because for these substances, the HHAWQC is being determined with respect to the *incremental* lifetime risk posed by a substance's presence in water, and is not being set with regard to an individual's total risk from all sources of exposure (EPA 2000a). Thus, the HHAWQC for any substance represents the concentration of that substance in water that would be expected to increase an individual's lifetime cancer risk by no more than the target risk level, regardless of any additional lifetime cancer risk contributed by potential exposures from other sources (EPA 2000a).

5.2 Body Weight (BW)

The HHAWQC methodology document (EPA 2000a) recommends using a default body weight of 70 kg for calculating HHAWQC. This is considered to be a representative average body weight for male and female adults, combined. Adult values are used because the HHAWQC are intended to be protective over the full lifespan. The methodology also notes that 70 kg is used in the derivation of cancer slope factors and unit risks that appear in IRIS and advocates maintaining consistency between the dose-response relationship and exposure factors (EPA 2000a).

5.3 Drinking Water Intake (DI)

EPA recommends using a default drinking water intake rate of 2 L/day, which is believed to represent a majority of the population over the course of a lifetime (EPA 2000a).

The basis for the drinking water intake rate is the 1994-96 Continuing Survey of Food Intake by Individuals *(*CSFII) conducted by the U.S. Department of Agriculture (EPA 2000a). The CSFII survey collected dietary intake information from nationally representative samples of non-institutionalized persons residing in United States households (EPA 2000a). Households in these national surveys were sampled from the 50 states and the District of Columbia (EPA 2000a). Each survey collected daily consumption records for approximately 10,000 food codes across nine food groups (EPA 2000a). This included the number of fluid ounces of plain drinking water consumed and also information on the household source of plain drinking water, water used to prepare beverages, and water added during food preparation (EPA 2000a).

The results of the 1994-96 CSFII analysis indicated that the arithmetic mean, 75th, and 90th percentile values for adults 20 years and older were 1.1, 1.5, and 2.2 L/day, respectively (EPA 2000a). The 2 L/day value selected by EPA represents the 86^{th} percentile for adults (EPA 2000a).

5.4 Fish Ingestion Rate (FI)

Because the level of fish intake in highly exposed populations varies by geographical location, EPA suggests a four preference hierarchy for states and authorized tribes to follow when deriving consumption rates that encourages use of the best local, state, or regional data available (EPA 2000a). The four preference hierarchy is: (1) use of local data; (2) use of data reflecting similar geography/population groups; (3) use of data from national surveys; and (4) use of EPA's default intake rates (EPA 2000a).

EPA's first preference is that states and authorized tribes use the results from fish intake surveys of local watersheds within the state or tribal jurisdiction to establish fish intake rates that are representative of the defined populations being addressed for the particular waterbody (EPA 2000a). EPA also recommends that the fish consumption rate used to develop the HHAWQC be based only on consumption of freshwater/estuarine species (EPA 2000a). In addition, for noncarcinogens and nonlinear carcinogens, any consumption of marine species of fish should be accounted for in the calculation of the RSC (EPA 2000a). States and authorized tribes may use either high-end values (such as the 90th or 95th percentile values) or average values for the population that they plan to protect (e.g., subsistence fishers, sport fishers, or the general population) (EPA 2000a).

If surveys conducted in the geographic area of the state or tribe are not available, EPA's second preference is that states and authorized tribes consider results from existing fish intake surveys that reflect similar geography and population groups (e.g., from a neighboring state or tribe or a similar watershed type) (EPA 2000a). As with the use of fish intake surveys of local watersheds, consumption rates based on data collected from similar geographic and population groups should be based only on consumption of freshwater/estuarine species with any consumption of marine species accounted for in the calculation of the RSC (EPA 2000a).

If applicable consumption rates are not available from local, state, or regional surveys, EPA's third preference is that states and authorized tribes select intake rate assumptions for different population groups from national food consumption surveys (EPA 2000a). The HHAWQC methodology document (EPA 2000a) references a document titled "Estimated Per Capita Fish Consumption in the United States" (EPA 2000c) as the source for this information, however, there is a more recent document, "Exposure Factors Handbook: 2011 Edition" (EPA 2011b) that provides more current regional and subpopulation data and is also useful for this purpose. Again, EPA recommends that fish consumption rates be based on consumption of freshwater and estuarine species only and any consumption of marine species of fish should be accounted for in the calculation of the RSC (EPA 2000a).

As their fourth and last preference, EPA recommends the use of a default fish consumption value for the general adult population of 17.5 grams/day (EPA 2000a). This default value is used by EPA in its derivation of HHAWQC. This represents an estimate of the 90th percentile per capita consumption rate for the U.S. adult population based on the CSFII 1994-96 data (EPA 2000a). EPA believes that this default value will be protective of the majority of the general population (EPA 2000a). If a state or authorized tribe identifies specific populations of sportfishers or subsistence fishers that may represent more highly exposed individuals, EPA recommends default fish consumption rates of 17.5 grams/day and 142.4 grams/day, respectively, though in such cases a subpopulation risk level may also be appropriate (EPA 2000a) as explained in Section 6.1.3.

5.5 Bioaccumulation Factors (BAF) and Trophic Level

Bioaccumulation is the process in which aquatic organisms accumulate certain chemicals in their tissues when exposed to those chemicals through water, their diet, and other sources, such as sediments. In order to account for potential exposures to these chemicals through the consumption of fish and shellfish, EPA uses national bioaccumulation factors (BAFs) in the derivation of HHAWQC. The HHAWQC methodology document (EPA 2000a) defines BAF as the ratio (in L/kg tissue) of a concentration of a chemical in the tissues of commonly consumed aquatic organisms to its concentration in the surrounding water in situations where the organisms and their food are exposed and the ratio does not change substantially over time (i.e., the ratio which reflects bioaccumulation at or near steady-state).

The HHAWQC methodology document (EPA 2000a), the "Technical Support Document Volume 2: Development of National Bioaccumulation Factors" (EPA 2003a), and the "Technical Support Document Volume 3: Development of Site-Specific Bioaccumulation Factors" (EPA 2009) describe procedures for deriving national and site-specific BAFs. Separate procedures are provided for different types of chemicals (i.e., nonionic organic, ionic organic, inorganic and organometallic) (EPA 2000a). Also, EPA states that national BAFs should be derived separately for each trophic level because the concentrations of certain chemicals may increase in aquatic organisms of each successive trophic level due to increasing dietary exposures (e.g., increasing concentrations from algae, to zooplankton, to forage fish, to predatory fish) (EPA 2000a). In addition, because lipid content of aquatic organisms and the amount of organic carbon in the water column have been shown to affect bioaccumulation of nonionic organic chemicals, the national BAFs should be adjusted to reflect the lipid content of commonly consumed fish and shellfish and the freely dissolved fraction of the chemical in ambient water for these chemicals (EPA 2000a).

Even though the 2000 Methodology (EPA 2000a) and subsequent Technical Support documents (EPA 2003a, 2009) provide directions for the derivation of national BAF factors, EPA has, as yet, not calculated any BAFs for individual chemicals. Instead, when calculating national HHAWQC, EPA has replaced the factor "ΣFI_i*BAF_i" with the factor "FI*BCF," where BCF is the bioconcentration factor. A BCF is defined in the HHAWQC methodology document (2000a) as the ratio (in L/kg tissue) of the concentration of a substance in tissue of an aquatic organism to its concentration in the ambient water, in situations where the organism is exposed through the water only and the ratio does not change substantially over time. Like the BAF, the BCF represents a ratio that relates the concentration of a chemical in water to its expected concentration in commonly consumed aquatic organisms, but unlike the BAF, it does not consider uptake from the diet or potential sources such as sediments. BAFs are intended to be reflective of real environmental exposures and thus also reflect factors such as bioavailability and biodegradation. Thus, BAFs can be higher or lower than BCFs.

The factor FI*BCF is a single calculation rather than the summing of multiple trophic levels. In the most recent National Recommended Water Quality Criteria: 2002, Human Health Criteria Calculation Matrix tables, the BCF values used are accompanied by a footnote that reads, "The fish tissue bioconcentration factor (BCF) from the 1980 criteria documents was retained unless otherwise noted" (EPA 2002b).

States are free to calculate their own site-specific BAFs or follow the current EPA practice of using BCFs.

5.6 Implicit Elements in the Derivation of HHAWQC

The derivation of HHAWQC incorporates assumptions about exposure that are not explicitly recognized in the formal equations shown in Table 3.1. These include bioavailability, cooking loss, exposure duration, and exposure concentration.

5.6.1 *Relative Bioavailability*

Bioavailability may be defined as the degree to which a substance contained in water, food, soil, air, or other media can be absorbed by living organisms. Bioavailability is an important component of toxicity assessment since absorption is an essential prerequisite to systemic toxicity and the degree of bioavailability is an important determinant of the ultimate exposure level. EPA's recommendations for the derivation of HHAWQC do not account for the bioavailability of substances and thus implicit is the assumption that the bioavailability of chemical substances in drinking water and fish tissue obtained from regulated waterbodies is the same as the bioavailability of those chemical substances in the studies from which the toxicity parameters (RfD, POD, cancer potency factor) were derived.

5.6.2 *Cooking Loss*

Chemical substances that may be present in fish tissue can be lost as part of the cooking process. Many substances that accumulate in fish tissues are associated with the lipid (i.e., fatty) content in the tissues. Most cooking practices result in partial loss of lipid and associated chemical substances. Other substances may be volatilized during the cooking process.

EPA's recommendations for the derivation of HHAWQC do not account for chemical loss during cooking. Thus implicit is the assumption that 100% of chemical substances present in raw fish remain in edible portions of fish tissue after cooking.

5.6.3 *Exposure Duration*

EPA's intentions for HHAWQC are to "minimize the risk of adverse effects occurring to humans from chronic (lifetime) exposures to substances through the ingestion of drinking water and consumption of fish obtained from surface waters" (EPA 2000a). Lifetime exposure is assumed to be 70 years. Thus the derivation of HHAWQC implicitly assumes that exposure to the criteria substance occurs continuously over 70 years.

5.6.4 *Exposure Concentration*

The combination of explicit toxicity and exposure elements as typically used in the HHAWQC derivation equation act to form an implicit assumption that the average concentration of regulated substances in water and fish tissue exist in the environment at their maximum allowed concentrations at all times over the course of a person's lifetime (presumed to be 70 years).

6.0 PROTECTIVENESS, CONSERVATISM, AND THE COMBINED EFFECT OF CONSERVATIVE PARAMETER VALUE CHOICES IN DERIVATION OF HHAWQC

The Clean Water Act, from which authority for the designation of HHAWQC is derived, specifies, in a very broad sense, the level of protectiveness that should be embodied in the HHAWQC. The Clean Water Act includes language such as "protect the public health and welfare," "protect public health… from any reasonably anticipated adverse effects of each pollutant," and "[not] pose an unacceptable risk to human health."

In its HHAWQC methodology document, EPA provides another fairly broad description of its desired level of protectiveness: "Water quality criteria are derived to establish ambient concentrations of pollutants which, if not exceeded, will protect the general population from adverse health impacts from those pollutants due to consumption of aquatic organisms and water, including incidental water consumption related to recreational activities" (EPA 2000a). They also note that HHAWQC are usually derived to protect the majority of the general population from chronic adverse health effects and that they consider their target protection goal to be satisfied if the population as a whole will be adequately protected by the human health criteria when the criteria are met in ambient water (EPA 2000a).

In order to derive HHAWQC that are "adequately protective," EPA states that they have selected default parameter values that are "a combination of median values, mean values, and percentile estimates [that target] the high end of the general population" (EPA 2000a). EPA (2000a) "believes that this is reasonably conservative and appropriate to meet the goals of the CWA…"

The term "conservatism," in the context of derivation of HHAWQC, is used to describe the use of assumptions and defaults that are likely to overstate the true risks from exposure to substances in drinking water and fish tissues. The policy choice to use such overstatements is rooted in EPA's approach to dealing with uncertainty and variability in the data upon which defaults and assumptions are based.

Uncertainty is an inherent property of scientific data and thus of the process of risk assessment and the derivation of HHAWQC. Since uncertainty is due to lack of knowledge, it can be reduced by the collection of additional data, but never eliminated completely. Variability is an inherent characteristic of a population because people vary in their levels and types of exposures and their susceptibility to potentially harmful effects of the exposures (NRC 2009). Unlike uncertainty, variability cannot be reduced but can be better characterized with improved information (NRC 2009).

In a staff paper[3] on risk assessment principles and practices, EPA (2004) discussed its approach to dealing with uncertainty and variability:

> Since uncertainty and variability are present in risk assessments, EPA usually incorporates a "high-end" hazard and/or exposure level in order to ensure an adequate margin of safety for most of the potentially exposed, susceptible population, or ecosystem. EPA's high-end levels are around 90% and above…

[3] Staff paper prepared by the Risk Assessment Task Force through the Office of the Science Advisor at EPA. The document presents an analysis of EPA's general risk assessment practices.

> …EPA's policy is that risk assessments should not knowingly underestimate or grossly overestimate risks. This policy position prompts risk assessments to take a more "protective" stance given the underlying uncertainty with the risk estimates generated. Another framing policy position is that EPA will examine and report on the upper end of a range of risks or exposures when we are not very certain about where the particular risk lies… Further, when several parameters are assessed, upper-end values and/or central tendency values are generally combined to generate a risk estimate that falls within the higher end of the population risk range.
>
> [The] issue regarding the appropriate degree of "conservatism" in EPA's risk assessments has been a concern from the inception of the formal risk assessment process and has been a major part of the discussion and comments surrounding risk assessment…

Given the attention focused on the issue of "the appropriate degree of conservatism," it is not surprising that many researchers have studied ways in which uncertainty and variability can be better characterized and reduced, with the ultimate goal of developing risk estimates that better achieve EPA's stated goals of neither underestimating nor grossly overestimating risk without the use of highly conservative default assumptions. The sections below summarize some of these efforts and, where data are available, attempt to quantify the level of conservatism embodied in EPA's current policy choices related to the selection of parameters for use in calculating HHAWQC.

As means of examining the implications of conservatism embodied in the HHAWQC derivation process, several examples are presented in the following sections. The example substances, which include mercury, arsenic, methyl bromide, chlordane, bis (2-ethylhexyl)-phthalate (or BEHP), and polychlorinated biphenyls (PCBs), were chosen for illustration purposes because they represent broad chemical categories (e.g., metals and organics), current and legacy substances, and substances with low and high bioconcentration factors.

6.1 Toxicity Factors

Derivation of an RfD, selection of a POD and UFs, modeling the dose-response for carcinogens, and calculating the slope factor (m) are based on science, but also involve a variety of policy decisions. These policy decisions all embody some degree of conservatism. This section addresses in greater detail the conservatism associated with the lack of consideration of bioavailability and the selection of default values for uncertainty factors and cancer risk levels.

6.1.1 *Relative Bioavailability*

As noted in Section 5, an implicit assumption in the HHAWQC derivation equation is that the bioavailability of chemical substances in drinking water and fish tissue obtained from regulated waterbodies is the same as the bioavailability of those chemical substances in the studies from which the toxicity parameters (RfD, POD, cancer potency factor) were derived. However, a RfD is often based on an animal toxicity study in which exposures occurred via drinking water and for some substances, the bioavailability from fish tissue will be different from that from drinking water. In some cases, bioavailability from foods might be reduced by, for example, the formation of indigestible complexes with other food components or conversion to ionized forms that cannot pass through biological membranes and thus cannot be absorbed. For example, arsenic in drinking water is primarily inorganic arsenic, which is absorbed well, but almost all of the arsenic in fish tissues is organic arsenic, which is not highly bioavailable. Arsenic may also form insoluble complexes with, for example, iron, aluminum, and magnesium oxides, which limits bioavailability. For these substances, any particular dose consumed in fish tissue would result in a lower absorbed dose than the same dose consumed in drinking water. Thus, a RfD based on a drinking water study would be lower than a RfD based on a dose administered in fish tissue. Use of this lower RfD will overestimate the potential hazards associated with the ingestion of fish tissue and will yield a lower HHAWQC (see, e.g., EPA 2000b).

EPA rarely provides information on the potential impacts of bioavailability on their RfDs and does not typically calculate alternative RfDs that might be used when expected exposures are via a route that is likely to result in reduced bioavailability. For example, most inorganic contaminants, particularly divalent cations, have bioavailability values of 20 percent or less from a food matrix, but are much more available (about 80 percent or higher) from drinking water (EPA 2000b). The Technical Support Document Volume 1: Risk Assessment (EPA 2000b) for the HHAWQC methodology document (EPA 2000a) does allow for the selection of an alternative RfD in cases where there is lower bioavailability of the contaminant when ingested in fish than when ingested in water and the existing RfD is based on a study in which the contaminant was administered through drinking water. However, in actual practice, this has not been done.

6.1.2 *Uncertainty Factors*

The UF methodology, which has its origins in the concept of "safety factors," has been the subject of discussion among scientists in many forums over the years. One of the most common issues of discussion is the scientific basis for the default factor of 10. It is generally accepted that selection of the first safety factors was based on qualitative judgment (Nair et al. 1995). Subsequently, however, attempts were made to justify the use of 10-fold factors based on data collected to characterize the uncertainty and variability associated with parameters such as intra- and interspecies differences.

One commonly accepted justification for the selection of 10 as the standard default uncertainty factor is that for any given chemical, the dose at which the endpoint of concern will be observed in the population of concern (e.g., the most sensitive subpopulation of humans) will be less than 10 times higher than the dose at which the endpoint of concern will be observed in the population that serves as a surrogate (e.g., average humans) for the purposes of deriving an RfD (Dourson et al. 1996).

The degree of conservatism embodied in the use of default factors of 10 has been examined by researchers who have summarized published data and determined the actual distributions of these ratios. Dourson et al. (1996) noted that "there is growing sentiment that …routine application [of 10-fold UFs] often results in overly conservative risk assessments."

For example, Nessel et al. (1995) were interested in the scientific basis for the application of an uncertainty factor of 10 when using a sub-chronic study instead of a chronic study to derive the RfD. The underlying assumption is that for any given chemical, the NOAELs and LOAELs of sub-chronic studies will be within a factor of 10 of the NOAELs and LOAELs of chronic studies. So, Nessel et al. (1995) compared NOAELs and LOAELs from 23 different sub-chronic oral toxicity studies to the NOAELs and LOAELs of chronic studies that were identical except for the study duration. The mean and median $NOAEL_{subchronic}/NOAEL_{chronic}$ ratios were 2.4 and 2.0, respectively. Twenty-two of the 23 studies had NOAEL ratios of 5 or less; only one had a ratio of 10. The LOAEL ratios' mean and median were also 2.4 and 2.0, with all 23 studies having $LOAEL_{subchronic}/LOAEL_{chronic}$ ratio of 5 or less. So, based on this study, an uncertainty factor of 5 is sufficient to account for differences between sub-chronic and chronic studies in 98% of studies. Kadry et al. (1995) reported similar findings as did the review conducted by Dourson et al. (1996).

Similarly, differences between LOAELs and NOAELs are typically less than 10 fold. Ninety-six percent of all LOAEL-to-NOAEL ratios in one study were 5 or less and 91% were 6 or less in another (summarized by Dourson et al. 1996). Kadry et al. (1995) reported similar findings.

The decision to use conservative default UFs has particular significance on the overall conservatism of the RfD that is derived using the UFs. Gaylor and Kodell (2000) examined this issue and quantified the increasing degree of conservatism as the number of default UFs applied increases.

When ratios are calculated for UFs as described in the two previous paragraphs, the distributions of these ratios are lognormal, with the value of 10 typically representing the 95th percentile (Swartout et al. 1998). Gaylor and Kodel (2000) calculated the uncertainty factors that would be required to maintain an overall 95th percentile level when multiple default uncertainty factors are applied. They found that for the use of any two UFs, for which the current default total UF would be 100, the UF required to maintain the 95th percentile level ranged from 46 to 85. For the use of any three UFs, for which the current default total UF would be 1000, the UF required to maintain the 95th percentile level ranged from 190 to 340. Swartout et al. (1998) conducted a similar analysis using a different technique and reported similar findings, concluding that default UFs of 100, 1000, and 3000, for application of two, three, and four UFs, respectively, can be replaced with UFs of 51, 234, and 1040, while maintaining the 95th percentile level.

If a composite UF calculated to maintain the desired 95th percentile level is used instead of the default values of 100, 1000, and 3000, the resultant RfD and subsequently calculated HHAWQC could be as much as 5x higher. For example, if the RfD for methyl bromide was calculated using an UF of 340 (the top of the range calculated by Gaylor and Kodel (2000)) instead of 1000, the RfD would be 0.0041 mg/kg/day rather than the existing value of 0.0014 mg/kg/day. This would yield a HHAWQC of 139 µg/L rather than 47 µg/L.

6.1.3 *Cancer Risk Levels*

EPA chose to use the one-in-one-million (10^{-6}) risk level as the default value when calculating HHAWQC because it believes this risk level "reflects an appropriate risk for the general population" (EPA 2000a). However, EPA (2000a) also notes that risk levels of 10^{-5} for the general population and 10^{-4} for highly exposed populations are acceptable.

The frequent use of the 10^{-6} risk level to represent "an appropriate risk for the general population" appears to be simply a policy choice with no solid scientific basis. In a paper[4] presented at the 84th Annual Meeting of the Air & Waste Management Association in 1991, Kelly reported that:

> …despite its widespread use: no agencies we contacted could provide documentation on the origins of 10^{-6}; its origin was determined to be a completely arbitrary figure adopted by the FDA as an "essentially zero" level of risk for residues of animal drugs; there was virtually no public debate on the appropriateness of this level despite requests by the FDA; this legislation stated that 10^{-6} was specifically not intended to be used as a definition of acceptable risk; 10^{-6} is almost exclusively applied to contaminants perceived to be of great risk (hazardous waste sites, pesticides); and 10^{-6} as a single criterion of "acceptable risk" is not and has never been in any EPA legislation or guidance documents.

The decision of which cancer risk level to use in any particular circumstance is, for the most part, something that has evolved over many years through policy positions put forth in various EPA reports and legislation, but the idea that cancer risk levels between 10^{-6} and 10^{-4} are acceptable have become widely accepted among the different EPA programs. For example, the 1990 Clean Air Act Amendments endorse a 1989 EPA assessment for benzene in which EPA identified 1 in 10 thousand (10^{-4}) as being an "acceptable" risk level and 1 in a million (10^{-6}) as representing "an ample margin of safety." An EPA Region 8 superfund site discussion[5] stated that:

> In general, the USEPA considers excess cancer risks that are below about 1 chance in 1,000,000 (1×10^{-6} or 1E-06) to be so small as to be negligible, and risks above 1E-04 to be

[4] Available online at http://www.deltatoxicology.com/pdf/10-6.pdf
[5] http://www.epa.gov/region8/r8risk/hh_risk.html

> sufficiently large that some sort of remediation is desirable. Excess cancer risks that range between 1E-06 and 1E-04 are generally considered to be acceptable, although this is evaluated on a case-by-case basis and EPA may determine that risks lower than 1E-04 are not sufficiently protective and warrant remedial action.

Jones-Otazo et al. (2005) compared screening level risk assessment practices among different regulatory agencies and found that most have adopted acceptable risk levels in the same range as EPA. The European Union (EU) and World Health Organization (WHO) both identify risks in the range of 10^{-6} to 10^{-4} as acceptable, while Health Canada uses 10^{-5} as their acceptable risk level (Jones-Otazo et al. 2005). With respect to cancer risks associated with pollutants in drinking water, WHO uses a 10^{-5} risk level: "In this and previous editions of the Guidelines [for Drinking Water Quality], an upper-bound excess lifetime risk of cancer of 10^{-5} has been used, while accepting that this is a conservative position and almost certainly overestimates the true risk" (WHO 2008).

Population Risk - One factor that has a significant effect on the magnitude of acceptable risk is the size of the affected population. Exposure of a population of 1 million to a carcinogen at the risk level of 1 in a million theoretically results in one additional case of cancer among those 1 million people over the course of 70 years. If the size of the population of concern is decreased to 100,000 instead of 1 million, the theoretical additional cases of cancer among those 100,000 individuals decreases to only 0.1 case over the course of 70 years. Population risk is an important consideration in selecting a fish intake rate for use in developing AWQC because as the size of the exposed population decreases, the population risks also decrease when the same target risk level is used. The higher the FI rate selected for a particular population, the smaller the population to which that rate applies. For example, if the FI rate selected is a 95th percentile rate, it is assumed that it is protective of all but 5 percent of the exposed population or 50,000 of the 1 million people provided in the example above. Thus, if the same target risk level of 1E-06 is used with this reduced population, the resulting population risk is 0.05 excess cancers within a population of 1 million people. In other words, in order to reach the target risk of 1 excess cancer, it would be necessary for a population of 20 million people to have lifetime exposures equivalent to the estimated exposure conditions. This topic is discussed in much greater detail in Appendix A, Section 4.0 Population Risk.

This concept is particularly relevant to HHAWQC derivation because very small populations of fish consumers with high intake rates are frequently identified as being of special concern during the HHAWQC derivation process. The HHAWQC methodology document states that a risk level of 10^{-4} for highly exposed populations is acceptable (EPA 2000a). This is sometimes interpreted as meaning that highly exposed populations are not as well protected by the HHAWQC. However, as noted by Kocher (1996) in a discussion of cancer risks at hazardous waste sites, "if only a small population would be at greatest risk, the expected number of excess cancers corresponding to individual risks at the *de minimis* level of 10^{-4} would still be [essentially] zero." Travis et al. (1987) reviewed 132 federal regulatory decisions and concluded that in actual practice, for small population risks, the *de minimis* lifetime risk was considered to be 10^{-4}.

Given that the 10^{-4} risk level has been identified as an acceptable/*de minimis* risk level for highly exposed populations, it may be useful to consider exactly what that risk level represents in terms of FI. If the default FI of 17.5 g/day represents a 10^{-6} target risk level, then a highly exposed population that eats as much as 1750 g/day will still be protected at a 10^{-4} risk level.

6.2 Explicit and Implicit Exposure Factors

The specific exposure factors that EPA uses in the derivation of HHAWQC include human body weight, drinking water consumption rates, and fish ingestion rates. In the HHAWQC methodology document, EPA states that the selection of specific exposure factors is "based on both science policy decisions that consider the best available data, as well as risk management judgments regarding the overall protection afforded by the choice in the derivation of AWQC" (EPA 2000a). This section addresses the levels of conservatism represented by the default values selected by EPA for individual explicit and implicit exposure factors.

6.2.1 *RSC*

The RSC determines what portion of the RfD will be allocated to the consumption of water and fish from regulated waterbodies. For example, if the RfD for a particular substance is 1 mg/kg/day and the RSC is 20%, then the HHAWQC must be set such that exposures to that substance via water and fish can be no more than 0.2 mg/kg/day. Thus, the lower the RSC, the lower the HHAWQC that will be derived.

Although EPA (2000a) does provide a decision tree methodology for calculating chemical- or site-specific RSCs, the lowest allowable value, 20%, is specified as the default RSC by EPA in its calculations of HHAWQC. EPA explains this in the HHAWQC methodology document (EPA 2000a) with the statement that "[the default value of 20%] is likely to be used infrequently with the Exposure Decision Tree approach, given that the information [required to calculate a chemical-specific RSC]…should be available in most cases. However, EPA intends to use 20 percent…" This statement clearly indicates that for most chemicals, an RSC greater than 20% is appropriate, but EPA has chosen to use the most conservative 20% default value. Use of an RSC of 20% when data indicate that a larger percentage is more appropriate can result in as much as a 4-fold reduction in the HHAWQC.

The California Office of Environmental Health Hazard Assessment (OEHHA) concluded that the default use of an RSC of 20% is "unreasonably conservative for most chemicals" (Howd et al. 2004). For 22 of the 57 chemicals listed by Howd et al. (2004), a RSC value greater than 20% was used in the calculation of California Public Health Goals for those chemicals in drinking water. Howd et al. (2004) also noted that "[a] default RSC of 0.2 is based on tradition, not data."

A recent Government Accountability Office report (GAO (2011) calculated the effect of using different RSC factors on the determination of drinking water health reference levels (HRLs) for a hypothetical chemical with an RfD of 0.5 µg/kg/day. While holding all other variables constant, RSC values of 20%, 50%, and 80% were inserted into the equation. The corresponding HRLs were 3.5 ppb (20%), 8.8 ppb (50%), and 14 ppb (80%).

A RSC may be calculated in two ways. The subtraction method allocates 100% of the RfD among the various sources of exposure. So, the daily exposure from all exposure routes other than drinking water and fish consumption are first subtracted from the RfD, then the remainder of the RfD is allocated to drinking water and fish consumption. The percentage method does not attempt to quantify exposures from other sources, but rather simply allocates a percentage of total exposure to drinking water plus fish consumption and to other sources.

EPA has chosen to use the percentage method as the default approach. EPA states that in most cases, they lack adequate data to use the subtraction method and that the percentage method is more appropriate for situations in which multiple media criteria exist (EPA 2000a). The GAO report (GAO 2011) notes that the percentage method is considered to be the more conservative option and generally yields a lower water quality criteria value. The GAO illustrated the difference in outcome by using the data for a hypothetical chemical to calculate drinking water health reference values (HRV) using both methods. Using the subtraction method, the HRV was 12.3 ppb. Using the percentage method, the HRV was 8.8 ppb, a 1.4-fold reduction.

6.2.2 *Body Weight*

The HHAWQC methodology document (EPA 2000a) recommends using a BW of 70 kg. This number was chosen in part because it is in the range of average values for adults reported in several studies and in part because it is the default body weight used in IRIS calculations. However, in 2011, EPA released an updated edition of the Exposure Factors Handbook (EPA 2011b). Based on data from the National Health and Nutrition Examination Survey (NHANES) 1999-2006, the new handbook recommends a mean BW value of 80 kg for adults.

The RfD is defined as "an estimate (with uncertainty spanning approximately an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects over a lifetime" (EPA 2000b). The RfD expresses this daily exposure as a function of body weight (mg of chemical per kg of body weight), so the daily exposure that is likely to be without appreciable risk will be lower for an individual with a lower body weight than for an individual with a higher body weight. Thus, the lower the body weight used in the calculation of the HHAWQC, the lower the resulting criteria. For this reason, the choice to use 70 kg as the default body weight adds to the conservatism of the HHAWQC and yields criteria values approximately 12.5% lower than those calculated using the more accurate population mean of about 80 kg BW recommended by EPA in the latest Exposure Factors Handbook (EPA 2011b).

6.2.3 *Drinking Water Intake*

EPA (2000a) cites several reasons for including the drinking water exposure pathway in the derivation of HHAWQC:

(1) Drinking water is a designated use for surface waters under the CWA and, therefore, criteria are needed to assure that this designated use can be protected and maintained.

(2) Although rare, there are some public water supplies that provide drinking water from surface water sources without treatment.

(3) Even among the majority of water supplies that do treat surface waters, existing treatments may not necessarily be effective for reducing levels of particular contaminants.

(4) In consideration of the Agency's goals of pollution prevention, ambient waters should not be contaminated to a level where the burden of achieving health objectives is shifted away from those responsible for pollutant discharges and placed on downstream users to bear the costs of upgraded or supplemental water treatment.

These reasons make it clear that 2 L/day was selected as the default water consumption rate in support of larger goals related to pollution prevention and maintenance of designated use and does not represent a consideration of actual direct risk of adverse effect to any individual consumer. As EPA itself noted, it would be rare for anyone to use untreated surface water as a source of drinking water. The only direct consumption of untreated surface waters that might be considered to be routine is incidental ingestion during swimming, for which the EPA (2011b) recommended upper percentile default rates are 120 mL/hr for children and 71 mL/hour for adults. Using the 95th percentile estimate for time spent swimming each month (181 minutes) (EPA 2011b), annual daily average water consumption rates of 0.012 L/day (children) and 0.007 L/day (adults) can be calculated.

The default water consumption rate of 2L/day represents reported consumption of water from "community water," which is defined as tap water from a community or municipal water source. It does not represent a realistic level of consumption of untreated surface waters, which is likely to occur only as an incidental event of water-related recreational activities. However, by using 2 L/day in the calculation of the HHAWQC, EPA is deriving criteria values that are based on the assumption that the general population is indeed consuming 2 L/day of untreated surface water. Thus, the use of 2 L/day in the HHAWQC can insert a significant level of conservatism into the calculations.

The impact of the use of 2 L/day varies according to the BAF/BCF of the chemical. For chemicals with high BAFs/BCFs, the impact of drinking water intake on the ultimate HHAWQC is minimal due to the much larger contribution of the "fish intake x BAF" factor in the equation. However, for substances with low BAFs/BCFs, the impact is much greater. Table 6.1 shows the effect of changing drinking water intake rates on the HHAWQC of some example compounds with different BCFs.

Table 6.1 Human Health Ambient Water Quality Criteria Calculated for Varying Drinking Water Intakes

		HHAWQC (µg/L)		
Compound	BCF	DI = 2L/day (current default)	DI = 1L/day (mean DI for adults[1])	DI = 0.007L/day (ingestion while swimming)
Methyl bromide	3.75	47.4	91.96	1,349.40
Arsenic	44	0.017	0.031	0.137
BEHP[2]	130	1.17	1.53	2.19
Chlordane	14100	0.000804	0.000807	0.000811
PCBs	31200	0.0000639	0.0000640	0.0000641

[1]EPA 2011
[2]Bis(2-ethylhexyl)-phthalate

6.2.4 *Fish Consumption*

Note: Appendix A of this document contains a thorough treatment of topics related to the collection and interpretation of data used for deriving fish intake rates (FIs) (or fish consumption rates, FCRs) and applied in the derivation of HHAWQC. The appendix was prepared by Ellen Ebert, a recognized expert on interpretation of fish collection and consumption survey data.

Surveys of Fish Consumption - FIs tend to be overestimated in most surveys for a number of reasons. Individuals who respond to surveys with long recall periods tend to overestimate their participation in activities that are pleasurable to them. Creel surveys tend to be biased toward higher representation of more avid anglers who have high success rates and, thus, may consume at higher rates than the typical angler population. Short-term diet recall surveys tend to incorrectly classify people who eat a particular type of food infrequently as "non-consumers" and overestimate consumption by "consumers." Often people classified as "non-consumers" are excluded from the summary statistics of short-term diet recall survey resulting in an overestimate for ingestion rates for the entire survey population. Finally, when specific information is lacking from survey data, decisions are generally made during analysis of the survey data to ensure that consumption will not be underestimated (e.g., relatively large meal sizes will be substituted for unknown meal sizes, frequency of meals reported will be assumed to be consistent throughout the year regardless of fishing season, etc.) More detailed discussion of surveys used to determine FIs may be found in Appendix A.

Consumption of Marine and Imported Fish - As noted in Section 5.4 above, EPA's HHAWQC methodology document recommends that fish consumption rates be based on consumption of freshwater and estuarine species only and that any consumption of marine species of fish should be accounted for in the calculation of the RSC (EPA 2000a). However, the surveys used as the basis for EPA's recommended default fish consumptions rates collected information on the total consumption of fish of any species and from all sources, e.g., purchased or sport-caught fresh, frozen, or canned fish from local, domestic, or international sources (EPA 2011b). Surveys that collect information on the specific species consumed reveal that the majority of finfish consumed by Americans are marine species (Table 6.2). Also, as reported by the NOAA Fisheries Service[6], most of the seafood consumed in the U.S. is not caught in U.S. waters. In fact, about 86 percent of the seafood consumed in the U.S. is imported. Thus, the fish consumption rate used in the calculation of HHWQC significantly overestimates consumption of fish from regulated freshwater/estuarine waters by the majority of the population.

Table 6.2 Per Capita Consumption of Seafood in the U.S. – Top 10 Species (MBA 2011)

Type of Seafood	Pounds Consumed per Person/Year	Additional Comments
Shrimp	4	85% imported, mostly farmed, some wild caught
Canned tuna	2.7	Marine species
Salmon	2	Marine species
Tilapia	1.5	Farmed fish, most are imported
Pollack	1.2	Marine species
Catfish	0.8	Farmed fish, from both domestic and imported sources
Crab	0.6	
Cod	0.5	Marine species
Pangasius	0.4	Primary source is fish farms in Asia
Clams	0.3	

Additional discussion of the basis for excluding marine fish from fish consumption rate determinations may be found in Appendix B, which addresses issues relevant to the accumulation of persistent, bioaccumulative, and toxic chemicals by salmon in the context of the development of fish consumption rates in the state of Washington.

Consumption of Fish from Regulated Waters - Default assumptions that the general population consumes fish taken from contaminated water bodies every day and year of their entire life represent additional conservative assumptions. When applied to establishing permit limits or the risk

[6] http://www.noaanews.noaa.gov/stories2011/20110907_usfisheriesreport.html

assessment of a specific site or waterbody, the HHAWQC inherently assumes that 100 percent of the fish consumed over a lifetime are taken from that waterbody. This may be a reasonable assumption when the chemical constituents of concern are ubiquitous so that it is possible that individuals might receive similar levels of exposure even if they fish multiple waterbodies, but is likely to overestimate potential risk when applied to a single waterbody or one that is unique in terms of its chemical concentration or sources of the chemical in question. While it is possible individuals could obtain 100 percent of their fish from a single waterbody, this is not typical unless the waterbody is very large or represents a highly desirable fishery. In addition, individuals are likely to move many times during their lifetimes and, as a result of those moves, may change their fishing locations and the sources of the fish they consume. Finally, it is likely that most anglers will not fish every year of their lives. Health issues and other demands, like work and family obligations, will likely result in no fishing activities or reduced fishing activities during certain periods of time that they live in a given area. Thus, these assumptions add conservatism to the derivation of HHAWQC.

Implied Harvest Rate - EPA's default rate of 17.5 g/day indicates the amount of fish that is actually consumed. In order to achieve that rate, one must harvest 58 g/day of whole fish [assuming EPA's recommended edible portion of 30 percent (EPA 1989)] to yield 17.5 g/day of edible fish. When annualized, this results in 21,300 grams of fish per person or 47 pounds of fish per consumer per year. When considered over the 70-year exposure period (as assumed in the HHAWQC calculation), this results in the total removal of 3,300 pounds of fish/person during that period. In addition, if that individual is providing fish to a family of four, it would be necessary to remove roughly 13,000 pounds of fish from a single waterbody during that 70-year span. This represents a significant level of fishing effort and harvest and likely represents a substantial overestimate of any actual fish that is likely to be harvested from a single waterbody by a single individual.

Source of HHAWQC Default FIs - The food intake survey upon which the default fish consumption rates were based were short-term surveys. Numerous researchers have reported that the long-term average daily intake of a food cannot be determined using these short-term cross-sectional surveys (Tran et al. 2004). The use of short-term surveys has been shown to overestimate long-term food intakes in the upper percentile ranges (Tran et al. 2004) that are typically used by EPA in exposure assessments, especially for infrequently consumed foods (Lambe and Kearney 1999) like fish. Additional discussion of the limitations of the use of short-term survey data on fish consumption may be found in Appendix A, Section 3.2.2.

Summary - The fish consumption rates used in calculating HHAWQC can have a significant impact on the resulting HHAWQC. This is because the HHAWQC are proportional to the fish consumption rates (as the rate increases, the HHAWQC decreases) and there is substantial variability in the rates of fish consumption among the consuming population. In addition, the potential exposure through the fish consumption pathway is dependent upon a number of different variables including the types of fish consumed, the sources of those fish, and the rates at which they are consumed. The quantification of fish consumption rates is complicated by the methods used to collect consumption information, the availability of fish from regulated sources, and the habits of the targeted population of fish consumers.

The selection of fish consumption rates when calculating HHAWQC is discussed in more detail in Appendix A.

6.2.5 *Cooking Loss*

The derivation of HHAWQC is based on the assumption that there will be no loss of chemicals from fish tissues during the cooking process. However, numerous studies have shown that cooking reduces the levels of some chemicals. For example, Zabik et al. (1995) reported that cooking significantly reduced levels of the DDT complex, dieldrin, hexachlorobenzene, the chlordane complex, toxaphene, heptachlor epoxide, and total PCBs. Similarly, Sherer and Price (1993), in a review of published studies, reported that cooking processes such as baking, broiling, microwaving, poaching, and roasting removed 20-30% of the PCBs while frying removed more than 50%.

In its development of Fish Contaminant Goals (FCGs) and Advisory Tissue Levels, the State of California uses a cooking reduction factor to account for cooking loses for some chemicals:

> FCGs take into account organochlorine contaminant loss during the cooking process. The concentration of PCBs and other organic contaminants in fish are generally reduced by at least 30 percent, depending on cooking method… As such, a cooking reduction factor of 0.7 was included in the FCG equation for organic compounds (allowing for 70 percent of the contaminant to remain after cooking) (CA 2008).

By not incorporating a chemical-specific factor to adjust for cooking loss, the exposure level from fish consumption will be overestimated for organic compounds, thus lending an additional layer of conservatism to the resulting HHAWQC.

6.2.6 *Exposure Duration*

As noted in Section 5, exposure duration is an implicit element in the derivation of HHAWQC and a value of 70 years, or an approximate lifetime, is assumed. While average lifetimes may be approximated by 70 years, it is generally considered conservative to assume that an individual would be continuously exposed to substances managed through the development of HHAQWC because waters contaminated with such substances do not exist everywhere and it is unlikely that many persons would reside only in contaminated areas, and drink and fish only in these waters for an entire lifetime. Choosing to assume a 70-year exposure duration may be justified in cases where a pollutant is ubiquitous in the environment and thus it could reasonably be assumed that ingestion of drinking water and locally caught fish from essentially all freshwater locations would lead to similar levels of exposure. There is little evidence, however, supporting the ubiquity of most substances for which HHAWQC have been established (though an exception might be justified for mercury or other pollutants for which atmospheric deposition is the dominant mechanism contributing substances to surface waters).

Perhaps more significantly, however, it is uncommon for people to reside in a single location for their entire life. EPA's Exposure Factors Handbook (EPA 2011) contains activity factors, including data for residence time, from several US studies. Table 6.3 summarizes some of these results.

Table 6.3 Values for Population Mobility

	Mean	90th Percentile	95th Percentile
Residential Occupancy Period (Johnson and Capel 1992)	12 years	26 years	33 years
Current Residence Time (US Census Bureau 2008)	8 years (median) 13 years (mean)	32 years	46 years

As with other survey results, there is some uncertainty and potentially some bias associated with the residency periods reported in these studies. Additional studies are discussed (EPA 2011) concerning the distance people move, when they do move. However, the data clearly suggest that the central tendency (mean or median) and upper percentile values are substantially less than the 70 year exposure period assumed by EPA. The assumption of a 70 exposure duration overestimates median exposure duration by 8-fold, mean exposure duration by approximately 6-fold and the 90th percentile by 2- to 3-fold. Thus, the choice to use 70 years is conservative for most non-ubiquitous chemicals. Table 6.4 shows the effect on some example HHAWQC when assuming exposure durations of 70 and 30 years.

Table 6.4 HHAWQC Calculated Based on 70 and 30 Year Exposure Durations

	HHAWQC (µg/L)	
Compound	70 year exposure duration	30 year exposure duration
Arsenic	0.017	0.040
BEHP	1.17	2.73
Chlordane	0.000804	0.00187
PCBs	0.0000639	0.000149

6.2.7 *Exposure Concentration*

As noted in Section 5, implicit with the derivation of HHAQWC is the assumption that both the water column and fish tissue concentrations exist at their maximum allowed values for the entire 70 year exposure duration. In reality, water column concentrations vary over time and space. The assumption that concentrations are always the maximum allowed is unnecessarily conservative as a practical matter because, as described in the following paragraphs, regulations governing water quality in the US would not allow a substance to persist in a water body at the HHAQWC concentration for such a period.

EPA's Impaired Waters and Total Maximum Daily Load Program provides guidance to states concerning when waters are considered to be impaired. The EPA guidance is not specific as to recommendations for identifying stream impairments due to exceedances of HHAWQC and many state impaired stream listing methodologies lack specific provisions unique to the basis for establishing HHAWQC (i.e., exposure over a 70 year lifetime). However, it is common that states will consider listing a stream that exceeds WQC for chronic aquatic life (i.e., the CCC) and human health more than 10% of the time (i.e., the "10% rule"). Indeed, EPA guidance for listing impaired surface waters (EPA 2003b) states:

> "Use of the '10% rule' in interpreting water quality data in comparison with chronic WQC will generally be more appropriate than its use when making attainment determinations where the relevant WQC is expressed "concentration never to exceed ___, at any time." Chronic WQC are always expressed as average concentrations over at least several days. (EPA's chronic WQC for toxics in freshwater environments are expressed as 4-day averages. On the other extreme, EPA's human health WQC for carcinogens are calculated based on a 70-year lifetime exposure period.) Using the '10% rule' to interpret data for comparison with chronic WQC will often be consistent with such WQC because it is unlikely to lead to the conclusion that water conditions are better than WQC when in fact, they are not."

The guidance above suggests that listing of waters using the 10% rule is likely to be over protective for chronic aquatic life criteria. That is, it is considered unlikely that a water exceeding the chronic WQC 10% or less of the time would exist, on average, at the criterion value for the 4-day averaging period on which chronic WQC are based. By this same logic, it is an essentially impossible scenario that a water exceeding a HHAWQC 10% or less of the time would average at the criterion value for the 70 year averaging period on which HHAWQC are based.

It may be more realistic, instead, to predict a mean or median water column concentration using the HHAWQC as an upper percentile value occurring in the stream. Considering the 10% rule, one might predict the average water column concentration by assuming that the HHAWQC is the 90th percentile value in a distribution of water column concentrations existing over 70 years. By way of example, Table 6.5 illustrates the effect of variable stream concentrations on the ratio of the 90th percentile concentration to the mean concentration. An approximately normal distribution is assumed for these examples.

Table 6.5 Ratio of 90th Percentile Upper Bound Concentration to the Mean (normal distribution)

	Assumed Distribution	HHAWQC	Standard Deviation and Coefficient of Variation[1]	Estimated Mean[2]	Ratio HHAWQC/Mean
Substance X	Normal	1	0.25	0.68	1.5x
Substance Y	Normal	1	0.50	0.36	2.8x
Substance Z	Normal	1	0.60	0.23	4.3x

[1]The coefficient of variation (or relative standard deviation) is the ratio of the standard deviation to the mean and represents the degree of relative variability of the data around the mean.
[2]The 90th upper percentile of a normal distribution lies about 1.28 standard deviations from the mean.
The same general characteristic would be expected for stream concentrations that are log-normally distributed, which is a more common situation. Assuming that the values used in the normal distribution case in the previous table apply to the logarithms of the original data, a ratio of the antilogs of the HHAWQC (90th percentile value) and mean values in the normal distribution case can be calculated. Results are shown below in Table 6.6.

Table 6.6 Ratio of 90th Percentile Upper Bound Concentration to the Mean (lognormal distribution)

	Assumed Distribution	Antilog of HHAWQC	Standard Deviation of log concentrations	Estimated Geometric Mean[1]	Ratio HHAWQC/Geometric Mean
Subst. X	Lognormal	10	0.25	4.8	2.1x
Subst. Y	Lognormal	10	0.50	2.3	4.4x
Subst. Z	Lognormal	10	0.60	1.7	5.9x

[1]The geometric mean is equal to the antilog of the Estimated Mean in the normal distribution table.

As can be seen in Tables 6.5 and 6.6, the actual mean can be a small fraction of the upper 90th percentile value. In these examples the degree of conservatism embodied in the HHAWQC value ranges between 1.5x and 5.9x.

6.3 Compounded Conservatism

Compounded conservatism is the term used to describe the "impact of using conservative, upper-bound estimates of the values of multiple input variables in order to obtain a conservative estimate of risk…" (Bogen 1994). Bogen (1994) pointed out that "safety or conservatism initially assumed for each risk component may typically magnify, potentially quite dramatically, the resultant safety level of a corresponding final risk prediction based on upper-bound inputs." In the HHAWQC derivation process, compounded conservatism plays a role both in the determination of individual factors of the Equations 3.1, 3.2, and 3.3 (i.e., in the toxicity factors and explicit and implicit exposure elements) and in the equations' use of multiple factors, each based on upper bound limits and/or conservative assumptions.

In addition to the conservatism embodied in the selection of individual components of the calculations (both explicit and implicit), the fundamental underlying assumption, which is that the most sensitive subpopulations will be exposed to maximum allowable concentrations over a full lifetime, is a highly unlikely and highly protective scenario. For example, the derivation of HHAWQC is based on the assumptions that an individual will live in the same place for their entire life (70 years) and that 100% of the drinking water and fish consumed during those 70 years will come from the local water body being regulated.

The suggestion that the use of multiple default factors based on upper bound limits and/or conservative assumptions lead to a situation of compounded conservatism has been the subject of considerable discussion (see Section 6.0). However, in a staff paper, EPA suggests that "when exposure data or probabilistic simulations are not available, an exposure estimate that lies between the 90th percentile and the maximum exposure in the exposed population [should] be constructed by using maximum or near-maximum values for one or more of the most sensitive variables, leaving others at their mean values" (EPA 2004). This appears to be an acknowledgement that adequately protective assessments do not require that each, or even most, component parameter(s) be represented by a 90th or 95th percentile value.

Similarly, in the 2005 Cancer Risk Assessment Guidelines, EPA (2005) stated:

> Overly conservative assumptions, when combined, can lead to unrealistic estimates of risk. This means that when constructing estimates from a series of factors (e.g., emissions, exposure, and unit risk estimates) not all factors should be set to values that maximize exposure, dose, or effect, since this will almost always lead to an estimate that is above the 99th-percentile confidence level and may be of limited use to decision makers.

Viscusi et al. (1997) provided a simple example to illustrate compounded conservatism. In Superfund exposure assessments, EPA states that they consider "reasonable worst case" exposures to be in the 90-95th percentile range (Viscusi et al. 1997). However, the use of just three conservative default variables (i.e. 95th percentile values) yields a reasonable worst case exposure in the 99.78th percentile. Adding a fourth default variable increases the estimate to the 99.95th percentile value. In a survey of 141 Superfund sites, the authors reported that the use of conservative risk assessment parameters in site assessments yields estimated risks that are 27 times greater than those estimated using mean values for contaminant concentrations, exposure durations, and ingestion rates.

In a recent report on the economics of health risk assessment, Lichtenberg (2010) noted that the use of conservative default parameters is intended to deliberately introduce an upward bias into estimates of risk. Lichtenberg (2010) also stated that "the numbers generated by such procedures can't really be thought of as estimates of risk, since they bear only a tenuous relationship to the probability that individuals will experience adverse health consequences or to the expected prevalence of adverse health consequences in the population." Indeed, he pointed out that the number of actual cancer deaths that can be attributed to all environmental and occupational causes is much lower than the number that is predicted by risk assessments (Doll and Peto 1981, as cited by Lichtenberg 2010). Lichtenberg (2010) describes concerns about compounded conservatism by saying:

> …regulators continue to patch together risk estimates using a mix of "conservative" estimates and default values of key parameters in the risk generation process. Such approaches give rise to the phenomenon of compounded conservatism: The resulting estimates correspond to the upper bound of a confidence interval whose probability is far, far greater than the probabilities of each of the components used to construct it and which depends on arbitrary factors like the number of parameters included in the risk assessment.

6.4 Summary

Most of the components of the equations used to calculate HHAWQC contain some level of conservatism. The toxicity factors in and of themselves contain multiple conservative parameters, leading to a compounding of conservatism in their derivation. The default RSC is the most conservative allowable level derived using the more conservative of two possible approaches. The default body weight of 70 kg is 10 kg less than the EPA currently recommended value of 80 kg. The derivation process for the HHAWQC does not take into account expected cooking losses of organic chemicals. The compounded conservatism that results from the use of multiple conservative factors yields a HHAWQC that provides a margin of safety that is considerably larger than EPA suggests is required to be protective of the population, even when sensitive or highly exposed individuals are considered. Tables 6.7 and 6.8 illustrate the impact of replacing just two default parameters, body weight and drinking water intake, with average values and allowing for cooking loss on the HHAWQC for methyl bromide and bis(2-ethylhexyl)-phthalate (BEHP).

Table 6.7 Impact of Multiple Conservative Defaults/Assumption on Methyl Bromide HHAWQC

Parameters Used	HHAWQC (µg/L)
Default	47
Factor of 0.7 included for cooking loss	48
Factor of 0.7 included for cooking loss + DI default (2 L/day) replaced by mean value of 1 L/day	94
Factor of 0.7 included for cooking loss + DI default (2 L/day) replaced by mean value of 1 L/day + Default BW of 70 kg replaced by current EPA recommended BW of 80 kg	107

Table 6.8 Impact of Multiple Conservative Defaults/Assumption on BEHP HHAWQC

Parameters Used	HHAWQC (µg/L)
Default	1.17
Factor of 0.7 included for cooking loss	1.39
Factor of 0.7 included for cooking loss + DI default (2 L/day) replaced by mean value of 1 L/day	1.93
Factor of 0.7 included for cooking loss + DI default (2 L/day) replaced by mean value of 1 L/day + Default BW of 70 kg replaced by current EPA recommended BW of 80 kg	2.20

Not only do the individual components of the equations represent a variety of conservative assumptions, the underlying premise upon which calculations of HHAWQC are based is itself highly conservative. It assumes that 100 percent of the fish and drinking water consumed by an individual over a 70 year period is obtained from a single waterbody (or that a chemical is ubiquitous in all water), that the chemical is present at the HHAWQC at all times, an individual consumes fish every year at the selected upper bound consumption rate, and that no loss of the chemical of interest occurs during cooking.

In addition, the toxicological criteria used to develop the HHAWQC have been selected to be protective of the most sensitive individuals within the exposed population and have been combined with conservative target risks. It is unlikely that this combination of assumptions is representative of the exposures and risks experienced by many, if any, individuals within the exposed population.

Tables 6.9 and 6.10 summarize the primary sources of conservatism found in both the explicit and implicit toxicity and exposure parameters of HHAWQC derivation and, for some parameters, quantify the extent of that conservatism.

Table 6.9 Conservatism in Explicit Toxicity and Exposure Parameters

Explicit Exposure Parameter	Default Value	Represents:	Default is conservative because:	Impact of conservatism on HHAWQC (if known)
RfD	N/A	Estimate of daily exposure likely to be without appreciable risk of adverse effects over a lifetime	Bioavailability not typically considered, effects of compounded conservatism in use of multiple UFs	Larger RfD yields higher HHAWQC, magnitude uncertain and varies between compounds
RSD	N/A	Dose associated with incremental risk level of 10^{-6}	based on upper bound risk estimate	Magnitude uncertain, varies between compounds
Relative Source Contribution (RSC)	20%	Fraction of total exposure attributable to freshwater/ estuarine fish	For most chemicals, available data support a larger RSC	Larger RSC yields 1.5x to 4x higher HHAWQC
Body Weight (BW)	70 kg	Adult weight, average for the general population	Mean body weight for adults is now 80 kg	Use of 80 kg yields 1.125x higher HHAWQC
Drinking Water Intake (DI)	2 L/day	86th percentile of general population	Assumes all water consumed is at HHAWQC and that all drinking water is untreated surface water	Magnitude is compound specific[7]
Fish Intake (FI)	17.5 grams/ day for general population and sportfishers 142.4 grams/ day for subsistence fishers	90th percentile per capita consumption rate for the U.S. adult population	Represents an upper percentile, most people eat less fish	Magnitude is compound specific[8]
Bioconcentration Factor (BCF)	Substance specific	Tissue:water ratio at 3% tissue lipid	NA	NA

[7] HHAQWC are inversely proportional to DI value for substances with low BCFs. The DI value has very little influence on HHAWQC for substances with high BCFs.
[8] HHAQWC are inversely proportional to FI value for substances with high BCFs. The FI value has very little influence on HHAWQC for substances with low BCFs.

Table 6.10 Conservatism in Implicit Exposure Parameters

Implicit Exposure Parameter	Default Value	Represents:	Default is conservative because:	Impact of conservatism on HHAWQC (if known)
Cooking Loss	zero	loss of organic chemical during cooking	Does not account for the known 20-50% reduction in concentration of organic chemical in fish tissues following cooking	Inclusion of a factor to account for cooking loss yields 1.25x to 2x higher HHAWQC
Exposure Duration	70 years	Length of time a person is exposed	Assumes 100% of drinking water and fish consumed over the course of 70 years will come from a regulated water body	For non-ubiquitous compounds, recognizing that residency periods are much shorter than 70 years yields HHAQWC that are 2x to 8x higher.
Exposure Concentration	HHAWQC	Concentration in water body of interest equal to HHAWQC	Assumes concentration is always equal to HHAWQC without regard for changes in input or in flow characteristics	Magnitude uncertain but could easily be 1.5x to more than 4x
Relative Bioavailability	1	Bioavailability from fish and water compared to bioavailability in the experiment from which the toxicity benchmark was derived.	Some chemicals are less bioavailable in water or fish tissue than in the experiments from which toxicity benchmarks were derived.	Magnitude is chemical specific

7.0 IMPLICATIONS OF HHAWQC FOR FISH TISSUE CONCENTRATIONS AND CHEMICAL EXPOSURES VIA FISH CONSUMPTION

7.1 Fish Tissue Concentrations

The purpose for including factors for fish intake and bioaccumulation/bioconcentration in the derivation of HHAWQC is to account for consumption of chemicals that are contained within fish tissues. An underlying assumption of this approach is that the HHAWQC correspond to a chemical concentration in edible fish tissue that yields an acceptable daily intake when fish from surface waters are consumed at the default intake rates (e.g., 17.5 g/day general population or 142 g/day subsistence anglers). Once a HHAWQC is calculated, the allowable fish tissue concentration (FTC) associated with that HHAWQC can be easily derived using the same equation. One way of assessing the overall conservatism of the process through which HHAWQC are derived is to compare the associated allowable fish tissue concentrations to existing fish tissue concentration data and concentrations found in other foods, as well as other guidelines or risk-based levels used to regulate chemical concentrations in edible fish tissues (e.g., fish consumption advisory "trigger levels," US Food and Drug Administration (FDA) tolerances).

Appendix C, "Fish Tissue Concentrations Allowed by USEPA Ambient Water Quality Criteria (AWQC): A Comparison with Other Regulatory Mechanisms Controlling Chemicals in Fish," illustrates this type of analysis using six example compounds: arsenic, methyl bromide, mercury (total, inorganic, organic), PCBS (total), chlordane, and bis-(2-ethylhexyl)phthalate (BEHP). The analysis revealed that:

- Concentrations of PCBs and mercury in fish from virtually all surface waters in the U.S. exceed FTCs associated with HHAWQC derived using the FI rate for subsistence anglers (142 g/day).
- FTCs associated with HHAWQC derived using the FI rate for the general public (17.5 g/day) are 20 times to 4,000 times lower (more stringent) than fish consumption advisory "trigger levels" commonly used by state programs.
- Although about 50% of fish samples collected during a national survey had PCB levels greater than the allowable PCB FTC associated with the HHAWQC, only about 15% of the nation's reservoirs and lakes (on a surface area basis) are subject to a fish consumption advisory. When the FI for subsistence anglers is used to calculate a HHAWQC for PCBs, the percentage of samples exceeding the associated FTC increases to 95%.
- The FDA food tolerances for PCBs, chlordane, and mercury in fish are, respectively, 500, 27, and 2.5 times greater than the FTCs associated with the HHAWQC for those chemicals. If the subsistence angler FI rate (142 g/day) is used to calculate the HHAWQC, the FDA food tolerances for those chemicals are, respectively, 4,000, 214, and 20 times greater.

These results indicate that, with respect to FTCs, the HHAWQC as they are currently calculated, with a default FI rate of 17.5 g/day, provides a wide margin of safety below the FTCs considered acceptable by states (as indicated by FCA trigger levels) and by the FDA (as indicated by food tolerances).

7.2 Chemical Exposures via Fish Consumption

Once the FTC associated with a HHAWQC is calculated, that value can also be used to estimate the allowable daily dose of that chemical. Comparing the allowable daily dose associated with HHAWQC with actual exposures to the general population via other sources provides an indication of the potential health benefits that might be gained by increasing the default fish consumption rate and thus lowering the HHAWQC. Appendix C shows the results of such a comparison for six example compounds (arsenic, methyl bromide, mercury (total, inorganic, organic), PCBS (total), chlordane, and BEHP and indicates that for all of these chemicals, exposure via consumption of fish from surface waters to which HHAWQC apply represents only a small percentage of the total exposure from all sources. Therefore, reducing exposures to chemicals via fish consumption by lowering HHAWQC may not provide any measurable health benefits.

8.0 CONCLUSIONS

HHAWQC are derived by EPA, or by authorized states or tribes, under the authority of Section 304(a) (1) of the Clean Water Act (CWA). The methodology by which HHAWQC are derived is based on equations that express a risk analysis. The values used in the HHAWQC equation are based on scientific observations (generally a range of observations) and, thus, have a scientific basis. However, the selection of a single value to represent the full range of observations represents a policy choice and is a subjective decision. Therefore, HHAWQC, though based on science, represent a policy (i.e., non-scientific) choice (EPA 2011a). EPA has stated that their goal in setting HHAWQC is to "protect individuals who represent high-end exposures (typically around the 90th percentile and above) or those who have some underlying biological sensitivity" (EPA 2004). To that end, its selections for individual default parameter values are typically upper percentiles of a distribution (e.g., a 90th percentiles value for fish consumption rate) or conservative assumptions (e.g., 100% of water used for drinking and cooking during a 70 year lifespan is untreated surface water).

The parameters used in the derivation of HHAWQC may be divided into two categories, toxicity parameters and exposure parameters. Toxicity parameters fall into three categories: 1.) non-carcinogenic effects, for which the parameter is the RfD, 2.) non-linear carcinogenic effects, for which the parameters are the POD and UF, and 3.) linear carcinogenic effects, for which the parameter is the RSD, which is derived from the slope factor and the target incremental cancer risk. Derivation of an RfD, selection of a POD and UFs, modeling the dose-response for carcinogenic effects, and calculating the slope factor (m) are based on science, but also involve a variety of policy decisions. These policy decisions all embody some degree of conservatism, such as the use of multiple 95th percentiles and upper bound confidence limits. Thus, the factors representing toxicity in the HHAWQC derivation equation certainly represent conservative (i.e., selected to more likely overestimate than underestimate risks) estimates of toxicity and act to drive HHAWQC toward lower concentrations.

Explicit exposure parameters include the RSC, BW, DI, FI, and BAF. There are also implicit parameters that, while not components of the equations used to calculate HHAWQC, are assumptions that underlie HHAWQC derivation. As with the toxicity parameters, most of the exposure parameters are based on scientific observations, generally a range of observations and thus have a scientific basis. However, selection of a single value to represent the full range of observations is a policy choice. Default values for these parameters and the degree of conservatism associated with them are summarized in Tables 6.9 and 6.10, which shows that these parameter values represent upper percentile values and highly conservative assumptions that act to drive HHAWQC toward lower concentrations.

EPA acknowledges in more recent guidance that the existence of the phenomenon of compounded conservatism, which occurs when the combination of multiple highly conservative assumptions leads to unrealistic estimates of risk. It suggests that in order to avoid this problem when constructing estimates from a series of factors (e.g., exposure and toxicity estimates), not all factors should be set to values that maximize exposure, dose, or effect (e.g., EPA 2005). However, in spite of that, most of the parameters used for the derivation of HHAWQC are set at the 90th (or higher) percentile level.

The overall level of conservatism embodied within the HHAWQC derivation process is illustrated by comparing the allowable fish tissue concentration implied by the designation of HHAWQC to existing guidelines or risk-based levels used to regulate chemical concentrations in edible fish tissues, such as fish consumption advisory "trigger levels" and US Food and Drug Administration (FDA) tolerances. Fish tissue concentrations associated with HHAWQC derived using the fish intake rate for the general public (17.5 g/day) are 20 times to 4,000 times lower (more stringent) than fish consumption advisory "trigger levels" commonly used by state programs. Similarly, FDA food tolerances for PCBs, chlordane, and mercury in fish are, respectively, 500, 27, and 2.5 times greater than the HHAWQC-associated fish tissue concentrations and if the subsistence angler fish intake rate (142 g/day) is used to calculate the HHAWQC, the FDA food tolerances for those chemicals are, respectively, 4,000, 214, and 20 times greater.

Following a consideration of the overall level of conservatism contained within the HHAWQC, the level of protectiveness that EPA has indicated that states should achieve, and concerns that have been expressed by certain segments of the public and some state regulators and elected officials, three issues in particular seem to stand out. The first is the idea that HHAWQC represent an estimate of likely actual exposures to the public, such that, for example, if a HHAWQC is set at 42 ppb, the general public will be exposed to 42 ppb and therefore, any subgroups that may, e.g., consume more fish than average, will not be adequately protected by a 42 ppb HHAWQC. However, a consideration of the sources of the various parameters used to calculate the HHAWQC, as provided in preceding sections of this report, clearly shows that this is not the case.

The second is the idea that, because the HHAWQC for carcinogens are based on a 10^{-6} risk level for the general population, highly exposed subgroups whose risk level might be 10^{-5} or 10^{-4} are not being adequately protected. A consideration of the concept of population risk, as described in Section 6.1.3 demonstrates that this is not the case. Even if a small subgroup of the general population has higher exposures (e.g., higher rates of fish consumption), the expected number of excess cancers corresponding to individual risks at the 10^{-4} risk level is essentially zero. Indeed, in actual practice, in Federal regulatory decisions related to small population risks, the *de minimis* lifetime risk is typically considered to be 10^{-4}.

Finally, there is the belief that increasing the fish consumption rates used to derive HHAWQC which will, in turn, lower HHAWQC, will benefit public health, particularly for populations of high level consumers of fish from regulated surface waters. However, an analysis of six chemicals, selected to represent a range of chemical classes, clearly shows that exposures via consumption of fish from regulated water bodies is only a small percentage of the total dietary exposure from all sources. Thus, the establishment of more stringent HHAWQC may not provide any measurable public health benefit.

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APPENDIX A

FISH CONSUMPTION RATE (FCR)

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1.0 INTRODUCTION

A key component of the equation used to derive ambient water quality criteria (AWQC) is the long-term fish consumption rate (FCR). Selection of an appropriate FCR can be challenging for a number of reasons. In certain cases, there may not be relevant, local or regional fish consumption data available from which to select rates. In other instances, numerous studies of fish consumption behaviors may have been conducted, but the studies report a wide range of FCRs for similar consumer populations. Often, in light of the variability in FCRs, there is a tendency for regulators to select the most conservative (highest) of the available rates to ensure that HHAWQC will be protective of potentially exposed populations, thereby adding considerable conservative bias to the HHAWQC. While there is always variability in consumption rates due to differing behaviors among the consumers, in many cases, the variability among the reported rates for similar populations is a consequence of the survey design, methodology, and approach used to analyze the data, rather than actual variability in consumption rates. It is important to understand how the approaches used to collect and analyze fish consumption data may bias results so that the most appropriate and representative rates can be selected for the development of HHAWQC.

2.0 CURRENT EPA GUIDANCE

EPA's (2000) methodology for deriving AWQC recommends that, when available, consumption rates for populations of concern should be drawn from local or regional survey data. The consideration of local and regional survey data is important in deriving AWQC because these data may vary widely depending upon the waterbodies to which the AWQC will be applied, the population of individuals who may consume fish from those waterbodies, seasonal influences on fishing, availability of desirable species, and the particular consumption habits of those individuals. In many situations, the population of consumers may be the general population who consume fish from commercial sources; in other situations, the only consumers may be the population of fishermen who catch and consume their own fish from a particular waterbody. Typically, recreational fishermen are the population that is likely to consume the most fish from a specific waterbody as they may repeatedly fish that waterbody over time. This is a common rationale for using the habits of this population as a basis for deriving an FCR to be used in developing AWQC.

When local or regional survey data are not available, EPA has historically recommended that a default FCR of 17.5 g/day be used (EPA 2000). This rate is an estimate of the 90th percentile rate of consumption of freshwater and estuarine finfish and shellfish by adults in the general population of the United States. It is an annualized, long-term rate that indicates that the targeted population may consume roughly one half-pound fish meal every two weeks (28 meals/year) from the waterbodies to which the AWQC will be applied. It is based on the USDA's Continuing Food Studies data (USDA 1998) and is recommended by EPA for deriving AWQC because it represents an estimate of high end fish consumption by the general population and average consumption among sport anglers. If subsistence populations are present, EPA (2000) states that a default consumption rate of 142.4 g/day may be used. This rate indicates that this population may consume roughly 229 half-pound meals of fish per year or more than four meals per week.

In addition, EPA (2011) has evaluated a substantial portion of the fish consumption literature and has presented the results of its analysis in its revised *Exposure Factors Handbook*. This guidance presents the findings of the studies and the estimates that EPA has derived based on its analysis of the data. A variety of recommended FCRs are presented for the general population of the United States, individuals who consume sport-caught fish from marine waters, individuals who consume sport-caught fish from freshwaters, and various subpopulations of fishermen. While the previous version of the *Exposure Factors Handbook* made specific recommendations of FCRs to be used, the revised version does not provide specific recommendations. Instead, it presents a range of values from studies that it identified as being relevant and reliable and instructs readers to select the value that is most relevant to their needs.

One difficulty with the way that the FCRs are presented in EPA's tables of recommendations is that not all studies are conducted in the same way. While the text of that guidance discusses the methodologies, strengths and weaknesses of each of those studies, it presents the resulting rates as if they are equivalent. However, the choices made in study design, target population, and approach to data analysis result in a wide range of FCRs. This variability among the FCRs presented can be confusing, resulting in a tendency for risk managers to select rates at the high end of those ranges to ensure protection of public health. The variability, however, is primarily the result of differences in the types of populations and fisheries studied, and the study designs employed. It is important to consider all of these factors in selecting an FCR (Ebert et al. 1994). When setting AWQC, it is important to select values that are representative of the target population to ensure that public health is being protected without putting unmanageable or unnecessary burdens on those who must comply with the AWQC (Ebert et al. 1994).

3.0 ANALYSIS OF FCR SURVEY DATA

While there are many studies of fishing consumption behavior available, it is important to consider the quality of the studies for the purpose of estimating FCRs. Many fishing surveys include collection of some data related to consumption of fish but often that is not the purpose for which the surveys were designed. Instead they may have been designed to determine dietary preferences, assess compliance with advisories, estimate fishing effort and success, determine angler preferences, etc. As such, while they may contain some information about consumption by the surveyed individuals, the data collected may not be adequately detailed or comprehensive to permit the estimation of reliable, long-term FCRs for that population.

For example, Connelly et al. (1992) conducted a survey of New York recreational anglers that provided information about sport-caught fish consumption but the study was designed for the purpose of providing information about anglers' knowledge of fishing advisories in New York and the impacts of the advisories on their fishing and consumption behavior. While it collected information about the number of meals and species consumed, it did not collect information about the size of fish meals. In order to use these data, one must make an assumption about the size of each meal, which in turn affects the rates derived from the study. When EPA (2011) analyzed these data to derive consumption rates, they assumed that each meal was 150 g in size based on a study of the general population conducted by Pao et al. (1982). Had EPA made different assumptions about meal size, they might have derived substantially higher or lower consumption rate estimates. It cannot be determined from the available data whether the rates derived by EPA were actually representative of consumption rates for the surveyed population.

There are a number of other survey design and analysis issues that affect the estimation of FCRs that may be considered in deriving AWQC. To better understand the nuances of FCRs derived from surveys of target populations, it is important to understand the influence that survey design and analysis can have on consumption rate estimates. These issues are discussed below.

3.1 Survey Methods

Fish consumption surveys can be conducted in a number of different ways. These methods include creel (or intercept) surveys, recall mail and telephone surveys, fishing diaries, and dietary recall studies. Each of these methods can be designed to provide information based on short- or long-term periods of recall (periods of time over which individuals are asked to remember their fish consumption behaviors).

While each of the survey methods can be used to estimate rates of consumption, each method has particular strengths and weaknesses and the survey design can greatly affect the resulting FCR estimates. Thus, the survey method used, the recall period, and the target population all need to be considered carefully when comparing FCRs that are reported. Many times the magnitude of the estimated FCRs are an artifact of the study methodology rather than a reflection of actual differences in fish consumption behaviors.

3.1.1 Creel Surveys

Historically, creel surveys have been used by fisheries managers to collect information about catch and harvest rates and determine the adequacy and characteristics of fishery stock. In some cases, however, creel surveys are modified to collect specific information about fish consumption based on individual fishing trips to a particular waterbody. Generally, survey clerks make contact with individuals who are fishing on a particular survey day to ask them what they have caught and what they intend to eat. Typically individuals are only interviewed once during a survey period (no repeat interview) although sometimes repeat interviews are part of the survey design and the responses on multiple interview days are combined for the individual.

Creel surveys are very effective for collecting information about consumption from a specific waterbody by the individuals who use that waterbody. In addition, if there is a particular subpopulation that uses the fishery differently from the general angler population, those individuals will be identified and their consumption habits captured.

While creel surveys provide reliable information about the fish catch on the day of the interview, they are subject to a number of limitations when attempting to estimate long-term average FCRs, which are the rates that are generally used in developing AWQC.

- Consumption rates based on creel surveys are subject to avidity bias; that is, there is a greater chance of interviewing more avid anglers because they are present at the fishery more frequently. More avid anglers are likely to be more successful anglers and, if they harvest fish for consumption, their rates of consumption are likely to be higher than the typical anglers' consumption rates. In order to use creel survey data to estimate consumption habits of the total user population, it is necessary to make a correction for avidity bias so that the results are representative of the entire angler population that uses the fishery (EPA 2011).

  EPA (2011) discusses this phenomenon in its discussion of FCRs in its 2011 *Exposure Factors Handbook*, stating that "in a creel study, the target population is anyone who fishes at the locations being studied. Generally in a creel study, the probability of being sampled is not the same for all members of the target population. For instance, if the survey is conducted for one day at a site, then it will include all persons who fish there daily but only about 1/7 of the people who fish there weekly, 1/30th of the people who fish there monthly, etc. In this example, the probability of being sampled … is seen to be proportional to the frequency of fishing...[B]ecause the sampling probabilities in a creel survey, even with repeated interviewing at a site, are highly dependent on fishing frequency, the fish intake distributions reported for these surveys are not reflective of the corresponding target populations. Instead, those individuals with high fishing frequencies are given too big a weight and the distribution is skewed to the right, i.e., it overestimates the target population distribution." (EPA 2011, p. 10-3)

To correct for avidity bias, the survey sample is typically weighted based on the reported frequency of fishing by survey participants (EPA 2011; Price et al. 1994). For example, a single day of surveying may have encountered three individuals: 1) one individual who fished with a frequency of one day per year; 2) one individual who fished with a frequency of one day per month; and 3) one individual who fished daily. If those individuals ate one half pound (227 g) fish meal on each day of fishing, their annualized average daily FCRs would be 0.62, 7.5 and 227 g/day, respectively. Based on this 3-person sample, one would conclude that the average consumption rate for these three individuals was 78 g/day. However, if the survey were to be conducted at that location daily throughout the year, it is likely that it might have encountered 365 individuals who fished once per year, 12 individuals who fished once per month, and one individual who fished daily. Thus, the total user population would be 396 individuals, representing 396 points on the fish consumption distribution for the total user population. If their FCRs were identical to the rates for the individuals interviewed during the single day of the survey, the result would be 365 individuals consuming 0.62 g/day, 30 individuals consuming 7.5 g/day, and 1 individual consuming 227 g/day. Thus, for this total angler population, the average rate would be 1.7 g/day. This is substantially lower than the average of 78 g/day based on the actual sample of three individuals. This demonstrates the considerable conservative bias introduced to the FCR estimate if avidity bias is not corrected. Actual corrections depend on the frequency of sampling and the population sampled and so need to be made on a study-by-study basis.

While it is now recognized that avidity bias needs to be considered when analyzing survey data to derive estimates that are representative of the total consuming population, this was not generally done for historical surveys and is still often not done by current study authors. Instead, the consumption rates presented in many survey reports reflect the consumption rates derived from only those individuals who were sampled and thus are biased toward more frequent anglers and consumers. Sometimes it is possible to make these corrections retroactively if the raw data are still available, but often this is not the case. As a result, many consumption estimates that are presented based on creel survey data have not been adjusted to reduce this conservative bias and consequently overestimate consumption rates for the total target population.

- Short-term behavior captured during a single snapshot in time may not be representative of long-term behavior because of variability in fishing effort and success. There may be substantial seasonal variations in the habits of anglers due to fishing regulations, climate, and the availability of target species. Consequently, information collected during a single interview may not be representative of activity on previous or subsequent trips or at other times of the year. Because of limited time for conducting interviews, it is difficult to ask enough detailed questions to allow development of a reliable estimate of the long-term rates of consumption. In addition, the assumptions that must generally be made to extrapolate from short-term data to estimate long-term behaviors add greatly to the uncertainties associated with those estimates.

  Creel surveys are effective at characterizing the consumption habits of individuals who use a specific fishery and are helpful in identifying any subpopulations of fish consumers that are present. It is more challenging, however, to derive a long-term estimate of consumption or to expand the results to a larger geographic area unless very detailed information is collected and there is an appropriate correction for avidity bias.

3.1.2 *Mail Surveys*

Mail surveys are a good tool for collecting detailed information about fishing and consumption behaviors. Generally, mail surveys are designed to randomly sample the target population. Often, for fish consumption, the target population is recreational anglers and mailing addresses are obtained from fishing licenses sold within the target area. Mail surveys can generally collect more detailed information over a longer period of recall, ranging from months to a year. There are, however, some limitations associated with the use of mail surveys.

- Response rates may be low, unless there is a concerted follow-up effort. If rates are very low, then the resulting FCRs may not be representative of the entire target population. In this case, rates are generally overestimated due to the fact that individuals who choose to respond to the survey tend to self-select; that is, the individuals who are most likely to return a mail survey are those for which fishing is an important activity. These individuals tend to be more avid anglers who fish more frequently than the typical angler population and have a higher rate of success in catching fish. Thus, consumption rates based on data collected in a survey with a low response rate may be biased higher than rates that would be estimated if the entire angler population was equally represented in the survey data.
- Because mail surveys often focus on a longer period of recall, the resulting FCRs are subject to recall bias. It is possible that difficulties in recalling specific information about fishing activity may result in the omission of some meals; however, data on the biases associated with long-term recall periods for recreational activities indicate that individuals tend to overestimate their participation, particularly if the issue being investigated is salient for them (Westat 1989). Thus, the tendency is for FCRs to be overestimated with longer recall periods.
- It can be difficult to target certain subpopulations of fish consumers (e.g., high end consumers, specific ethnic groups, individuals who fish a particular waterbody, etc.) with a mail survey. Individuals who are homeless or migrant will not be captured, and those individuals who have limited language skills and/or low levels of literacy may not understand the survey questions and, thus, may choose not to complete and return it. Thus, these groups may be under-represented in the survey sample.

Mail surveys are often conducted to collect information on a statewide or regional basis. If well designed, they can provide detailed information about the fish consumption behaviors of study participants as they can be completed at the respondent’s leisure rather than requiring instantaneous recall of past events. However, FCRs derived from mail surveys may be overestimated if recall periods are long. They may also be overestimated if response rates are low because often non-respondents are less interested in the subject of the survey and, therefore, choose not to participate. In this case, however, data collected through follow-up contact with non-respondents can be used to adjust survey results.

3.1.3 *Telephone Surveys*

Telephone surveys generally consist of the one-time collection of data from a survey participant by telephone. Lists of telephone numbers of individuals within the target population are developed either through the random selection of telephone numbers from all telephone listings in a given area (e.g., statewide, population within certain counties, or population within certain zip codes near a specific waterbody or fishery) or, in the case of surveys of recreational anglers, may be based on information obtained from fishing licenses purchased. Survey respondents are asked to recall information about past fishing trips and fish consumption behavior.

Telephone surveys are rarely used in isolation, however, and are often a follow-up to surveys that have been previously sent to the targeted individuals, thereby providing an opportunity for those individuals to review the survey questions before being asked to respond to them (EPA 1992). They may also be conducted to provide information about non-response bias (for those individuals who did not respond to a mail survey effort) or to confirm or add to data that were collected in the field during a creel survey (EPA 1992).

Telephone surveys are effective in evaluating regional information and can reach large numbers of individuals (EPA 1992) but also have limitations, including the following:

- Individuals who are being interviewed by telephone are rarely willing to spend more than 10 or 15 minutes participating in a telephone interview, particularly when they have had no warning that they will be called. This limits the amount of information that can be captured from them and is likely to result in recall bias due to the fact that individuals may not recall information completely or accurately when they are unprepared to do so. In addition, because of limited time, they can only be asked general information about their long-term fish consumption habits or specific information about their most recent activities.
- Because telephone surveys generally only include a single interview with an individual, they are subject to bias due to the fact that the responses of the participants may only reflect their most recent activities. Thus, if the telephone interview occurs at a time that the respondent is actively fishing or consuming fish, the resulting data may over-estimate his long term level of activity. At the same time, if the telephone interview occurs during a period of inactivity, his long term consumption activity may be under-estimated.
- Individuals who do not have telephones cannot be included in the sample population. Because those individuals are likely to be low income individuals who cannot afford the cost of a telephone, this segment of the population is likely to be under-represented in the survey sample. Similarly, individuals with unlisted numbers will not be included in the survey.
- Recent telephone surveys may be biased toward an older, higher income population if they have not included the sampling of cell phones in addition to land lines, as younger people are more likely than older individuals to rely completely on cell phones. In addition, even if cell phones are sampled, it is not always possible to accurately sample the geographic location targeted because cell phones are not tied to specific addresses (individuals may move to a different home or area but retain the same cell phone number).
- Telephone surveys can be useful if the general population of a given area is being targeted or if anglers are being targeted and the telephone numbers have been obtained from recent fishing licenses. However, if the target population is a particular socioeconomic subpopulation (e.g., ethnicity or income level), it is very difficult to identify those individuals in advance when selecting a list of telephone numbers. Thus, the smaller the target population, the larger the survey effort necessary to gain enough data about the subpopulation or group of interest.

All of these issues can affect the FCR estimates that are derived based on a telephone survey. The most important considerations are the way that the short-term recall information has been used to estimate long term consumption rates and the attention to avoiding the bias introduced in survey results if certain segments of the population are not well represented in the sampling.

3.1.4 *Fishing Diaries*

Diary studies are an excellent means of collecting detailed information about specific fishing trips and fish meals. In these studies, individuals from the targeted population are recruited to participate in the study and are asked to keep a diary of the fishing trips taken. These studies can be short- or long-term studies. For long-term studies, individuals are generally asked to complete monthly diaries and can record very detailed information about every trip taken and every harvested fish that was consumed. If the individuals complete the diaries in a timely fashion, these studies minimize the potential for recall bias and also increase the level of detail that the person is able to recall (e.g., the size of a fish meal, the species consumed, the number of people who shared in the meal, etc.). If this information is collected over a long time period (e.g., for example, monthly diaries completed over a one year period), it can result in very accurate estimates of long-term fish consumption.

One difficulty with long-term diary studies is that there can be a high level of attrition because people tire of recording their information and so stop completing the diaries. However, while the information gathered may only be partial (e.g., several months of the targeted one-year period for the study), the level of detail provided in the diary and the partial data can still yield valid estimates of long-term fish consumption behaviors by the study participants (Balogh et al. 1971).

3.1.5 *Diet Recall Studies*

Diet recall studies are a form of diary study but are generally shorter term. In these studies, individuals are commonly asked to record all foods eaten during a one- or two-day period. The days may be consecutive days or two different days during the study period. These recall studies work well for foods that are consumed on a regular basis (i.e., foods that are consumed daily or at least once every two days) and when evaluating population-level trends, but are not as effective for developing reliable estimates of long-term consumption behavior of foods that are consumed less regularly (as discussed in more detail in Section 3.2.2)). Thus, for those individuals who consume fish daily or several times per week, the estimated rates of consumption based on these data may be representative of their behavior.

However, for many individuals, fish is not consumed on a daily or regular basis. This is particularly true of sport-caught fish, which may only be consumed occasionally (e.g., once per week or less or only during a specific time of the year) (Ebert et al. 1994). As discussed in more detail in Section 3.2.2, short-term recall periods may substantially bias the results by incorrectly assuming that individuals who did not consume during the recall period are non-consumers, and leaving them out of the consumption rate distribution, thereby skewing that distribution toward more frequent consumers. This results in overestimated consumption rates for the total population. In addition, the timing of the diet recall study can substantially affect the resulting consumption estimates if there is a seasonal component to the consumption habits of sport-fishermen. For example, in most states, fishing regulations limit the harvest for individual fish species to certain times of the year. Some individuals have a strong preference for a certain species and only consume fish when those species are available. Thus, while they may consume those fish regularly during that season, they may not consume fish at all during the remainder of the year. If the diet recall survey is conducted during the season when they are regularly consuming those fish, and the survey is not carefully designed to address seasonal variations, their annualized, average FCRs will be overestimated. Conversely, if the diet recall study is conducted during the time when these fish are not being consumed, their FCR will be underestimated as it will, by necessity (due to lack of consumption information) be assumed that they are non-consumers. Because of this, their consumption will not be included in the consumption rate distribution from the survey, thereby biasing that distribution to more frequent consumers and higher consumption rates.

3.2 Analysis of Survey Data to Derive FCRs

Data from surveys can be analyzed a number of different ways and the approach to analysis will depend, in part, on survey design. The key consumption metric for deriving AWQC is to derive an annualized average daily FCR. When estimating these FCRs, it is necessary to understand the size of each meal consumed and the frequency with which those meals are consumed.

There are two common approaches for estimating consumption rates. These include an approach based on reported meal frequency and size, and an approach based on the amount of fish harvested and consumed on a yearly basis.

The meal frequency approach requires that information on the number and size of meals consumed by the surveyed individual over a period of time be collected and then extrapolated to the extent necessary to derive an annualized daily average FCR. Thus, for example, if the survey respondent indicates that he or she eats 26 half-pound [227 gram (g)] fish meals per year, the ingestion rate would be calculated as follows:

$$FCR = 26 \text{ meals/yr} * 227 \text{ g/meal} * 1 \text{ yr/365 days} = 16.2 \text{ g/day}$$

Similarly, if the respondent indicates that she eats 1 meal every two weeks, her FCR is calculated as follows:

$$FCR = 0.5 \text{ meal/week} * 227 \text{ g/meal} * 52 \text{ weeks/year} * 1 \text{ yr/365 days} = 16.2 \text{ g/day}$$

Alternatively, the harvest rate approach uses information about the mass of fish actually harvested by the survey participant over time, adjusts that mass by the edible portion of the fish (total mass minus the mass of the parts not consumed by the angler, such as viscera, head, bones, etc.) and the number of people to share in the fish meal. Thus, if a survey respondent indicates that he or she harvested 40 kg (88 pounds) of fish during a year, the default edible fraction of 30 percent (EPA 1989) is used, and it is reported that a total of 2 adults consumed the fish, the FCR would be calculated as follows:

$$FCR = 40{,}000 \text{ g whole fish/yr} * 0.30 \text{ g edible/g whole} * 1/2 \text{ persons} * 1\text{yr/365 days} = 16.4 \text{ g/day}$$

Depending upon the survey approach used and the questions asked, one method may be more appropriate than the other. There are some limitations of each of these approaches, however, that need to be considered.

- There are uncertainties about the meal method due to the fact that the size of fish meals may vary considerably. Meals of store-purchased fish are likely to be fairly consistent due to the fact that a consistent amount of fish may be purchased for consumption. The same is not true for sport-caught fish. Meal sizes will vary depending upon the mass of fish harvested on a given day and the number of individuals consuming it. Thus, because individuals are generally asked to estimate the size of fish meals consumed, they may or may not accurately represent the variety of meal sizes that are actually consumed over time if the fish are sport-caught fish. While individuals involved in the surveys are often provided with photographs of meals of different sizes, these estimated meal weights may not be representative of the fish actually consumed due to differences in mass resulting from cooking, the way the fish were prepared, and the density of the fish tissue. In addition, although they may provide their estimated average weekly rate of consumption, this weekly rate may vary considerably by season due to changes in weather, fishing time, or availability of target species. Unless data are collected to specifically capture these variations, there is substantial uncertainty introduced by this approach.

- There are also uncertainties introduced when using the harvest method because individuals may not recall exactly how much fish they have harvested over time, and the portion sizes of the individuals who share in the consumption of the fish may vary. Thus, if two people share in the catch it will normally be assumed that the total mass should be divided by two; however, the portions consumed by those individuals may not be equivalent. In addition, there may be some variability around the edible portion of the fish depending on the parts consumed by the survey participants, the fact that edible portions vary somewhat by species, and the number of individuals who share in individual fish meals.

3.2.1 *Identifying "Consumers" and "Non-Consumers"*

When determining the population to be targeted in selecting an FCR for use in developing AWQC, it is important to determine who is likely to be exposed to that chemical via the consumption of fish. Clearly, individuals who never consume fish will have no potential for exposure via this pathway so that the emphasis needs to be on the individuals who actually consume fish as this will be the potentially exposed population. However, depending upon the waterbodies to which the AWQC will be applied, the fish consuming population will vary. If the AWQC will be applied to waterbodies that are commercially fished, then there is potential for exposure to the general population, because they will have access to that fish through commercial sources such as fish markets, grocery stores and restaurants. However, if the waterbodies that are the focus of the AWQC are not commercially fished, then the fish from those waterbodies will not be available to the general population. The only sources of those fish are the recreational anglers who fish those waterbodies.

Once the target population has been identified, it is necessary to identify the FCRs for the individuals within that population who consume fish. Depending upon the survey approach used, this determination can be challenging. For example, if the AWQC are to be applied to commercially fished waterbodies, then the general population who have access to those fish is the target population. However, most surveys of the general population collect information about total fish consumption including consumption of fresh, frozen, canned and prepared fish and shellfish obtained from stores and restaurants, which are most often imported from locations outside of the area of influence of the AWQC, as well as sport-caught fish and shellfish from local sources.

Even if the survey has distinguished among different sources of fish, the identification of consumers may be affected by the survey method. As discussed in more detail in Section 3.2.2 below, short-term diet recall studies, which are often used to evaluate food consumption within the general population, often misclassify individuals as non-consumers. Thus, while the rates are reportedly based on consumers of those fish, they are likely to be excluding a large proportion of actual consumers who have lower frequency of consumption.

3.2.2 *Limitations on the Use of Short Recall Period Survey Data*

Attempting to extrapolate long-term FCRs based on short recall period survey data presents a number of problems. These include the potential misclassification of non-consumers, the overestimation of FCRs based on data collected as a snapshot in time, and the lack of consideration of variation over time.

In general, the length of recall period affects the resulting estimated rates of consumption with shorter term studies resulting in higher estimated rates of consumption than studies with longer recall periods. The higher rates of consumption from the short-term studies may not be a reflection of actual differences in the behaviors within the surveyed populations but may instead be an artifact of the short recall period (EPA 2011; Ebert et al. 1994).

Short-term dietary recall studies can result in misclassification of participants as non-consumers and consequently overestimate consumption rates for true consumers within the surveyed population. Essentially, when a diet recall survey is conducted, if an individual does not indicate that fish was consumed during the recall period, that individual is identified as a non-consumer and is assumed to have zero consumption. When this occurs, rates are reported as either "per capita" rates (which include the non-consumers and their estimated rates of 0 g/day) or as "consumers only" rates, which means that all of the individuals who did not consume fish during that period of time are excluded from the reported results and only those individuals who did consume fish during that period are counted in the consumption rates.

The USDA dietary data that form the basis for EPA's (2000) default FCR of 17.5 g/day were collected using a dietary recall study of survey participants during two non-consecutive 24-hour periods (EPA, 2000). Because of the way in which sampling was conducted, the actual fish consumption behaviors reported are strongly biased toward those respondents who consume fish with a high frequency. All of the individuals included as fish consumers in the USDA estimate consumed fish at least once during the 2-day sampling period. To use these data to estimate long-term consumption rates, EPA assumes that the consumption behavior that occurred during the 2-day period is the same as the consumption behavior that occurs throughout every other 2-day period during the year. Thus, if an individual reported eating one fish meal during the sampling period, the extrapolation used to estimate long-term consumption was the assumption that the individual continues to eat fish with a frequency of one meal every two days, or as many as 183 meals per year. If it is assumed that an individual eats one-half pound (227 g) of fish per meal, this results in a consumption rate of 114 g/day. However, the individual who consumed fish during that sampling period may not actually be a regular fish consumer. In fact, that fish meal could have been the only fish meal that the individual consumed in an entire year. Thus, that person's FCR would be substantially overestimated using this extrapolation method.

Conversely, individuals who did not consume fish during the 2-day sampling period were assumed to be non-consumers of fish, despite the fact that those individuals may simply have been fish consumers who coincidentally did not consume fish during the 2-day sampling period. Because there are no data upon which to base consumption estimates for these individuals, they were assumed to consume 0 g/day. However, they may in fact consume fish with a frequency ranging from as little as zero meals per year to as much as one meal per day (or even more than one meal per day) on all days except the two that USDA conducted the survey. As with the high consumers identified in the USDA database, there is no way to determine whether 0 g/day consumers are actually non-consumers or just individuals who did not consume fish during the 2-day survey period.

There can be enormous variability in the frequency of consumption of specific foods (Balogh et al. 1971; Garn et al. 1976), and the variability in the number of fish meals may be further enhanced by seasonal effects. For example, recreational fishermen in many states are only permitted to fish during certain months due to fishing regulations. Thus, it is possible that their sport-caught fish ingestion rates are substantially higher during the fishing season, when fresh fish are readily available, than they are during the remainder of the year. In addition, many anglers target specific species and only fish when those species are available. For example, many anglers in the Pacific Northwest target salmon, which are only available during their time-limited spawning runs. Thus, they may not fish at all or consume sport-caught fish during other times of the year when the salmon are not available.

Because of this phenomenon, there is a tendency, if only "consumers" are considered, for short-term recall surveys to report substantially higher FCRs than do surveys with longer periods of recall. This is well demonstrated in EPA's (2011) tables of relevant fish consumption studies. For example, when reviewing EPA's relevant studies of statewide[9] freshwater recreational fish intake (EPA 2011, Table 10-5), FCRs appear to be highly variable, with means for "consuming" anglers ranging from 5.8 to 53 g/day and 95th percentile (95th %ile) values ranging from 26 to 61 g/day.[10] However, one of those studies collected data from individuals on a single day (ADEM 1994), one involved a single interview but also included a 10-day dietary diary component (Balcom et al. 1999), one involved a 90-day recall period (Williams et al. 1999), one included a 7-day recall period but also collected some

[9] There are additional studies provided on EPA's table of relevant studies but those studies are waterbody specific and thus are not directly comparable with the statewide studies.

[10] 95th percentiles are not available for all studies listed in EPA's Table 10-5. For example, EPA reports the highest mean rates for studies conducted in Alabama and Connecticut but provides no 95th percentile values from those studies. Thus, those studies cannot be included in the comparison of 95th %ile rates.

information on seasonal variation for the remainder of the year (West et al. 1989), and the remainder of the studies collected data for a 1-year recall period. When the statewide studies are segregated by recall period, the bias toward higher consumption rates based on shorter recall periods is apparent, as shown below.

Rates for Sport-caught Freshwater Fish Consumption (Adult consumers) from Statewide Studies by Recall Period (Table 10-5, EPA 2011)

Recall Period	1-day		1-day interview and 10-day diary		90 day				1 year	
Metric	Mean	95th %ile	Mean	95th %ile	Mean	95th %ile	Mean	95th %ile	Mean	95th %ile
FCR (g/day)	53	NA	53	NA	20	61	14	39	5.8-14	26-43
Study	ADEM 1994		Balcom et al. 1999		Williams et al. 1999		West et al. 1989		Ebert et al. 1993; Benson et al. 2001, Connelly et al. 1996, Fiore et al. 1989	

NA: Not available. This value was not presented by EPA (2011)
[a]The West et al. 1989 study requested information about a 7 day recall period but also collected some information on variation in behavior during different seasons of the year which were used to estimate long-term FCRs.
[b]A subsequent West et al. (1993) study collected information for a 7-day recall period but collected no longer term information that could be used to annualize the rates. While the means from the 1989 and 1993 surveys were nearly identical, the 95th percentile for the 1993 study (78 g/day; EPA 1997) was substantially higher than the 95th percentile of 39 g/day that was derived from the 1989 survey data.

Consumption of sport-caught fish is likely to have a seasonal component, particularly in states where fishing may occur for only a portion of the year. Like other seasonal foods, it is likely that these foods are eaten more frequently during their seasons than they are at other times of the year. For example, fresh, local strawberries are only available in the northeastern United States for a few weeks during the summer. When they are available locally, it is likely that strawberries are consumed in greater quantities than they are when they are out of season and can only be imported from other locations and purchased from supermarkets. That is not to say that they are never eaten when they are out of season but rather that if individuals were to be asked about their strawberry consumption during the time that fresh strawberries are in-season, it is likely that they would overestimate their consumption for other times of the year when local strawberries are not available. At the same time, if they were asked in the winter to report their strawberry consumption, it is likely that they would underestimate their strawberry consumption during the summer when fresh, local strawberries are readily available. These seasonal variations are important in terms of their affect on estimating long term consumption rates. While the USDA survey (upon which EPA's rate of 17.5 g/day is based) collected data on two different days, the survey days were no more than 10 days apart. Thus, the rates of consumption for all foods that are seasonally affected would have been dependent upon the timing of those survey days and would not necessarily reflect the participants' long-term average consumption rates.

EPA (2011) has acknowledged that short-term dietary records are problematic when attempting to estimate long-term rates of consumption, particularly for upper bound FCR estimates. In its review of NHANES 2003-2006 study data, EPA (2011, p. 10-16) stated, "the distribution of average daily intake rates generated using short-term data (e.g., 2-day) does not necessarily reflect the long-term distribution of average daily intake rates." In addition, in its discussion of the limitation of the West et al. (1993) study of Michigan anglers EPA (2011, p. 10-38) stated: "However, because this survey only measured fish consumption over a short (1 week) interval, the resulting distribution will not be indicative of the long-term fish consumption distribution, and the upper percentiles reported from the U.S. EPA analysis will likely considerably overestimate the corresponding long-term percentiles. The overall 95th percentile calculated by U.S. EPA (1995) was 77.9; this is about double the 95th percentile estimated using yearlong consumption data from the 1989 Michigan survey." In addition, when discussing the USDA methodology, EPA (1998, p. 10-107) stated that "[t]he non-consumption of finfish or shellfish by a majority of individuals, combined with consumption data from high-end consumers, resulted in a wide range of observed fish consumption. This range of fish consumption data would tend to produce distributions of fish consumption with larger variances than would be associated with a longer survey period, such as 30 days." As a result, upper-bound fish consumption estimates based on these data will be biased high and overestimate actual upper-bound consumption rates for the total population of consumers.

Short-term recall periods generally result in an overestimate of consumption behavior, particularly for foods that are not eaten on a daily basis. While this does not appear to greatly affect central tendency values for the populations studied (EPA 2011; Garn et al. 1976), the inverse relationship between upper-bound FCRs and the length of survey recall period has been clearly demonstrated (Ebert et al. 1994).

3.2.3 *Estimating Means and Upper Percentiles*

Once FCRs have been calculated for the individual survey respondents, they are typically evaluated statistically to define a central tendency or upper-bound estimate of consumption to be used in deriving AWQC. The central tendency may be an arithmetic mean, geometric mean, or a median (50th percentile value) of the range of consumption rates derived. Because the estimated FCR distribution (the range of rates) is generally very highly skewed, as are consumption rates for most foods (Garn et al. 1976), with a very large number of individuals consuming fish at very low FCRs and a few individuals consuming at high rates, the arithmetic mean is typically not a good estimate of actual central tendency. For example, in the statewide survey of Maine's recreational anglers, which included rates ranging from 0.02 to 183 g/day, the median rate of consumption by individuals who ate at least one fish meal from Maine's freshwater bodies during the year was 2 g/day but the arithmetic mean FCR for this same population was 6.4 g/day and represented the 77th percentile of the distribution of FCRs from that survey (Ebert et al. 1993).

Upper-bound FCRs may be calculated in a number of ways. For some surveys, they may be calculated as the 95th upper confidence limit of the arithmetic mean consumption rate. Alternatively, for some surveys, FCR results are ranked in order of magnitude and then the upper-bound value is selected as the 95th percentile of that distribution. Thus, for example, in the same Maine survey for which there were 1,053 FCRs calculated, the 95th percentile value of 26 g/day represented the FCR reported for angler 1,000 after order ranking of the results (Ebert et al., 1993).

3.2.4 *Consumption of Resident and Anadromous Fish Species*

It is important that the FCR used in deriving AWQC reflects consumption of the fish species that will be affected by the AWQC. This will ensure that FCRs are not overestimated.

Estimated FCRs are generally based on the total consumption of fish, and may include fish of a variety of types, including resident finfish, anadromous finfish, and shellfish. For example, the FCR recently adopted by Oregon Department of Environmental Quality was supported by state-specific data on consumption for which a substantial portion of the consumption was the ingestion of anadromous species such as salmon and steelhead. Anadromous species are not substantially affected by local water quality in estuaries and rivers because they are only present in those waterbodies when they are juveniles and when they return as adults to spawn. They spend the majority of their lives in marine waters and are typically harvested during their return spawning runs. As a result, any chemical constituents that are present in their bodies are predominantly the result of exposures they have received during their time in marine waters. Thus, changes in AWQC for local waterbodies will not affect the concentrations of those chemicals in their edible tissues. Instead the fish that are sensitive to changes in local water quality are the resident species that spend their entire life stages in local waters.

This is an important consideration for states, such as Oregon and Washington, where a substantial portion of the fish harvested for consumption are anadromous fish. For example, the Columbia River tribes consume, on average, nearly three times more anadromous fish (including salmon, trout, lamprey and smelt) as they do resident species (CRITFC 1994). Similarly, Toy et al. (1996) reported that at the 95th %ile consumption rate for the combined Tulalip and Squaxin tribes, who fish Puget Sound, 95% of the total finfish consumed were anadromous species.

Because the AWQC approach incorporates a chemical-specific bioaccumulation factor, it essentially assumes that fish are in equilibrium with constituent concentrations in the water bodies of interest. This is not likely to be the case for anadromous species because of the short time period during which they are in fresh and estuarine waters. For example, after hatching, juvenile Chinook salmon spend several months in the Columbia River before they begin their out-migration to marine feeding areas. They generally return to the river to spawn between the ages of two and six years (ODFW, 1989) and do not generally feed during their spawning run. These fish, which provide a substantial portion of the freshwater fish harvested both commercially and recreationally from the river, are clearly not at equilibrium with their surroundings.

Because migrating fish do not spend adequate time in a particular river reach to achieve equilibrium with concentrations in the water column and sediments there, the bioaccumulation factor used in developing the AWQC overestimates the tissue concentrations in such fish that can be attributed to that reach. It is only the resident species that will be impacted by local water quality. Consequently, the use of an FCR that includes anadromous fish substantially overestimates exposure to local chemicals. For example, if an individual has a total FCR of 20 g/day and 90 percent of the fish consumed during the year are anadromous fish, only 10 percent of the fish consumed, or 2 g/day, are resident fish that are likely to be affected by changes in local water quality. Thus, to use a total FCR of 20 g/day overestimates the individuals' actual potential for exposure due to local contaminants by a factor of 10. Instead, it is the consumption rates for resident species that should be used to derive AWQC because it is these species that will be affected by changes in water quality.

Not all states have the type of access to anadromous species that occurs in the Pacific Northwest. Thus, these fish will not constitute a substantial fraction of consumers' diets in many areas of the country. This makes it extremely important to ensure that the FCRs that are used in developing AWQC for a specific region are based on fish consumption information for that region and not simply based on a one-size-fits-all approach for selecting consumption rates.

3.2.5 *Consumption of Freshwater and Estuarine Species*

In developing AWQC in coastal states, the FCRs that are used typically do not differentiate between the ingestion of freshwater and estuarine finfish and shellfish. This is because AWQC need to be applied to a number of different types of water bodies. However, this assumption is very conservative when one considers permitting of individual discharges that occur in specific areas of individual water bodies and may only affect freshwater areas. If there is a permitted discharge to a freshwater body, the consumption of estuarine fish and shellfish is likely to be irrelevant. Similarly, if there is a discharge to an estuarine area, the freshwater fish upstream will likely not be affected by that discharge. Thus, inclusion of rates of consumption of freshwater and estuarine finfish and shellfish is a very conservative assumption for these specific applications, providing an additional level of health protection when AWQC are applied to specific waterbodies.

4.0 POPULATION RISK

AWQC are typically derived using a target individual risk level of 1 in 1,000,000 million (1E-06) risk for carcinogens and a hazard index of 1 for non-carcinogens. For carcinogens, this target risk represents the increased probability that an individual will develop cancer as a result of exposure through the consumption of fish tissue. The background rate for contracting cancer is roughly 30 percent; thus, when a 1E-06 risk level is selected as the target risk, this means that the probability of an individual contracting cancer increases from 30 percent to 30.0001 percent.

There is, however, another risk metric that should be considered in selecting an FCR. This risk metric is known as the population risk. It is calculated by multiplying the target risk level by the size of the affected population to predict the number of excess cancer cases that might result from that exposure. Thus, if the target risk is 1 in one million, and the size of the population is one million people, the population risk will be calculated as 1 excess cancer over the combined lifetimes of 1 million individuals who are actually exposed as a result of the modeled exposures.

Population risk is an important consideration in selecting an FCR for use in developing AWQC because as the size of the exposed population decreases, the population risks also decrease when the same target risk level is used. The higher the FCR selected for a particular population, the smaller the population to which that FCR applies. For example, if the FCR selected is a 95^{th} percentile rate, it is assumed that it is protective of all but 5 percent of the exposed population or 50,000 of the 1 million people provided in the example above. Thus, if the same target risk level of 1E-06 is used with this reduced population, the resulting population risk is 0.05 excess cancers within a population of 1 million people. In other words, in order to reach the target risk of 1 excess cancer, it would be necessary for a population of 20 million people to have lifetime exposures equivalent to the estimated exposure conditions.

EPA (2000) states that both a 1E-06 and 1 in 100,000 (1E-05) target risk level may be acceptable for the general population as long as highly exposed populations do not exceed a target risk level of 1E-04 or 1 in 10,000. In other words, if an AWQC is based on a 1E-06 risk level and an FCR if 17.5 g/day is used, this means that if there is a subpopulation of individuals who consume fish at a rate of 175 g/day, they will be protected at a risk level of 1E-05, and in order for a subpopulation to exceed the recommended upper bound risk level of 1E-04 outlined in EPA's (2000) methodology, they would have to consume more than 1,750 g of fish daily throughout their lifetimes.

EPA (2000) states that "[a]doption of a 10-6 or 10-5 risk level, both of which States and authorized Tribes have chosen in adopting water quality standards to date, represents a generally acceptable risk management decision, and EPA intends to continue providing this flexibility to States and Tribes. EPA believes that such State or Tribal decisions are consistent with Section 303(c) if the State or authorized Tribe has identified the most highly exposed subpopulation, has demonstrated that the chosen risk level is adequately protective of the most highly exposed subpopulation, and has completed all necessary public participation" (EPA 2000).

Selection of an FCR to be used in developing AWQC is as much a policy decision as a technical decision. There are wide ranges of FCRs available depending upon the population targeted for study and it is important that the target population be identified so that the selection of an FCR rate can be based on that target population and the target risk level can consider both individual and population risks for that population.

5.0 DISCUSSION

When selecting an FCR for establishing HHAWQC, it is critical that a number of important issues be considered. These include: 1) identifying the target population of fish consumers and the waterbodies that will be affected by changes in HHAWQC; 2) evaluating and selecting FCRs based on fish consumption studies that provide reliable, long-term information on the fish consumption habits of the target populations and waterbodies; and 3) consideration of both individual and population risks in selecting an FCR.

Generally speaking, the population of interest for the development of HHAWQC consists of those individuals who consume freshwater or estuarine finfish and/or shellfish from the area of interest. If the waters to which HHAWQC are to be applied are commercially fished, then this population will include members of the general population who may consume fish from a wide variety of commercial and recreational sources. In this case, FCRs should be based on general population studies of good quality. If, however, the waterbodies of interest are not commercially fished, then the target population includes those anglers who catch and consume their own fish from those waterbodies and the FCR should be selected from regionally-appropriate studies of consumption by recreational anglers.

HHAWQC are used as environmental benchmarks and as objectives in the development of environmental permits. While they are applicable to all ambient waters in a state, they are most often considered for individual water bodies when state regulatory agencies are developing permitting and effluent limits. Thus, assumptions that are already judged and selected to be conservative when one is attempting to develop statewide criteria, become extremely conservative when considering individual water bodies.

In light of the way in which HHAWQC are applied in permitting, the approach used to develop HHAWQC includes a number of highly conservative assumptions, particularly for constituents that are limited and localized. The conservative assumptions used in the development of HHAWQC and subsequently applied to permitting typically include:

- FCRs that include the combined consumption of freshwater and estuarine fish and shellfish and, in some areas, include anadromous species that are not impacted by local water quality conditions;
- 100 percent of the fish consumed in a lifetime are obtained from a single, impacted waterbody;
- There is no reduction in chemical concentration that occurs as a result of cooking or preparation methods;
- Concentrations of compounds in fish are in equilibrium with compound concentrations in the water body; and,
- The allowable risk level upon which they are typically based is one in one million. This means that the probability of developing cancer over a lifetime increases from 30% to 30.0001%.

There are a very small number of individuals, if any, to whom all of these conservative assumptions would apply.

EPA's recommended FCR of 17.5 g/day can reasonable be judged as conservative and protective when used in establishing AWQC for a number of reasons.

- It is based on survey data collected by the USDA, which are surveys of the general population, and includes information about many species and meals of fish that would not be found in the waterbodies that are subject to the HHAWQC. The reported fish meals were obtained from numerous sources and included fresh, frozen, prepared and canned fish products that may have been produced in other regions of the United States or other countries and, consequently, not derived from local waterbodies. Thus, the USDA data overestimate the consumption of locally caught fish, particularly if there are no commercial fisheries, and certainly overstate consumption from individual waterbodies that are regulated under the HHAWQC.
- As discussed previously, this rate is based on 24-hour dietary recall data. Use of such data to estimate long term consumption rates for any population results in biased and highly uncertain estimates.
- HHAWQC based on that consumption rate, combined with other very conservative assumptions that are included in the HHAWQC calculation, ensure that risks of consuming fish from a single regulated waterbody are likely to be substantially overestimated and, therefore, will also be protective of individuals who are at the high end of the consumption distribution.

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APPENDIX B

A BRIEF REVIEW OF ISSUES RELEVANT TO THE ACCUMULATION OF PERSISTENT, BIOACCUMULATIVE, AND TOXIC (PBT) CHEMICALS BY SALMON

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1.0 INTRODUCTION

In September 2011 Washington State Department of Ecology (WDOE) issued Publication No. 11-09-050, *Fish Consumption Rates Technical Support Document, A Review of Data and Information about Fish Consumption in Washington*. This technical support document (TSD) was generated to support decision making regarding how to obtain an appropriate fish consumption rate (FCR) for use in calculating water quality standards for protecting human health (HHWQS). One of the issues WDOE raised in this TSD was whether consumption of salmon should be included in whatever FCR is ultimately used in these calculations, and if it is concluded that salmon should be included in an FCR, how to do so.

The driver behind this is human exposure to toxic chemicals, specifically via consumption of fish (or aquatic tissue in general). The greatest risk to human health from consumption of fish is generally understood to result from the presence of persistent, bioaccumulative, and toxic (PBT) chemicals. Thus the primary factor in determining the appropriateness of including consumption of salmon in an FCR is where salmon actually pick up these contaminants. A brief review of what is known about this subject is presented herein.

2.0 WHERE SALMON ACCUMULATE PBT CHEMICALS

As discussed by NOAA (2005), different runs of salmon exhibit different life histories. More specifically, NOAA described stream-type and ocean-type life histories. Behavioral attributes of these two general types of salmon are summarized in Table B1.

From Table B1, different species of salmon and different runs of the same species can exhibit distinctly different life histories, including how much time is spent in freshwater and where in freshwater systems this time is spent. These differences are potentially significant in that they may lead to differences in the mass (burden) of chemical contaminants (e.g., PBT chemicals) ultimately accumulated by the salmon, and in the fraction of this ultimate burden accumulated in freshwater vs. saltwater. Although the latter may not be relevant when assessing the risk to human health resulting from eating contaminated fish in general, it is relevant when considering what fraction of this overall risk results from accumulation of contaminants in freshwater systems vs. saltwater systems.

This last point is directly relevant to the question of whether there is any utility in including consumption of salmon in an FCR that will be used to drive remedial action(s) on the geographically limited scale of a single state. If a significant fraction of the contaminant burden found in salmon is accumulated in true freshwater systems it makes sense that the consumption of salmon be included in an FCR. However, if accumulation in the open ocean dominates, inclusion of salmon in an FCR makes no sense because there is no action the state can take that will have a significant effect on the contaminant burden found in returning adult salmon.

Table B1 A Summary of the Juvenile Characteristics of Stream and Ocean Life History Types

Stream-Type Fish	Ocean-Type Fish
Species	
Coho salmon	Coho salmon
Some Chinook populations	Some Chinook populations
Steelhead	Chum
Sockeye	Pink
Attributes	
Long period of freshwater rearing (>1 yr)	Short period of freshwater rearing
Shorter ocean residence	Longer ocean residence
Short period of estuarine residence	Longer period of estuarine residence
Larger size at time of estuarine entry	Smaller size at time of estuarine entry
Mostly use deeper, main channel estuarine habitats	Mostly use shallow water estuarine habitats, especially vegetated ones

[SOURCE: NOAA 2005]

Exclusion of salmon from an FCR does not imply that human exposure to contaminants due to consumption of salmon should not be accounted for when assessing overall risks to human health. Instead, these issues should be weighed when deciding whether salmon are accounted for when assessing the risks resulting from consumption of freshwater fish (by including consumption of salmon in an FCR) or when assessing the risks resulting from consumption of saltwater or marine fish (salmon would be backed out of the risk assessment for deriving a freshwater HHWQS via the relative source contribution or RSC). Ultimately, the issue of where the risks from consumption of salmon are counted appears to be an academic question. The more important factor (from the perspective of characterizing risk) is to ensure that consumption of salmon is not double counted by including it in both an FCR and as a component of the RSC.

In any case, the issue of salmon (or anadromous fish in general) is unique in that it is quite likely that a generic salmon will accumulate contaminants in both freshwater and saltwater habitats, and that the relative fraction accumulated in one habitat vs. the other will vary with species, run, and even individual. Taken to the extreme, this implies that each run needs to be evaluated independently to determine where contaminants are accumulated. However, much of the scientific literature supports accumulation in the open ocean as the dominant pathway for uptake of PBT chemicals by salmon, with the work of O'Neill, West, and Hoeman (1998), West and O'Neill (2007), and O'Neill and West (2009) providing perhaps the most thorough examination of the issue.

Figure B1 is taken from O'Neill and West (2009) and shows that levels of polychlorinated biphenyls (PCBs) in adult Chinook salmon (fillets) collected from a wide range of geographic locations are relatively uniform except for fish taken from Puget Sound, which show three to five times higher levels of PCBs than fish taken from other locations. As discussed by the authors, these data can be interpreted as indicating accumulation of PCBs in Puget Sound and/or along the migratory routes of these fish, which, depending on the specific runs, can pass through some highly contaminated Superfund sites (e.g., Duwamish Waterway). However, O'Neill and West (2009) concluded that, on average, >96% of the total body burden (mass) of PCBs in these Puget Sound Chinook was accumulated in the Sound and not in natal river(s).

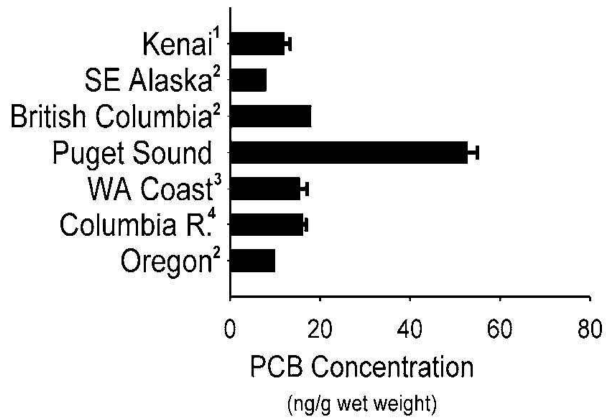

Figure B1 Average (±SE) PCB Concentration in Chinook Salmon Fillets
Data for Puget Sound were based on 204 samples collected by the Washington Department of Fish and Wildlife from 1992 to 1996; data for other locations were taken from the following (indicated by superscript numbers): [1]Rice and Moles (2006), [2]Hites et al. (2004; estimated from publication), [3]Missildine et al. (2005), and [4]United States Environmental Protection Agency (USEPA 2002) [SOURCE: O'Neill and West 2009]

The basis for this conclusion is presented in Table B2, which compares PCB concentrations and body burdens in out migrating Chinook smolts collected from the Duwamish River and adults returning to the Duwamish.

Table B2 Concentration of PCBs (ng/g) and Body Burden of PCBs (total ng/fish) in Out-migrating Chinook Salmon Smolts and Returning Adults from the Contaminated Duwamish River, Washington

Variable	Smolts	Adults
Number of samples	80	34
Mean fish weight (g)	10	6,000
Whole body PCB concentration (ng/g)[a]		
Mean	170	57
95th percentile	860	88
PCB body burden (ng/fish)[a]		
Mean	2,100	350,000
95th percentile	9,200	800,000
Mean % of PCB body burden from the most contaminated smolts[b]	—	3.8

[a] Values for smolts are from J. P. Meador (National Oceanic and Atmospheric Administration Fisheries, Northwest Fisheries Science Center, personal communication); values for adults were estimated from measured muscle tissue concentration using the fillet–whole-body regression (see Methods) for PCBs.

[b] Contaminant data were only available for out-migrating subyearling smolts, so only samples with adults that went to sea as subyearlings were included in the analysis.

[SOURCE: O'Neill and West 2009]

These data show that even the most contaminated out migrating smolts contained no more than 4% of the body burden (mass) of PCBs found in returning adults. Thus, >96% of the PCB mass (burden) found in the returning adults was accumulated in Puget Sound. Even allowing for an order of magnitude underestimate in the body burden of out migrating smolts, O'Neill and West (2009) concluded that accumulation in freshwater would account for <10% of the average PCB burden ultimately found in adults returning to the Duwamish. By extension, this analysis supports the conclusion that Chinook salmon passing through uncontaminated estuaries during out migration accumulate a dominant fraction of their ultimate PCB body burdens in the open ocean. Other researchers have also reached this conclusion using their own data (e.g., Johnson et al. 2007; Cullon et al. 2009).

However, this analysis does not explain why Chinook salmon collected in Puget Sound exhibit higher concentrations of PCBs than Chinook salmon collected from other locations (Figure B1). Ultimately, O'Neill and West (2009) attributed this to a combination of factors, specifically PCB contamination of the Puget Sound food web (e.g., West, O'Neill, and Ylitalo 2008) combined with a high percentage of Chinook displaying resident behavior. That is, a large fraction of out migrating Chinook smolts take up permanent residence in the Sound, where they feed from a more contaminated food web than found in the open ocean. These factors would not affect Chinook runs or runs of any other species associated with natal rivers that discharge to saltwater outside Puget Sound.

Overall, these data support the position that, as a general rule, the predominant fraction of the ultimate PCB burden found in harvested adult fish is accumulated while in the ocean-phase of their life cycle (e.g., Cullon et al. 2009; Johnson et al. 2007; O'Neill and West 2009). Although this conclusion is specific to PCBs, there is no reason to suppose that it would not also hold for other legacy PBTs (e.g., DDT, dioxins) or globally ubiquitous PBTs (e.g., PBDEs, methylmercury) in general (e.g., Cullon et al. 2009). Because concerns about human consumption of fish are driven by risks from exposure to PBTs, driving the FCR higher by including salmon would thus appear to be of limited utility from the perspective of protecting human health simply because these contaminants are accumulated in the ocean.

With that said, there are sufficient data to conclude that the food web in Puget Sound is contaminated with PCBs to a greater degree than the food web in the open ocean. To the extent that this is a result of true local sources (e.g., sediment hotspots), there may in fact be some “local” action that can be taken to reduce PCBs, or potentially other PBTs, in Puget Sound salmon. However, this is totally dependent on identification of localized sources amenable to remediation, and not simply a conclusion that the food web is contaminated (e.g., West and O’Neill 2007).

Again, simply increasing the FCR by including salmon will have essentially no positive effect on human health given that the dominant fraction of PBT body burdens in salmon appears to be accumulated in the open ocean, and not in waters immediately subject to in-state loadings.

3.0 PBT ACCUMULATION BY DIFFERENT SALMON SPECIES

As discussed, there is ample evidence that the body burdens of PBTs found in returning adult Chinook salmon depend to a significant extent on the life history of the specific run. Beyond this, there are interspecies differences in migratory and feeding behavior that suggest Coho, sockeye, pink, and chum salmon will not accumulate PBTs to the same extent as Chinook salmon under similar exposure scenarios (Groot and Margolis 1991; Higgs et al. 1995). Perhaps the most significant factor differentiating Chinook from the other salmon species is that Chinook tend to eat more fish (Higgs et al. 1995). Thus they effectively feed at a higher trophic level than the other species of salmon, and would be expected to accumulate greater burdens of PBT chemicals even when sharing the same habitat. This is in fact observable. For example, when looking at adult Chinook and Coho returning to the same rivers, O’Neill, West, and Hoeman (1998) found that Chinook muscle contained, on average, almost twice the total PCB concentrations found in Coho muscle. This was also true for adults collected in Puget Sound proper (O’Neill, West, and Hoeman 1998).

Differences between species can also manifest in sub-adults. For example, Johnson et al. (2007) reported ΣPCB concentrations in juvenile wild Coho collected from five different estuaries ranging from 5.9 to 27 ng/g (wet weight; whole body minus stomach contents). The corresponding range for wild Chinook juveniles collected from the same estuaries was 11 to 46 ng/g (wet weight; whole body minus stomach contents). Overall, PCB concentrations in juvenile Coho were, on average, equivalent to nominally 50% of those found in the paired Chinook juveniles. This is essentially the same ratio observed by O’Neill, West, and Hoeman (1998) in adult fish.

All this indicates that PBT residues in salmon will vary within species depending on the specific run, and between species regardless (i.e., even when different species share the same general habitat). Thus, grouping all salmon together does not provide an accurate assessment of PBT doses delivered to human consumers due to consumption of salmon. This suggests that human health risk assessments should, as a general rule, incorporate salmon on a species-specific basis, if not a run-specific basis.

Certainly, none of this is supportive of adopting a single default value for the dose of any contaminant received by humans via consumption of salmon. Thus adoption of a single default FCR for salmon is also not supported.

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APPENDIX C

FISH TISSUE CONCENTRATIONS ALLOWED BY USEPA AMBIENT WATER QUALITY CRITERIA (AWQC): A COMPARISON WITH OTHER REGULATORY MECHANISMS CONTROLLING CHEMICALS IN FISH

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1.0 INTRODUCTION

For chemicals that are capable of concentrating in fish, Ambient Water Quality Criteria for the Protection of Human Health (HH-WQC) are derived based on the uptake of the chemical by edible fish and an assumed level of fish consumption by anglers (USEPA 2000). It follows that for these chemicals, there is an allowable fish tissue concentration corresponding with each HH-WQC. The associated allowable concentrations are risk-based benchmarks analogous to other risk-based thresholds applied to edible fish in other circumstances and, therefore, the comparison with the more formal screening levels or guidelines is of interest. This appendix first describes how these allowable fish tissue concentrations, which are an integral component of the HH-WQCs, are derived. Next, several comparisons are presented between these allowable fish tissue concentrations and existing fish concentration data, concentrations found in other foods, as well as other guidelines or risk-based levels used for regulating chemical concentrations in edible fish, such as fish consumption advisory (FCA) “trigger levels” issued by state and federal agencies, and U.S. Food and Drug Administration (USFDA) tolerances, illustrating the differences in these values.

These comparisons will focus on a short list of chemicals for which an HH-WQC has been established and for which fish tissue concentration data are likely to be available. This list is comprised of the following chemicals:

- arsenic
- methyl bromide
- mercury (total, inorganic and organic)
- PCBs (total)
- chlordane; and
- bis-(2-ethylhexyl)phthalate (DEHP)

These six chemicals were selected based on several considerations: 1) propensity for accumulating in fish; 2) inclusion in fish tissue monitoring programs; 3) inclusion in recent studies measuring chemicals in other foods; 4) inclusion in specific analyses estimating human (dietary) intake; and 5) subject of FCAs in at least one state. Not all of these criteria were satisfied for each of the six example chemicals; nor did the available data allow comparisons to be made for all six chemicals; however, in general, at least four of the six chemicals could be included in each of the comparisons that were undertaken as part of this analysis.

2.0 ALLOWABLE FISH TISSUE CONCENTRATIONS DERIVED FROM THE HH-WQCS

The HH-WQCs are established based on two exposure pathways: use of surface water as a source of drinking water; and the consumption of fish that may be caught and eaten from the surface water. The same algorithms that are used to calculate the HH-WQC can be rearranged to "back-calculate" an allowable fish tissue concentration.[11] Such values could be termed a water quality-based fish tissue concentration (FTC_{WQ}). These values are therefore a function of the same exposure assumptions, toxicity values and target risk level of 1 x 10^{-6} (for carcinogenic effects) used in calculating the HH-WQC.

The fish consumption rate (FCR) is an important factor in determining the HH-WQCs for chemicals having a moderate or high bioaccumulation potential. This analysis employs three different FCRs. As intended for the general population of fish consumers, we used the U.S. Environmental Protection Agency's (USEPA's) previously recommended default FCR of 6.5 grams/day or the current USEPA-recommended FCR of 17.5 grams/day. The choice between these two FCRs for each of the six chemicals was based on the derivation of the current HH-WQC, as published by USEPA. Specifically, the FCR used by USEPA to derive the current WQC for each chemical was selected for this analysis. For all but one chemical, this FCR was 17.5 grams/day. The exception was arsenic, where the HH-WQC is still based on an FCR of 6.5 grams/day. (The FTCs based on a FCR of 17.5 grams/day are referred to as the $FTC_{WQ\text{-}17.5}$ in the remainder of this appendix. Note that the recreational consumption rate FTC for arsenic is also referred to as $FTC_{WQ\text{-}17.5}$ despite being based on a FCR of 6.5 grams/day.)

Applying a FCR of 142.4 grams/day produced another set of FTC_{WQ} (referred to as the $FTC_{WQ\text{-}142}$ in this appendix); this FCR represents a higher-end fish intake, which USEPA specifically recommends for subsistence anglers and is similar to the FCR recently adopted by the state of Oregon for state-wide ambient water quality criteria (Oregon DEQ 2011). The resulting FTC_{WQ} for the six chemicals represent concentrations a regulatory agency might use to restrict consumption of fish in areas where there was reason to believe that subsistence fishing was known to occur. FTC_{WQ} calculated for the six chemicals are summarized in Tables C1a (based on a FCR of 6.5 or 17.5 gram/day) and C1b (based on a FCR of 142 gram/day).

FTC_{WQ} were derived from both the "water + organism" and the "organism only" HH-WQC. The former assumes that a surface water body is used as a source of drinking water and a source of fish consumption. The latter assumes that a surface water body is used only for consumption of fish. The influence of the drinking water consumption pathway is minor, or negligible for chemicals with a high bioconcentration factor (BCF), such as polychlorinated biphenyls (PCBs) and chlordane; however, it is important for chemicals with lower BCFs, such as methyl bromide, arsenic, and BEHP. For these chemicals, the use of the water and organism HH-WQC means that the allowable fish tissue concentration (i.e., FTC_{WQ}) will be substantially lower, because the target risk levels must be split between these pathways. However, the resulting FTC_{WQ} would be assumed to be applicable in most areas because most states require that surface water bodies be protected for use as a source of drinking water.

[11] Mathematically, this is the equivalent of multiplying the HH-WQC by the BCF, as long as a pathway-specific HH-WQC is used, i.e., based on the "organism only" or "water+organism" HH-WQC values.

Table C1a Allowable Fish Tissue Concentrations Derived from HH-WQC ($FTC_{WQ-17.5}$) for Six Chemicals: FCR = 17.5 g/day[1]

		HH-WQC Category[2]			
		Water+Organism		Organism Only	
Chemical	BCF (L/kg)	HH-WQC (µg/L, ppb)	$FTC_{WQ-17.5}$ (µg/kg, ppb)	HH-WQC (µg/L, ppb)	$FTC_{WQ-17.5}$ (µg/kg, ppb)
PCBs	31,200	6.4E-05	2.0	6.4E-05	2.0
Methyl bromide	3.75	47	178	1,493	5,600
Arsenic	44	0.018	0.77(1)	0.14	6.2
Mercury	7,343	0.054	394(3)	0.054	400
Chlordane	14,100	8.0E-04	11.3	8.1E-04	11.4
BEHP	130	1.2	15	2.2	286

Notes:
[1] Tissue concentration for arsenic was calculated based on former FCR of 6.5 g/day, because current HH-WQC still uses this value.
[2] Assumed use of the surface water body
[3] USEPA has established a Fish Tissue WQC for methylmercury of 300 ppb, which would be expected to supersede this value.

Despite the limited applicability of "organism only" FTC_{WQ} concentrations, they are still presented in some of the comparisons below because some regulatory agencies have derived FCA trigger levels based on fish consumption only or such triggers may be applied to waters not designated as a drinking water source (e.g., estuaries).

Table C1b Allowable Fish Tissue Concentrations Derived from HH-WQC (FTC_{WQ-142}) for Six Chemicals: FCR = 142 g/day

		HH-WQC Category[1]			
		Water+Organism		Organism Only	
Chemical	BCF (L/kg)	HH-WQC (µg/L, ppb)	FTC_{WQ-142} (µg/kg, ppb)	HH-WQC (µg/L, ppb)	FTC_{WQ-142} (µg/kg, ppb)
PCBs	31,200	7.9E-6	0.25	7.9E-6	0.25
Methyl bromide	3.75	38.7	145	184	690
Arsenic	44	4.9E-3	0.21	6.4E-3	0.28
Mercury	7,343	6.7E-3	49.2(2)	6.7E-3	49.3(2)
Chlordane	14,100	1.0E-04	1.4	1.0E-04	1.4
BEHP	130	0.24	31.8	0.27	35.2

Notes:
[1] Assumed use of the surface water body
[2] USEPA has established a Fish Tissue WQC for methylmercury of 300 ppb; this value does not apply to subsistence levels of fish consumption, but the unique approach applied to mercury by USEPA could have an effect on these values.

3.0 MEASURED FISH TISSUE CONCENTRATIONS IN U.S. LAKES AND RESERVOIRS: COMPARISON WITH FTC_{WQ}

Several federal and state programs have provided data on the fish tissue concentrations of environmental chemicals in U.S. lakes and rivers. In addition to nationwide programs sponsored by USEPA, such as the National Study of Chemical Residues in Fish (USEPA 1992), some states have ongoing fish monitoring programs or have sponsored targeted studies. Many of these programs are focused on a particular set of compounds or a particular area.

The National Study of Chemical Residues in Lake Fish Tissue (or "National Lake Fish Tissue Study", or NLFTS) was a statistically-based study conducted by USEPA Office of Water, with an objective of assessing mean levels of selected bioaccumulative chemicals in fish on a national scale. The results represent concentrations throughout the U.S. based on samples collected from 500 lakes and reservoirs in 48 states (USEPA 2009; Stahl et al. 2009). The sampling phase was carried out from late 1999 through 2003. The focus on lakes and reservoirs, rather than rivers and streams, was based on the greater tendency of lakes for receiving and accumulating environmental chemicals. A *National Rivers and Streams Assessment*[12] is currently in progress, and it would be of interest to examine the fish tissue concentration data from this survey when the data become available. It is likely that any fresh water survey of a national scope, whether it included bound or flowing water bodies would find a broad range of fish tissue concentrations, with the concentrations being more highly influenced by the location and history of the water body.

The NLFTS included PCBs, dioxins, polycyclic aromatic hydrocarbons (PAHs), 46 pesticides, arsenic and mercury. Adult fish were collected from two categories: predator and bottom-dwelling, with the predatory fish comprised of largemouth bass (50%), walleye (10%) and northern pike (7%), and bottom-dwelling species comprised of common carp (26%), white sucker (20%) and channel catfish (16%). A summary of the results from this study is shown in Table C2a.

Table C2a Concentrations in Fish as Reported by the National Lake Fish Tissue Study (USEPA 2009)

	Predator (Fillets) (µg/kg, ppb)			FTC_{WQ} Water+Organism (µg/kg, ppb)	
Chemical	Mean	50th %ile	90th %ile	$FTC_{WQ-17.5}$	FTC_{WQ-142}
PCBs	13.2	2.2	18.2	2.0	0.25
Arsenic	ND$^{(2)}$	ND$^{(2)}$	ND$^{(2)}$	0.77	0.21
Mercury	352	285	562	394	49
Chlordane	ND$^{(2)}$	ND$^{(2)}$	3.6	11.3	1.4

Notes:

[1] National Lake Fish Tissue Study (NLFTS) (USEPA 2009); data from 486 predator fillet samples

[2] Infrequent detection in fish. Arsenic was detected at <1% of sampling locations, for predatory fish with a detection limit of 30 ppb. Chlordane was detected at 1-5% of sampling locations (for predatory fish) with a detection limits of 0.02 (alpha) and 0.49 (gamma) ppb. BEHP was detected at 1-5% of sampling locations (for predatory fish) and results are not provided by USEPA (2009).

[12] http://water.epa.gov/type/rsl/monitoring/riverssurvey/index.cfm

The NLFTS was not focused on areas specifically affected by industrial activities or historic releases. The water bodies included in this survey were selected at random with an objective of capturing typical levels of the chemicals analyzed. In fact, many lakes were included that could be regarded as pristine, likely to have been affected by only minimal human activity. Therefore, the resulting data could be representative of ‘background’ concentrations, which are from unavoidable depositional inputs of the chemicals of interest. However, because many of the water bodies included the NLFTS may have been affected by specific discharges or historic releases, we refer to the resulting data being only representative of typical levels for U.S. lakes. For simplicity, only the data representing predatory fish were included in this analysis, because these are the species likely to be targeted by anglers. The bottom-dwelling fish, which were included in the NLFTS to represent ecological (wildlife) exposures, contained substantially higher concentrations of PCBs (6 times greater at the median) and chlordane (1.7 ppb vs. ND), but lower concentrations of mercury (4 times lower at the median).

As shown in Table C2a, this study provided data for PCBs and mercury, as well as for arsenic and chlordane. Arsenic and chlordane were reported at very low frequencies of detection making quantitative comparisons between fish concentrations and FTCs challenging. Nevertheless, because the detection limits for chlordane (0.02 ppb for alpha and 0.5 ppb for gama) are less than the $FTC_{WQ-17.5}$ (11.3 ppb), and the 90th percentile of the distribution of chlordane concentrations is roughly 3 times lower than the $FTC_{WQ-17.5}$, NLFTS data do demonstrate that chlordane concentrations in predatory fish from the large majority of U.S. surface waters are below the $FTC_{WQ-17.5}$. This also suggests that current concentrations of chlordane in most U.S. surface waters are unlikely to be above the HH-WQC derived based on the consumption rate of recreational anglers.

A similar evaluation could not be conducted for arsenic. The reported arsenic detection limits was above the $FTC_{WQ-17.5}$ derived from the HH-WQC, precluding a comparison with the $FTC_{WQ-17.5}$ absent making assumptions about the concentration of arsenic in fish samples with non-detectable concentrations. As a specific example, the NLFTS reported a method detection limit (MDL) for inorganic arsenic of 30 ppb, even using a state-of-the-art analysis, Method 1632A for the speciation of arsenic. Given that the $FTC_{WQ-17.5}$ for arsenic is 0.77 ppb, it is not possible to determine whether concentrations in predator fillets are above or below that $FTC_{WQ.}$ Assuming detection limits for arsenic cannot be easily refined, this comparison does suggest that it is not possible to demonstrate compliance with the arsenic $FTC_{WQ-17.5.}$

For PCBs, the NLFTS data indicate that a substantial portion of predatory fish from U.S. lakes exceed the $FTC_{WQ-17.5}$ for PCBs (2 ppb). The extent of this exceedance depends on whether the data are represented by the mean concentration (13.2 ppb), which exceeds the $FTC_{WQ-17.5}$ by a factor of about 6x, or the median (i.e., 50th percentile) concentration (2.3 ppb), which is nearly equivalent to the $FTC_{WQ-17.5}$. While this comparison indicates the average concentration of PCBs in fish throughout the U.S. is substantially higher than the $FTC_{WQ-17.5}$, it does not follow that fish in most surface waters of the U.S. have PCB concentrations greater than both of the FTC_{WQ}s. The difference between the mean and median concentration comparisons for this data set likely arises because the data are skewed, with the majority of samples having relatively low concentrations. As noted above, the 50th percentile of the distribution of PCB concentrations in predatory fish from U.S. lakes is approximately equal to the $FTC_{WQ-17.5}$. Assuming the BCF accurately reflects the relationship between the PCB concentration in fish and water, the comparison of the $FTC_{WQ-17.5}$ to the 50th percentile indicates that roughly half of sampled U.S. waters had PCB concentrations that met or were below the HH-WQC derived based on the consumption of recreational anglers. .

The mean mercury concentration of the NLFTS data (352 ppb) is slightly lower than the $FTC_{WQ-17.5}$ for mercury (394 ppb). The percentile data provided by USEPA (2009) indicate the distribution of mercury concentrations in predatory fish is also skewed, though a smaller proportion of the samples (approximately 25%) exceed the mercury $FTC_{WQ-17.5}$ than exceeded the PCB $FTC_{WQ-17.5.}$

The results of parallel comparisons with FTCs derived based on subsistence anglers (i.e., FTC_{WQ-142}) lead to a different conclusion for three for the four compounds (chlordane, PCBs and mercury). The arsenic FTC_{WQ-142} is about four times lower than the $FTC_{WQ-17.5}$ and is also below the typical detection limits for inorganic arsenic, precluding any meaningful quantitative comparisons with the FTC_{WQ-142}.

The detection limit for alpha chlordane is slightly above the FTC_{WQ-142} and the detection limit for gamma is slightly below (see footnotes to Table C2a). Additionally, the 90th percentile of the distribution of chlordane concentrations is only about 2.5 times higher than the $FTC_{WQ-142.}$ These comparisons suggest that typical concentrations of chlordane may be similar to or less than the FTC_{WQ-142} in many U.S. surface waters, though the upper percentiles of the distribution do exceed the FTC_{WQ-142}, in some cases, substantially (Table C2a).

The FTC_{WQ-142} is about 10 times lower than the $FTC_{WQ-17.5}$ for PCBs and mercury (Table C2a). With the increase in FCR, the average fish tissue concentration exceeds the FTC_{WQ-142} by approximately 50x and 7x for PCBs and mercury, respectively (Table C2a). Additionally, the majority of the distribution of PCB and mercury concentrations is above the $FTC_{WQ-142.}$ For both chemicals, the concentration at the 5th percentile of the distribution exceeds the $FTC_{WQ-142.}$ These comparisons indicate that if HH-WQC were to be revised using an FCR of 142 grams/day, assumed to be representative of subsistence anglers, the concentrations of PCBs and mercury in fish from virtually all surface waters in the U.S. would exceed the allowable fish concentration associated with such an HH-WQC.

Several state programs have surveyed fish tissue concentrations, often including PCBs, metals and/or pesticides. The state data assembled for our analyses included surveys conducted by Washington State Department of Ecology (WA-DOE) and by the Florida St. Johns River Water Management District (SJRWMD). Overall, the state programs include more recent data (through 2011) than those presented in the NLFTS (through 2003). These are much more limited data sets compared to the data from the NLFTS. Additionally, the number of observations from each state varies by chemical and in some instances all the data points are from a single state (e.g., all PCB data are from Washington).

Table C2b Measured Concentrations in Fish Samples from Washington and Florida

	Data from State Programs (µg/kg, ppb)			FTC_{WQ}[1] (µg/kg, ppb)	
Chemical	Mean[2]	50th %ile	90th %ile	$FTC_{WQ-17.5}$	FTC_{WQ-142}
PCBs	27.4	22.1	49.8	2.0	0.25
Mercury	191	120	408	394	49
Chlordane	1.4	0.62	2.8	11.3	1.4

Notes:
Based on data provided by J. Beebe (NCASI) and comprised of data from Washington State WA-DOE (2011), WA-EIMS, http://www.ecy.wa.gov/eim), and St. Johns River Water Management District (SJRWMD), Florida (http://sjr.state.fl.us).
[1] FTC_{WQ} derived from water and organism HH-WQC.
[2] Data included: for PCBs, 45 samples from WA-EIMS; for mercury, 1598 samples from WA-EIMS and SJRWMD; and for chlordane, 382 samples from SJRWMD.

The mean concentration of PCBs in predatory fish (27.4 ppb), is about 14 times and 100 times higher than the $FTC_{WQ-17.5}$ and FTC_{WQ-142}, respectively. In fact, both FTC_{WQ}s are well below the minimum reported concentration (9.7 ppb) from this data set. Assuming these data were collected from waters potentially affected by PCB releases suggests that meeting the HH-WQC, based on either the recreational of subsistence FCR, in such waters is likely to be a challenge. To the extent these data are only from Washington, this finding may only apply to waters of that state.

The mean concentrations of mercury and chlordane from state programs are below their respective $FTC_{WQ-17.5}$ by approximately 2x- and 8x-, respectively (Table 4-2b) suggesting that a substantial portion of the surface waters in these states would meet an HH-WQC derived based on an FCR assumed to be representative of a recreational angler. The mean concentration of chlordane is equal to the FTC_{WQ-142}. If the chlordane distribution from these two states has a similar "shape" to the distribution in the national survey, this comparison suggests that a substantial portion of surface waters in these two states would meet an HH-WQC based on an FCR representative of a subsistence angler. Fewer waters are likely to meet such an HH-WQC for mercury, given that the mean concentration exceeds the FTC_{WQ-142} by approximately 4x.

Arsenic was included in several of the state databases, however, inorganic arsenic was not detected at measurable concentrations. As discussed above for the NLFTS data, meaningful comparison of inorganic arsenic concentrations to FTCs is precluded because MDLs are greater than the FTCs.

4.0 COMPARISON OF FTC_{WQ} TO FCA TRIGGER LEVELS ESTABLISHED BY STATE OR OTHER PUBLIC HEALTH AGENCIES

Most states and various federal agencies have programs for the protection of anglers who may eat fish containing trace amounts of chemicals. These programs are responsible for issuing FCAs for lakes and reservoirs where particular chemicals have been detected at levels in fish that exceed some risk-based "trigger level." While the approach to setting FCAs may differ, most programs use a risk-based approach to develop guidelines that are intended to be protective of the health of the angler communities with a wide margin of safety. USEPA (2000) issued guidance that could be used to establish some uniformity in the methods used to derive FCAs, but most states are maintaining programs and guidelines that have served them for many years. A common feature of both federal and state guidelines is the movement away from a single trigger level and towards a progression of trigger levels, each associated with an increasing level of restricted intake for the fish (and chemical) in question. Despite this increased complexity, USEPA (2000) also provided screening values (SV) based on moderate (recreational) and high (subsistence) levels of fish consumption, termed SVrec and SVsub, respectively, and shown in Table 4-3 for PCBs, arsenic, chlordane, and mercury.

Also shown in Table 4-3 are examples of FCA trigger levels from state programs that publish numerical benchmarks for this purpose. For states that have adopted a series of trigger levels, this analysis presents the levels based on either a "no more than 2 meal per month" restriction (noted as "L2" in Table 4-3), or a 'do not eat' advisory (complete restriction, notes as "R" in Table 4-3). Two 8-ounce (227 g) meals per month is assumed to be comparable to the 17.5 gram/day FCR applied by USEPA to the derivation of HH-WQC.[13]

[13] The guidelines from WI-DNR and MI-DCH, however, only included a one meal per month advisory level, and the concentrations accompanying this advisory level are shown for these two agencies (noted as "L1" in Table 4-3).

Table C3 USEPA Screening Values for Fish and FCA Trigger Levels Used by Select State Agencies[1]

	Federal USEPA (2000)[2] (µg/kg, ppb)		Select State Programs (µg/kg, ppb)			FTC_{WQ} Organism Only Values (µg/kg, ppb)	
Chemical	SV(rec)[3]	SV(sub)[3]	WI-DNR	MI-DCH	WV-DHHS	$FTC_{WQ-17.5}$	FTC_{WQ-142}
PCBs	20	2.5	220 (L1) 2,000 (R)	200 (L1) 2,000 (R)	150 (L2) 1,340 (R)	2.0	0.25
Arsenic	26	3.3	--	NA	140 (L2) 1,250 (R)	6.2	0.28
Mercury	400	50	500-1000 (NS)	500 (L) 1,500 (R)	220 (L2) 1,880 (R)	400	49
Chlordane	114	14	660 (L1) 5,620 (R)	300 (NS)	880 (L2) 7,660 (R)	2.2	1.4

Notes:
R: Restricted, referring to 'do not eat' advisory.
L: Limited, or a limited amount of consumption is advised.
L1: Limited to 1 meal per month.
L2: Limited to 2 meals per month.
NS: Not stated whether the value represents a restriction or a limit.
[1] Wisconsin Department of Natural Resources (WI-DNR), 2007, 2011; Michigan Department of Community Health (MI-DCH), 2008; West Virginia Department of Health and Human Services (WV-DHHS).
[2] USEPA, 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1.
[3] Screening values (SV) for the recreational and subsistence angler.

When compared to these FCA trigger levels, the $FTC_{WQ-17.5}$ for PCBs, arsenic and chlordane are 20-4,000 times lower (more stringent) (Table C3). For mercury, the $FTC_{WQ-17.5}$ is comparable to the trigger levels prompting some restriction on fish consumption, but is as much as 4x lower than the level where a 'do not eat' advisory is prompted. FTC_{WQ-142} are between 200-8,000 times lower than the FCA trigger levels for PCBs, arsenic, and chlordane, and 4 to 40 times lower than the trigger levels for mercury (Table C3).

As shown in Table C3, the USEPA SVs are either similar or 10x higher than the FTC_{WQ} derived from the HH-WQC. Because these USEPA values are intended to be generic screening-level benchmarks, they are very conservative compared to the trigger levels used by the most state programs (discussed further below).

Comparing the USEPA SVs to FTC_{WQ} for chemicals for which noncancer endpoints are the driver, such as mercury, SVs are the same as the FTC_{WQ}s. For the other three constituents, for which the cancer endpoint is most sensitive, the SVs are approximately 10 times higher, because SVs are derived based on a $1x10^{-5}$ target risk level, rather than a $1x10^{-6}$ target risk level.

In contrast, fish advisory trigger levels used by public health agencies in Wisconsin, Michigan, and West Virginia (Table C3) are less stringent, and in general, would require substantially higher concentrations of arsenic, chlordane and PCBs than allowed by the HH-WQC before issuing even a moderate restriction on fish consumption. Based on our survey of state "trigger levels" and recent reviews comparing the FCAs between states (IWG-ACA, 2008; Scherer et al. 2008), we believe that the FCAs from Wisconsin, Michigan, and West Virginia are likely to be representative of the FCAs from many state programs. Scherer et al. (2008) found the FCAs among states to be quite similar, despite some variation in the methods used to develop the FCAs. Many state programs rely on less-stringent food tolerance levels as the basis for their trigger levels; this choice is consistent with the desire by States to consider the value of their recreational fisheries and the benefits of fish consumption, while protecting the public from potential chemical risks. The difference in the State vs. EPA trigger levels is due to several factors. As noted previously, state guidelines are typically based on a series of FCA trigger levels, giving the States the ability to partially restrict fish consumption at many concentration levels. Further, the ability to issue consumption limits for specific target fish species also permits states to allow higher fish tissue concentrations. Lastly, state agencies are more likely to apply lower assumed fish consumption rates based on local or regional surveys conducted within the state.

A key illustration of the conservative nature of the FTCs is provided by a comparison of the proportion of samples in the NLFTS data set that exceed an FTC_{WQ} to the proportion of waters in the U.S. that have a fish consumption advisory. As described above approximately 50% of fish samples have PCB concentrations that exceed the $FTC_{WQ-17.5}$ and over 95% exceed the FTC_{WQ-142}. Yet, only about 15% of the nation's lakes are subject to a fish consumption advisory (USEPA 2009). Given that a goal of both an HH-WQC and an FCA is protection of the health of anglers, the much larger proportion of waters estimated to potentially pose an unacceptable risk when an HH-WQC is used than measured by the posting of an FCA, suggests that the derivation of HH-WQC by USEPA is substantially more conservative than the derivation of FCAs by state agencies.

5.0 COMPARISON OF FTC_{WQ}S TO HEALTH-BASED LIMITS FOR FISH OR OTHER FOODS

Other federal and global agencies charged with protection of food safety have established guidelines for ensuring the safety of foods in commerce. The most notable examples in the U.S. are the food tolerances established by USFDA. These tolerances have been used as a guideline for assessing the safety of food, largely animal products, such as beef, chicken, fish, milk and eggs. These tolerances are typically less stringent than analogous values derived using USEPA methods for risk assessment. Unlike the USEPA, the USFDA must balance potential economic concerns with the potential benefits to public health; in other words, the USFDA must consider the consequences of its actions on the U.S food supply. USEPA exposure limits and screening levels may also be considered for their economic consequences, but this review is conducted outside of the Agency and only after the value has been derived. Regardless, USFDA tolerances are risk-based concentrations and many risk assessors and scientists support the idea that the tolerances are protective of the public health (Cordle et al. 1982; Maxim and Harrington 1984; Boyer et al. 1991). Due to recent incidents in Europe in which PCBs were accidentally introduced into animal feeds, the European Commission (EC) has set maximum levels for PCBs in foods and feedstuffs, including fish (EC, 2011). The limits were based on a report of the European Food Safety Authority (EFSA) deriving allowable exposure levels, and on monitoring data compiled throughout the European Union (EU). The EU considered both the public health protection and the feasibility of attaining these limits, based on current levels measured in foods.

FTC_{WQ} derived from the HH-WQC are in all cases well below both the USFDA and EU food tolerance levels (Table C4). The USFDA tolerance for PCBs in fish of 2,000 ppb is 1,000 times higher than the $FTC_{WQ-17.5}$ and 8,000 times higher than the FTC_{WQ-142}.

Table C4 Comparison of FTC_{WQ} to Food Safety Guidelines for Chemical Concentrations in Fish

	Food Safety Standards		HH-WQC-Based Threshold for Fish	
Chemical	USFDA Tolerance for Fish[1] (µg/kg, ppb)	EU Limit for Fresh Fish[2] (µg/kg, ppb)	FTC_{WQ} FCR = 17.5 (µg/kg, ppb)	FTC_{WQ} FCR=142 (µg/kg, ppb)
PCBs	1,000 (action level) 2,000 (limit)	250[(3)]	2.0	0.25
Mercury	1,000 (action limit)	--	394	49.2
Chlordane	300	--	11.3	1.4

Notes:
[1] USFDA (1998, 2011); Values are based on wet weight.
[2] European Commission (EC) 2011. Commission Regulation No. 1259/2011.
[3] EC Limit for PCBs is 125 ng/g wet wt. for the sum of 6 'marker' congeners, which comprise about 50% of the PCBs in fish. Therefore, to be applicable to a measure of total PCBs, this value was multiplied by a factor of 2 (EC, 2011).

6.0 TYPICAL INTAKES OF THE CHEMICALS IN THE U.S. POPULATION: COMPARISON TO THE ALLOWABLE DAILY INTAKES DERIVED FROM THE HH-WQC

The goal of an HH-WQC is to limit exposure of the population to chemicals in water such that an allowable dose (or risk) is not exceeded. If the dominant exposure pathway for a chemical is direct contact or use of surface water, then compliance with the AWQC may, indeed, limit overall exposure to allowable levels. However, if other pathways also contribute to overall exposure and, in particular, if the other pathways represent larger exposures than surface water, then establishment and enforcement of a stringent surface water criterion may not provide a measurable public health benefit. This section compares exposures allowed by the HH-WQC to the potential exposures from a limited set of other exposure sources or pathways for five chemicals.

One of the key assumptions used to derive FTC_{WQ} is an allowable daily intake of each constituent in question. This allowable daily intake is a toxicologically-derived value and is represented by a reference dose (RfD) (for noncancer endpoints) or a risk-specific dose (RSD) (when cancer is the endpoint). The RSD is equal to the target risk level (typically 1×10^{-6}) divided by the cancer slope factor (CSF) for a particular constituent.

As shown in Table C5, the RfDs and RSDs for the six chemicals evaluated in this appendix range from 0.35 µg/day for PCBs to 98 µg/day for methyl bromide.[14] These are the toxicity values chosen by USEPA for the derivation of HH-WQC.

Another way to estimate the allowable daily dose associated with the HH-WQC, and the FTC_{WQ} in particular, is to multiply the allowable fish tissue concentrations (i.e., the FTC_{WQ}) by the assumed FCR of 17.5 grams/day. The results, as shown in Table C5 as "Fish Dose", represent the dose of each chemical that someone would receive who ate fish containing chemicals at concentrations equal to the FTC_{WQ}.

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[14] Traditional units of dose in mg/kg-day are converted to units of intake (µg/day) by multiplying by an adult body weight of 70 kg and a conversion factor of 1000 µg/mg.

For PCBs, mercury and arsenic, very low, but measurable daily intakes by the U.S. population are based on releases of these substances into the environment and their presence in trace quantities in the food supply. Arsenic occurs naturally in soils and groundwater and, therefore, there is a normal daily intake that varies by region. For BEHP, the presence of trace amounts in food stems from its use in plastic food packaging materials (Fromme et al. 2007). A summary of the data used to provide an estimate of the typical daily intake of each chemical is presented below.

PCBs: The intake of PCBs through foods, mainly animal products, has declined dramatically in the last 30 years. However, Schecter et al. (2010) recently carried out a market-basket survey of several types of foods and found measurable levels in enough foods to propose a daily intake of about 0.1 µg/day for a typical resident of the U.S. Other studies in Europe have proposed slightly higher intake levels (as high as 0.8 µg/day), but overall, corroborate the findings of Schecter et al. (2010). This range of typical dietary intakes of PCBs is 3 times to as much as 20 times greater than the risk-specific dose (RSD) used to derive the HH-WQC (0.035 µg/day) (Table C5). Thus, the HH-WQC is based on an exposure limit for PCBs that is routinely exceeded by the typical PCB intake that occurs through dietary exposures.

BEHP: Considerable effort has been made to estimate the human exposure to phthalate esters, which arises from food packaging materials, e.g., plastic food wraps. A German study by Fromme et al. (2007) provides the most reliable estimates of intake, based on a study using both samples of dietary items and biomonitoring data. Because phthalate ester exposures are derived from plastic packaging/wrapping that is sold across the globe, intakes estimated by this study for a German population are likely to be comparable to those in U.S. The authors report a median BEHP intake of 2.4 µg/kg-day (162 µg/day) which is approximately 30 times greater than the RSD used by the HH-WQC (Table C5). Thus, the HH-WQC is based on an exposure limit for BEHP that is routinely exceeded by the typical intake that occurs through dietary exposures.

Table C5 Allowable vs. Actual Daily Intakes for Select Chemicals

	Allowable Daily Intakes Used as the Basis for the HH-WQCs		Measured or Estimated Average Daily Intakes Derived from Food		
	Value [RfD or RSD] (µg/day)	Fish Dose[1] (µg/day)	Intake (µg/day)	Group	Note
PCBs	0.035 [RSD]	0.035	0.1-0.8	all	(a)
Methyl bromide	98 [RfD]	3.1	6.5 (mean); 310 (95th %ile)	male	(b)
			10 (mean); 350 (95th %ile)	female	
Arsenic	0.04 [RSD]	0.014	3.6 / 2.7 (avg.); 9.4 (90th %ile)	male	(c)
			2.8 / 2.4 (avg.); 11.4 (90th %ile)	female	
Mercury	7 [RfD]	7	8.6 (mean); 166 (90th %ile)	male	(d)
			8.2 (avg.); 204 (90th %ile)	female	
BEHP	5 [RSD]	0.26	162 (median); 309 (95th %ile)	all	(e)

Notes:
RfD, Reference Dose; RSD, Risk-Specific Dose
[1] Computed as FTC_{WQ} [from Table C1a] x FCR [17.5 g/day]
(a) Range is based on the results of several studies (Darnerud et al. 2006; Arnich et al. 2009; Roosens et al. 2010; Schecter et al. 2010).
(b) Cal-EPA 2002; assumed body weight of 70 kg for adults.
(c) Meacher et al. 2002; assumed body weight of 70 kg for adults.
(d) MacIntosh et al. 1996.
(e) Fromme et al. 2007.

Arsenic: A study by Meacher et al. (2002) represents a comprehensive evaluation of total inorganic arsenic exposure in the U.S. population. The authors discuss other studies with a similar aim and conclude that the average daily intake, primarily from food and drinking water, is in the range of 1 to 10 µg/day. Estimates of average daily intakes are 60 to 90 times greater than the RSD. Thus, the HH-WQC is based on an exposure limit for arsenic that is exceeded by a wide margin, by typical dietary intakes of arsenic.

Methyl bromide: The concentrations detected in foods are mainly in animal products, such as milk, which makes estimates of a one-time exposure as high as 4-5 µg/kg-day, but with average daily exposures likely to be less than 1 µg/kg-day, according to a study by Cal-EPA (2002). While 95th percentile values (310-350 µg/day) are more than 40 times higher that the mean intake estimates, it can be concluded that typical methyl bromide intakes based on diet are likely to be below the RfD of 98 µg/day. Thus, for methyl bromide, dietary intakes would not appear to hinder the objective of limiting the exposures based on fish consumption.

Mercury: The predominant human intake is from concentrations in predatory and deep-sea fish such as tuna. Average daily intakes are estimated to be about 8 µg/day (MacIntosh et al. 1996) and are comparable to the RfD of 7 µg/day (Table C5). Thus, for mercury, it is not uncommon for the consumption of store-bought tuna to provide an intake equivalent to the RfD; achieving this level of exposure would at least appear to be an achievable public health objective.

In summary, estimated daily intakes for five of the six chemicals could be obtained from the literature (Table C5). For PCBs, arsenic and BEHP, the chemicals for which potential cancer risk is the most sensitive endpoint, the estimated daily intake for the U.S. population is between 3 times to 90 times greater than the RSD. In surface waters with fish that have concentrations that are no more than a 2-times lower than the FTC, based on the comparisons shown in Table C5, decreasing exposures to the levels associated with HH-WQC would be likely to have no discernible effect on the intake of these chemicals in the community.

7.0 SUMMARY AND CONCLUSIONS

This paper described the derivation of allowable fish tissue concentrations (referred to as FTC_{WQ}) associated with HH-WQC for a select group of chemicals. FTC_{WQ} are based on the same exposure and toxicity factors used to derive the HH-WQC. Separate FTC_{WQ} were derived for USEPA's recommended fish consumption rate for recreational anglers (17.5 grams/day, $FTC_{WQ-17.5}$) and subsistence anglers (142 grams/day, FTC_{WQ-142}). Given the nearly 10x higher consumption rate assumed for subsistence anglers compared to recreational anglers, FTC_{WQ-142} were lower than the $FTC_{WQ-17.5}$ for every chemical by about 10x. FTC_{WQ} were compared to: (1) concentrations measured in fish from U.S. water bodies; (2) trigger levels used by State agencies to set fish consumption advisories; and (3) allowable concentrations set by other US and international health agencies. Additionally, ADIs used to derive FTC_{WQ} were compared to estimated daily dietary intakes from all sources.

PCB concentrations in about half of the fish from the NLFTS exceeded the $FTC_{WQ-17.5}$ and PCB concentrations in essentially all fish from the NLFTS exceeded the FTC_{WQ-142}. (Additionally, all of the fish from two state-specific surveys had PCB concentrations above the $FTC_{WQ-17.5}$ and the FTC_{WQ-142}.) The mercury concentrations for the majority of fish in the NLFTS were below the $FTC_{WQ-17.5}$ but most fish had mercury concentrations above the FTC_{WQ-142}. Chlordane was not detected in the majority of NLFTS samples with detection limits below the $FTC_{WQ-17.5}$ and the FTC_{WQ-142} suggesting the majority of fish have chlordane concentrations below either FTC_{WQ}. Arsenic was not detected in majority of NLFTS; however, unlike chlordane, the method detection limit for arsenic exceeds both the $FTC_{WQ-17.5}$ and the FTC_{WQ-142} by more than 30x, precluding the possibility of determining whether arsenic concentrations meet the HH-WQC. Thus, whether nationwide fish tissue concentrations meet the FTC_{WQ} depends upon the chemical of interest and whether recreational or subsistence angler consumption rates are used to derive the FTC_{WQ}. It does appear that if HH-WQC were to be revised using an FCR of 142 grams/day, the concentrations of PCBs and mercury in fish from virtually all surface waters in the U.S. would exceed the allowable fish concentration associated with such HH-WQC.

$FTC_{WQ-17.5}$ for PCBs, arsenic, and chlordane were 20 to 4,000 times lower (more stringent) than FCA trigger levels commonly used by state programs. For mercury, the $FTC_{WQ-17.5}$ was comparable to typical state trigger levels prompting some restriction on fish consumption, but it was as much as 4 times lower than the level where a 'do not eat' advisory is prompted. Again, the comparisons were much more remarkable using the FTC_{WQ-142}. FTC_{WQ-142} were between 200 times and 8,000 times lower than the FCA trigger levels for PCBs, arsenic, and chlordane, and 4 times to 40 times lower than the state trigger levels for mercury. These comparisons were based on the guidelines from a select number of states, including Wisconsin, Michigan, and West Virginia; however, the FCA trigger levels were comparable among this small group of states, and based on our review of guidelines in many other states not included in this analysis, we believe that these states can be considered representative of many other state programs.

A comparison of FCAs to the NLFTS data provides another comparison that highlights the conservatism of the FTC_{WQ} (and the HH-WQC from which they were derived). Approximately 50% of fish samples from the NLFTS had PCB concentrations that exceeded the $FTC_{WQ-17.5}$ and over 95% exceeded the FTC_{WQ-142}. However, only about 15% of the nation's lakes and reservoirs (on a surface area basis) are subject to a FCA based on PCBs (USEPA 2009). Thus, use of HH-WQC indicated that a much larger proportion of US surface waters pose an unacceptable risk than indicated by FCA postings. This comparison further illustrates that the assumptions used by USEPA to derive HH-WQC are more conservative than the assumptions used by state agencies to derive FCAs.

Various agencies, both Federal and international, have established concentration limits for fish as a food in commerce. The FDA food tolerances are the most notable example. FTC_{WQ} were compared to FDA tolerance limits and a recently established EU limit for PCBs in fish. The $FTC_{WQ-17.5}$ for PCBs of 2 ppb is 500 times lower than the FDA action limit of 1,000 ppb and 125 times lower than an EU limit of 250 ppb. The FTC_{WQ-142} is 1,000x and 4,000x lower than the EU and FDA action limits, respectively. The FDA tolerance of 300 ppb for chlordane is similarly much less stringent than either the $FTC_{WQ-17.5}$ (11.3 ppb) or the FTC_{WQ-142} (1.4 ppb) for chlordane. The FDA action level for mercury of 1,000 ppb is similar to but still higher than either the $FTC_{WQ-17.5}$ (394 ppb) or the FTC_{WQ-142} (49 ppb) for mercury. These comparisons indicate that HH-WQCs are limiting fish tissue concentrations to levels substantially below those considered to be without significant risk by public health agencies whose goal is to ensure the safety of edible fish.

Lastly, allowable daily intakes (RfDs for noncancer endpoints, RSDs for the cancer endpoint) assumed by the FTC_{WQ} were compared to estimates of the daily intake of arsenic, BEHP, mercury and PCBs obtained from the open literature. Specifically, daily intakes were taken from studies that measured concentrations in various foodstuffs. Typical daily dietary intakes of arsenic, BEHP and PCBs exceeded the allowable daily intakes used to derive HH-WQC by a substantial margin. The typical daily dietary intake of mercury, mostly from tuna, is comparable to the RfD used to derive the HH-WQC. Thus, for those compounds whose daily dietary intake is greater than the intake associated with surface water and already exceeds the allowable daily intakes used to establish HH-WQC, the establishment and enforcement of a more stringent HH-WQC may not provide a measurable public health benefit.

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Acronyms

Acronym	Definition
AACE	Association for the Advancement of Cost Engineering
AOP	advanced oxidation processes
AWB	Association of Washington Businesses
BAC	biological activated carbon
BAP	benzo(a)pyrene
BOD	biochemical oxygen demand
BTU	British thermal unit
CEPT	Chemically-enhanced primary treatment
cf	cubic feet
CIP	clean in place
CRITFC	Columbia River Inter-Tribal Fish Commission
Ecology	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
FCR	fish consumption rate
g/day	grams per day
GAC	granular activated carbon
gal	gallon
gfd	gallons per square foot per day
GHG	greenhouse gas
gpd	gallons per day
gpm	gallons per minute
GWh	giga watt hours
HDR	HDR Engineering, Inc.
HHWQC	human health water quality criteria
HRT	hydraulic residence time
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
KWh/MG	kilowatt-hours per million gallons
lb	pound
MBR	membrane bioreactor
MCL	maximum contaminant level
MF	microfiltration
mgd	million gallons per day
mg/L	milligrams per liter
MMBTU	million British thermal units
MWh/d	megawatt-hours per day
NF	nanofiltration
ng/L	nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O&M	operations and maintenance
ODEQ	Oregon Department of Environmental Quality
PAC	powdered activated carbon
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PE	population equivalents
PIX	potable ion exchange

Acronym	Definition
ppm	parts per million
RO	reverse osmosis
SDWA	Safe Drinking Water Act
sf	square feet
SGSP	salinity gradient solar pond
SRT	solids retention time
Study Partners	Association of Washington Businesses/Association of Washington Cities and Washington State Association of Counties consortium
TDS	total dissolved solids
TMDL	total maximum daily load
TSS	total suspended solids
UF	ultrafiltration
µg/L	micrograms per liter
USDA	U.S. Department of Agriculture
UV	ultraviolet
WAC	Washington Administrative Code
WAS	waste activated sludge
WLA	waste load allocation
WWTP	wastewater treatment plant
ZLD	zero liquid discharge

Executive Summary

This study evaluated treatment technologies potentially capable of meeting the State of Washington Department of Ecology's (Ecology) revised effluent discharge limits associated with revised human health water quality criteria (HHWQC). HDR Engineering, Inc. (HDR) completed a literature review of potential technologies and an engineering review of their capabilities to evaluate and screen treatment methods for meeting revised effluent limits for four constituents of concern: arsenic, benzo(a)pyrene (BAP), mercury, and polychlorinated biphenyls (PCBs). HDR selected two alternatives to compare against an assumed existing baseline secondary treatment system utilized by dischargers. These two alternatives included enhanced secondary treatment with membrane filtration/reverse osmosis (MF/RO) and enhanced secondary treatment with membrane filtration/granulated activated carbon (MF/GAC). HDR developed capital costs, operating costs, and a net present value (NPV) for each alternative, including the incremental cost to implement improvements for an existing secondary treatment facility.

Currently, there are no known facilities that treat to the HHWQC and anticipated effluent limits that are under consideration. Based on the literary review, research, and bench studies, the following conclusions can be made from this study:

- Revised HHWQC based on state of Oregon HHWQC (2001) and U.S. Environmental Protection Agency (EPA) "National Recommended Water Quality Criteria" will result in very low water quality criteria for toxic constituents.
- There are limited "proven" technologies available for dischargers to meet required effluent quality limits that would be derived from revised HHWQC.
  - Current secondary wastewater treatment facilities provide high degrees of removal for toxic constituents; however, they are not capable of compliance with water quality-based National Pollutant Discharge Elimination System (NPDES) permit effluent limits derived from the revised HHWQC.
  - Advanced treatment technologies have been investigated and candidate process trains have been conceptualized for toxics removal.
    - Advanced wastewater treatment technologies may enhance toxics removal rates; however, they will not be capable of compliance with HHWQC-based effluent limits for PCBs. The lowest levels achieved based on the literature review were between <0.00001 and 0.00004 micrograms per liter (µg/L), as compared to a HHWQC of 0.0000064 µg/L.
    - Based on very limited performance data for arsenic and mercury from advanced treatment information available in the technical literature, compliance with revised criteria may or may not be possible, depending upon site specific circumstances.
      - Compliance with a HHWQC for arsenic of 0.018 µg/L appears unlikely. Most treatment technology performance information available in the literature is based on drinking water treatment applications targeting a much higher Safe Drinking Water Act (SDWA) maximum contaminant level (MCL) of 10 µg/L.
      - Compliance with a HHWQC for mercury of 0.005 µg/L appears to be potentially attainable on an average basis, but perhaps not if effluent limits are structured on a maximum monthly, maximum weekly or maximum daily basis. Some secondary treatment facilities attain average effluent mercury levels of 0.009 to 0.066 µg/L. Some treatment facilities with effluent filters attain average effluent mercury levels of 0.002 to 0.010 µg/L. Additional

advanced treatment processes are expected to enhance these removal rates, but little mercury performance data is available for a definitive assessment.

- Little information is available to assess the potential for advanced technologies to comply with revised BAP criteria. A municipal wastewater treatment plant study reported both influent and effluent BAP concentrations less than the HHWQC of 0.0013 ug/L (Ecology, 2010).

  - Some technologies may be effective at treating identified constituents of concern to meet revised limits while others may not. It is therefore even more challenging to identify a technology that can meet all constituent limits simultaneously.
  - A HHWQC that is one order-of-magnitude less stringent could likely be met for mercury and BAP; however, it appears PCB and arsenic limits would not be met.

- Advanced treatment processes incur significant capital and operating costs.
  - Advanced treatment process to remove additional arsenic, BAP, mercury, and PCBs would combine enhancements to secondary treatment with microfiltration membranes and reverse osmosis or granular activated carbon and increase the estimated capital cost of treatment from $17 to $29 in dollars per gallon per day of capacity (based on a 5.0-million-gallon-per-day (mgd) facility).
  - The annual operation and maintenance costs for the advanced treatment process train will be substantially higher (approximately $5 million - $15 million increase for a 5.0 mgd capacity facility) than the current secondary treatment level.
- Implementation of additional treatment will result in additional collateral impacts.
  - High energy consumption.
  - Increased greenhouse gas emissions.
  - Increase in solids production from chemical addition to the primaries. Additionally, the membrane and GAC facilities will capture more solids that require handling.
  - Increased physical space requirements at treatment plant sites for advanced treatment facilities and residuals management including reverse osmosis reject brine processing.
- It appears advanced treatment technology alone cannot meet all revised water quality limits and implementation tools are necessary for discharger compliance.
  - Implementation flexibility will be necessary to reconcile the difference between the capabilities of treatment processes and the potential for HHWQC driven water quality based effluent limits to be lower than attainable with technology

Table ES-1 indicates that the unit NPV cost for baseline conventional secondary treatment ranges from $13 to $28 per gallon per day of treatment capacity. The unit cost for the advanced treatment alternatives increases the range from the low $20s to upper $70s on a per gallon per-day of treatment capacity. The resulting unit cost for improving from secondary treatment to advanced treatment ranges between $15 and $50 per gallon per day of treatment capacity. Unit costs were also evaluated for both a 0.5 and 25 mgd facility. The range of unit costs for improving a 0.5 mgd from secondary to advanced treatment is $60 to $162 per gallon per day of treatment capacity. The range of unit costs for improving a 25 mgd from secondary to advanced treatment is $10 to $35 per gallon per day of treatment capacity.

Table ES-1. Treatment Technology Costs in 2013 Dollars for a 5-mgd Facility

Alternative	Total Construction Cost, 2013 dollars ($ Million)	O&M Net Present Value, 2013 dollars ($ Million)***	Total Net Present Value, 2013 dollars ($ Million)	NPV Unit Cost, 2013 dollars ($/gpd)
Baseline (Conventional Secondary Treatment)*	59 - 127	5 - 11	65 - 138	13 - 28
Incremental Increase to Advanced Treatment - MF/RO	48 - 104	26 - 56	75 - 160	15 - 32
Advanced Treatment - MF/RO**	108 - 231	31 - 67	139 - 298	28 - 60
Incremental Increase to Advanced Treatment - MF/GAC	71 - 153	45 - 97	117 - 250	23 - 50
Advanced Treatment - MF/GAC	131 - 280	50 - 108	181 - 388	36 - 78

* Assumed existing treatment for dischargers. The additional cost to increase the SRT to upwards of 30-days is about $12 - 20 million additional dollars in total project cost for a 5 mgd design flow.

** Assumes zero liquid discharge for RO brine management, followed by evaporation ponds. Other options are available as listed in Section 4.4.2.

*** Does not include the cost for labor.

mgd=million gallons per day
MG=million gallons
MF/RO=membrane filtration/reverse osmosis
MF/GAC=membrane filtration/granulated activated carbon
O&M=operations and maintenance
Net Present Value = total financed cost assuming a 5% nominal discount rate over an assumed 25 year equipment life.

Costs presented above are based on a treatment capacity of 5.0 mgd, however, existing treatment facilities range dramatically across Washington in size and flow treated. The key differences in cost between the baseline and the advanced treatment MF/RO are as follows:

- Larger aeration basins than the baseline to account for the longer SRT (>8 days versus <8 days).
- Additional pumping stations to pass water through the membrane facilities and granulated activated carbon facilities. These are based on peak flows.
- Membrane facilities (equipment, tanks chemical feed facilities, pumping, etc.) and replacement membrane equipment.
- Granulated activated carbon facilities (equipment, contact tanks, pumping, granulated activated carbon media, etc.)
- Additional energy and chemical demand to operate the membrane and granulated activated carbon facilities
- Additional energy to feed and backwash the granulated activated carbon facilities.
- Zero liquid discharge facilities to further concentrate the brine reject.
  - o Zero liquid discharge facilities are energy/chemically intensive and they require membrane replacement every few years due to the brine reject water quality.
- Membrane and granulated activated carbon media replacement represent a significant maintenance cost.

- Additional hauling and fees to regenerate granulated activated carbon off-site.

The mass of pollutant removal by implementing advanced treatment was calculated based on reducing current secondary effluent discharges to revised effluent limits for the four pollutants of concern. These results are provided in Table ES-2 as well as a median estimated unit cost basis for the mass of pollutants removed.

Table ES-2. Unit Cost by Contaminant for a 5-mgd Facility Implementing Advanced Treatment using Membrane Filtration/Reverse Osmosis

Component	PCBs	Mercury	Arsenic	BAPs
Required HHWQC based Effluent Quality (µg/L)	0.0000064	0.005	0.018	0.0013
Current Secondary Effluent Concentration (µg/L)	0.002	0.025	7.5	0.006
Total Mass Removed (lbs) over 25 year Period	0.76	7.6	2,800	1.8
Median Estimated Unit Cost (NPV per total mass removed in pounds over 25 years)	$290,000,000	$29,000,000	$77,000	$120,000,000

µg/L=micrograms per liter
lbs=pounds
NPV=net present value

Collateral adverse environmental impacts associated with implementing advanced treatment were evaluated. The key impacts from this evaluation include increased energy use, greenhouse gas production, land requirements and treatment residuals disposal. Operation of advanced treatment technologies could increase electrical energy by a factor of 2.3 to 4.1 over the baseline secondary treatment system. Direct and indirect greenhouse gas emission increases are related to the operation of advanced treatment technologies and electrical power sourcing, with increases of at least 50 to 100 percent above the baseline technology. The energy and air emission implications of advanced treatment employing granulated activated carbon construction of advanced treatment facilities will require additional land area. The availability and cost of land adjacent to existing treatment facilities has not been included in cost estimates, but could be very substantial. It is worthwhile noting residual materials from treatment may potentially be hazardous and their disposal may be challenging to permit. Costs assume zero liquid discharge from the facilities.

1.0 Introduction

Washington's Department of Ecology (Ecology) has an obligation to periodically review waterbody "designated uses" and to modify, as appropriate, water quality standards to ensure those uses are protected. Ecology initiated this regulatory process in 2009 for the human health-based water quality criteria (HHWQC) in Washington's *Surface Water Quality Standards* (Washington Administrative Code [WAC] 173-201A). HHWQC are also commonly referred to as "toxic pollutant water quality standards." Numerous factors will influence Ecology's development of HHWQC. The expectation is that the adopted HHWQC will be more stringent than current adopted criteria. National Pollutant Discharge Elimination System (NPDES) effluent limits for permitted dischargers to surface waters are based on U.S. Environmental Protection Agency (EPA) and state guidance. Effluent limits are determined primarily from reasonable potential analyses and waste load allocations (WLAs) from total maximum daily loads (TMDLs), although the permit writer may use other water quality data. Water quality-based effluent limits are set to be protective of factors, including human health, aquatic uses, and recreational uses. Therefore, HHWQC can serve as a basis for effluent limits. The presumption is that more stringent HHWQC will, in time, drive lower effluent limits. The lower effluent limits will require advanced treatment technologies and will have a consequent financial impact on NPDES permittees. Ecology anticipates that a proposed revision to the water quality standards regulation will be issued in first quarter 2014, with adoption in late 2014.

The Association of Washington Businesses (AWB) is recognized as the state's chamber of commerce, manufacturing and technology association. AWB members, along with the Association of Washington Cities and Washington State Association of Counties (collectively referred to as Study Partners), hold NPDES permits authorizing wastewater discharges. The prospect of more stringent HHWQC, and the resulting needs for advanced treatment technologies to achieve lower effluent discharge limits, has led this consortium to sponsor a study to assess technology availability and capability, capital and operations and maintenance (O&M) costs, pollutant removal effectiveness, and collateral environmental impacts of candidate technologies.

The "base case" for the study began with the identification of four nearly ubiquitous toxic pollutants present in many industrial and municipal wastewater discharges, and the specification of pollutant concentrations in well-treated secondary effluent. The pollutants are arsenic, benzo(a)pyrene (BAP), mercury and polychlorinated biphenyls (PCBs), which were selected for review based on available monitoring data and abundant presence in the environment. The purpose of this study is to review the potential water quality standards and associated treatment technologies able to meet those standards for four pollutants.

A general wastewater treatment process and wastewater characteristics were used as the common baseline for comparison with all of the potential future treatment technologies considered. An existing secondary treatment process with disinfection at a flow of 5 million gallons per day (mgd) was used to represent existing conditions. Typical effluent biochemical oxygen demand (BOD) and total suspended solids (TSS) were assumed between 10 and 30 milligrams per liter (mg/L) for such a facility and no designed nutrient or toxics removal was assumed for the baseline existing treatment process.

Following a literature review of technologies, two advanced treatment process options for toxics removal were selected for further evaluation based on the characterization of removal effectiveness from the technical literature review and Study Partners' preferences. The two tertiary treatment options are microfiltration membrane filtration (MF) followed by either reverse osmosis (RO) or granular activated carbon (GAC) as an addition to an existing secondary treatment facility.

The advanced treatment technologies are evaluated for their efficacy and cost to achieve the effluent limitations implied by the more stringent HHWQC. Various sensitivities are examined, including for less stringent adopted HHWQC, and for a size range of treatment systems. Collateral environmental impacts associated with the operation of advanced technologies are also qualitatively described.

2.0 Derivation of the Baseline Study Conditions and Rationale for Selection of Effluent Limitations

2.1 Summary of Water Quality Criteria

Surface water quality standards for toxics in the State of Washington are being updated based on revised human fish consumption rates (FCRs). The revised water quality standards could drive very low effluent limitations for industrial and municipal wastewater dischargers. Four pollutants were selected for study based on available monitoring data and abundant presence in the environment. The four toxic constituents are arsenic, BAP, mercury, and PCBs.

2.2 Background

Ecology is in the process of updating the HHWQC in the state water quality standards regulation. Toxics include metals, pesticides, and organic compounds. The human health criteria for toxics are intended to protect people who consume water, fish, and shellfish. FCRs are an important factor in the derivation of water quality criteria for toxics.

The AWB/City/County consortium (hereafter “Study Partners”) has selected four pollutants for which more stringent HHWQC are expected to be promulgated. The Study Partners recognize that Ecology probably will not adopt more stringent arsenic HHWQC so the evaluation here is based on the current arsenic HHWQC imposed by the National Toxics Rule. Available monitoring information indicates these pollutants are ubiquitous in the environment and are expected to be present in many NPDES discharges. The four pollutants include the following:

- Arsenic
  - Elemental metalloid that occurs naturally and enters the environment through erosion processes. Also widely used in batteries, pesticides, wood preservatives, and semiconductors. Other current uses and legacy sources in fungicides/herbicides, copper smelting, paints/dyes, and personal care products.
- Benzo(a)pyrene (BAP)
  - Benzo(a)pyrene is a polycyclic aromatic hydrocarbon formed by a benzene ring fused to pyrene as the result of incomplete combustion. Its metabolites are highly carcinogenic. Sources include wood burning, coal tar, automobile exhaust, cigarette smoke, and char-broiled food.
- Mercury
  - Naturally occurring element with wide legacy uses in thermometers, electrical switches, fluorescent lamps, and dental amalgam. Also enters the environment through erosion processes, combustion (especially coal), and legacy industrial/commercial uses. Methylmercury is an organometallic that is a bioaccumulative toxic. In aquatic systems, an anaerobic methylation process converts inorganic mercury to methylmercury.
- Polychlorinated Biphenyls (PCBs)
  - Persistent organic compounds historically used as a dielectric and coolant in electrical equipment and banned from production in the U.S. in 1979. Available information indicates continued pollutant loadings to the environment as a byproduct from the use of some pigments, paints, caulking, motor oil, and coal combustion.

2.3 Assumptions Supporting Selected Ambient Water Quality Criteria and Effluent Limitations

Clean Water Act regulations require NPDES permittees to demonstrate their discharge will “not cause or contribute to a violation of water quality criteria.” If a “reasonable potential analysis” reveals the possibility of a standards violation, the permitting authority is obliged to develop “water quality-based effluent limits” to ensure standards achievement. In addition, if ambient water quality monitoring or fish tissue assessments reveal toxic pollutant concentrations above HHWQC levels, Ecology is required to identify that impairment (“303(d) listing”) and develop corrective action plans to force reduction in the toxic pollutant discharge or loading of the pollutant into the impaired water body segment. These plans, referred to as total maximum daily loads (TMDLs) or water cleanup plans, establish discharge allocations and are implemented for point discharge sources through NPDES permit effluent limits and other conditions.

The effect of more stringent HHWQC will intuitively result in more NPDES permittees “causing or contributing” to a water quality standards exceedance, and/or more waterbodies being determined to be impaired, thus requiring 303(d) listing, the development of TMDL/water cleanup plans, and more stringent effluent limitations to NPDES permittees whose treated wastewater contains the listed toxic pollutant.

The study design necessarily required certain assumptions to create a “baseline effluent scenario” against which the evaluation of advanced treatment technologies could occur. The Study Partners and HDR Engineering, Inc (HDR) developed the scenario. Details of the baseline effluent scenario are presented in Table 1. The essential assumptions and rationale for selection are presented below:

- Ecology has indicated proposed HHWQC revisions will be provided in first quarter 2014. A Study Partners objective was to gain an early view on the treatment technology and cost implications. Ecology typically allows 30 or 45 days for the submission of public comments on proposed regulations. To wait for the proposed HHWQC revisions would not allow sufficient time to complete a timely technology/cost evaluation and then to share the study results in the timeframe allowed for public involvement/public comments.
- Coincident with the issuance of the proposed regulation, Ecology has a statutory obligation to provide a Significant Legislative Rule evaluation, one element of which is a “determination whether the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented” (RCW 34.05.328(1)(d)). A statutory requirement also exists to assess the impact of the proposed regulation to small businesses. The implication is that Ecology will be conducting these economic evaluations in fourth quarter 2013 and early 2014. The Study Partners wanted to have a completed technology/cost study available to share with Ecology for their significant legislative rule/small business evaluations.
- The EPA, Indian tribes located in Washington, and various special interest groups have promoted the recently promulgated state of Oregon HHWQC (2011) as the “model” for Washington’s revisions of HHWQC. The Oregon HHWQC are generally based on a increased FCR of 175 grams per day (g/day) and an excess cancer risk of 10^{-6}. While the Study Partners do not concede the wisdom or appropriateness of the Oregon criteria, or the selection of scientific/technical elements used to derive those criteria, the Study Partners nevertheless have selected the Oregon HHWQC as a viable “starting point” upon which this study could be based.

- The scenario assumes generally that Oregon's HHWQC for ambient waters will, for some parameters in fact, become effluent limitations for Washington NPDES permittees. The reasoning for this important assumption includes:
  - The state of Washington's NPDES permitting program is bound by the *Friends of Pinto Creek vs. EPA* decision in the United States Court of Appeals for the Ninth Circuit (October 4, 2007). This decision held that no NPDES permits authorizing new or expanded discharges of a pollutant into a waterbody identified as impaired; i.e., listed on CWA section 303(d), for that pollutant, may be issued until such time as "existing dischargers" into the waterbody are "subject to compliance schedules designed to bring the (waterbody) into compliance with applicable water quality standards." In essence, any new/expanded discharge of a pollutant causing impairment must achieve the HHWQC at the point of discharge into the waterbody.
  - If a waterbody segment is identified as "impaired" (i.e., not achieving a HHWQC), then Ecology will eventually need to produce a TMDL or water cleanup plan. For an existing NPDES permittee with a discharge of the pollutant for which the receiving water is impaired, the logical assumption is that any waste load allocation granted to the discharger will be at or lower than the numeric HHWQC (to facilitate recovery of the waterbody to HHWQC attainment). As a practical matter, this equates to an effluent limit established at the HHWQC.
  - Acceptance of Oregon HHWQC as the baseline for technology/cost review also means acceptance of practical implementation tools used by Oregon. The HHWQC for mercury is presented as a fish tissue methyl mercury concentration. For the purposes of NPDES permitting, however, Oregon has developed an implementation management directive which states that any confirmed detection of mercury is considered to represent a "reasonable potential" to cause or contribute to a water quality standards violation of the methyl mercury criteria. The minimum quantification level for total mercury is presented as 0.005 micrograms per liter (µg/L) (5.0 nanograms per liter (ng/L)).
  - The assumed effluent limit for arsenic is taken from EPA's *National Recommended Water Quality Criteria* (2012) (inorganic, water and organisms, 10^{-6} excess cancer risk). Oregon's 2011 criterion is actually based on a less protective excess cancer risk (10^{-4}). This, however, is the result of a state-specific risk management choice and it is unclear if Washington's Department of Ecology would mimic the Oregon approach.
  - The assumption is that no mixing zone is granted such that HHWQC will effectively serve as NPDES permit effluent limits. Prior discussion on the impact of the Pinto Creek decision, 303(d) impairment and TMDL Waste Load Allocations processes, all lend support to this "no mixing zone" condition for the parameters evaluated in this study.
- Consistent with Ecology practice in the evaluation of proposed regulations, the HHWQC are assumed to be in effect for a 20-year period. It is assumed that analytical measurement technology and capability will continue to improve over this time frame and this will result in the detection and lower quantification of additional HHWQC in ambient water and NPDES dischargers. This knowledge will trigger the Pinto Creek/303(d)/TMDL issues identified above and tend to pressure NPDES permittees to evaluate and install advanced treatment technologies. The costs and efficacy of treatment for these additional HHWQC is unknown at this time.

Other elements of the Study Partners work scope, as presented to HDR, must be noted:

- The selection of four toxic pollutants and development of a baseline effluent scenario is not meant to imply that each NPDES permittee wastewater discharge will include those pollutants at the assumed concentrations. Rather, the scenario was intended to represent a composite of many NPDES permittees and to facilitate evaluation of advanced treatment technologies relying on mechanical, biological, physical, chemical processes.
- The scalability of advanced treatment technologies to wastewater treatment systems with different flow capacities, and the resulting unit costs for capital and O&M, is evaluated.
- Similarly, a sensitivity analysis on the unit costs for capital and O&M was evaluated on the assumption the adopted HHWQC (and effectively, NPDES effluent limits) are one order-of-magnitude less stringent than the Table 1 values.

Table 1: Summary of Effluent Discharge Toxics Limits

Constituent	Human Health Criteria based Limits to be met with no Mixing Zone (µg/L)	Basis for Criteria	Typical Concentration in Municipal Secondary Effluent (µg/L)	Typical Concentration in Industrial Secondary Effluent (µg/L)	Existing Washington HHC (water + org.), NTR (µg/L)
PCBs	0.0000064	Oregon Table 40 Criterion (water + organisms) at FCR of 175 grams/day	0.0005 to 0.0025[b,c,d,e,f]	0.002 to 0.005[i]	0.0017
Mercury	0.005	DEQ IMD[a]	0.003 to 0.050[h]	0.010 to 0.050[h]	0.140
Arsenic	0.018	EPA National Toxics Rule (water + organisms)[k]	0.500 to 5.0[j]	10 to 40[j]	0.018
Benzo(a)Pyrene	0.0013	Oregon Table 40 Criterion (water + organisms) at FCR of 175 grams/day	0.00028 to 0.006[b,g]	0.006 to1.9	0.0028

[a] Oregon Department of Environmental Quality (ODEQ). Internal Management Directive: Implementation of Methylmercury Criterion in NPDES Permits. January 8, 2013.
[b] Control of Toxic Chemicals in Puget Sound, Summary Technical Report for Phase 3: Loadings from POTW Discharge of Treated Wastewater, Washington Department of Ecology, Publication Number 10-10-057, December 2010.
[c] Spokane River PCB Source Assessment 2003-2007, Washington Department of Ecology, Publication No. 11-03-013, April 2011.
[d] Lower Okanogan River Basin DDT and PCBs Total Maximum Daily Load, Submittal Report, Washington Department of Ecology, Publication Number 04-10-043, October 2004.
[e] Palouse River Watershed PCB and Dieldrin Monitoring, 2007-2008, Wastewater Treatment Plants and Abandoned Landfills, Washington Department of Ecology, Publication No. 09-03-004, January 2009
[f] A Total Maximum Daily Load Evaluation for Chlorinated Pesticides and PCBs in the Walla Walla River, Washington Department of Ecology, Publication No. 04-03-032, October 2004.
[g] Removal of Polycyclic Aromatic Hydrocarbons and Heterocyclic Nitrogenous Compounds by A POTW Receiving Industrial Discharges, Melcer, H., Steel, P. and Bedford, W.K., Water Environment Federation, 66th Annual Conference and Exposition, October 1993.
[h] Data provided by Lincoln Loehr's summary of WDOE Puget Sound Loading data in emails from July 19, 2013.
[i] NCASI memo from Larry Lefleur, NCASI, to Llewellyn Matthews, NWPPA, revised June 17, 2011, summarizing available PCB monitoring data results from various sources.
[j] Professional judgment, discussed in August 6, 2013 team call.
[k] The applicable Washington Human Health Criteria cross-reference the EPA National Toxics Rule, 40 CFR 131.36. The EPA arsenic HHC is 0.018 ug/L for water and organisms.

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3.0 Wastewater Characterization Description

This section describes the wastewater treatment discharge considered in this technology evaluation. Treated wastewater characteristics are described, including average and peak flow, effluent concentrations, and toxic compounds of concern.

3.1 Summary of Wastewater Characterization

A general wastewater treatment process and wastewater characteristics were developed as the common baseline to represent the existing conditions as a starting point for comparison with potential future advanced treatment technologies and improvements. A secondary treatment process with disinfection at a flow of 5 mgd as the current, baseline treatment system for existing dischargers was also developed. Typical effluent biochemical oxygen demand (BOD) and total suspended solids (TSS) were assumed between 10 to 30 mg/L from such a facility and no nutrient or toxics removal was assumed to be accomplished in the existing baseline treatment process.

3.2 Existing Wastewater Treatment Facility

The first step in the process is to characterize the existing wastewater treatment plant to be evaluated in this study. The goal is to identify the necessary technology that would need to be added to an existing treatment facility to comply with revised toxic pollutant effluent limits. Rather than evaluating the technologies and costs to upgrade multiple actual operating facilities, the Study Partners specified that a generalized municipal/industrial wastewater treatment facility would be characterized and used as the basis for developing toxic removal approaches. General characteristics of the facility's discharge are described in Table 2.

Table 2. General Wastewater Treatment Facility Characteristics

Average Annual Wastewater Flow, mgd	Maximum Month Wastewater Flow, mgd	Peak Hourly Wastewater Flow, mgd	Effluent BOD, mg/L	Effluent TSS, mg/L
5.0	6.25	15.0	10 to 30	10 to 30

mgd=million gallons per day
mg/L=milligrams per liter
BOD=biochemical oxygen demand
TSS=total suspended solids

In the development of the advanced treatment technologies presented below, the capacity of major treatment elements are generally sized to accommodate the maximum month average wastewater flow. Hydraulic elements, such as pumps and pipelines, were selected to accommodate the peak hourly wastewater flow.

The general treatment facility incorporates a baseline treatment processes including influent screening, grit removal, primary sedimentation, suspended growth biological treatment (activated sludge), secondary clarification, and disinfection using chlorine. Solids removed during primary treatment and secondary clarification are assumed to be thickened, stabilized, dewatered, and land applied to agricultural land. The biological treatment process is assumed to be activated sludge with a relatively short (less than 10-day) solids retention time. The baseline secondary treatment facility is assumed not to have processes dedicated to removing nutrients or toxics. However, some coincident removal of toxics will occur during conventional treatment.

3.3 Toxic Constituents

As described in Section 2.3, the expectation of more stringent HHWQC will eventually trigger regulatory demands for NPDES permittees to install advanced treatment technologies. The Study Group and HDR selected four specific toxic pollutants reflecting a range of toxic constituents as the basis for this study to limit the constituents and technologies to be evaluated to a manageable level.

The four toxic pollutants selected were PCBs, mercury, arsenic, and BAP, a polycyclic aromatic hydrocarbon (PAH). Mercury and arsenic are metals, and PCBs and PAHs are organic compounds. Technologies for removing metals and organic compounds are in some cases different. Key information on each of the compounds, including a description of the constituent, the significance of each constituent, proposed HHWQC, basis for the proposed criteria, typical concentration in both municipal and industrial secondary effluent, and current Washington state water quality criteria, are shown in Table 1. It is assumed that compliance with the proposed criteria in the table would need to be achieved at the “end of pipe” and Ecology would not permit a mixing zone for toxic constituents. This represents a “worst–case,” but a plausible assumption about discharge conditions.

4.0 Treatment Approaches and Costs

4.1 Summary of Treatment Approach and Costs

Two advanced treatment process options for toxics removal for further evaluation based on the characterization of removal effectiveness from the technical literature review and Study Group preferences. The two tertiary treatment options are microfiltration MF followed by either RO or GAC as an addition to an existing secondary treatment facility. Based on the literature review, it is not anticipated that any of the treatment options will be effective in reducing all of the selected pollutants to below the anticipated water quality criteria. A summary of the capital and operations and maintenance costs for tertiary treatment is provided, as well as a comparison of the adverse environmental impacts for each alternative.

4.2 Constituent Removal – Literature Review

The evaluation of treatment technologies relevant to the constituents of concern was initiated with a literature review. The literature review included a desktop search using typical web-based search engines, and search engines dedicated to technical and research journal databases. At the same time, HDR's experience with the performance of existing treatment technologies specifically related to the four constituents of concern, was used in evaluating candidate technologies. A summary of the constituents of concern and relevant treatment technologies is provided in the following literature review section.

4.2.1 Polychlorinated Biphenyls

PCBs are persistent organic pollutants that can be difficult to remove in treatment. PCB treatment in wastewater can be achieved using oxidation with peroxide, filtration, biological treatment or a combination of these technologies. There is limited information available about achieving ultra-low effluent PCB concentrations near the 0.0000064 µg/L range under consideration in the proposed rulemaking process. This review provides a summary of treatment technology options and anticipated effluent PCB concentrations.

Research on the effectiveness of ultraviolet (UV) light and peroxide on removing PCBs was tested in bench scale batch reactions (Yu, Macawile, Abella, & Gallardo 2011). The combination of UV and peroxide treatment achieved PCB removal greater than 89 percent, and in several cases exceeding 98 percent removal. The influent PCB concentration for the batch tests ranged from 50 to 100 micrograms per liter (µg/L). The final PCB concentration (for the one congener tested) was <10 µg/L (10,000 ng/L) for all tests and <5 µg/L (5,000 ng/L) for some tests. The lowest PCB concentrations in the effluent occurred at higher UV and peroxide doses.

Pilot testing was performed to determine the effectiveness of conventional activated sludge and a membrane bioreactor to remove PCBs (Bolzonella, Fatone, Pavan, & Cecchi 2010). EPA Method 1668 was used for the PCB analysis (detection limit of 0.01 ng/L per congener). Influent to the pilot system was a combination of municipal and industrial effluent. The detailed analysis was for several individual congeners. Limited testing using the Aroclor method (total PCBs) was used to compare the individual congeners and the total concentration of PCBs. Both conventional activated sludge and membrane bioreactor (MBR) systems removed PCBs. The effluent MBR concentrations ranged from <0.01 ng/L to 0.04 ng/L compared to <0.01 ng/L to 0.88 ng/L for conventional activated sludge. The pilot testing showed that increased solids retention time (SRT) and higher mixed liquor suspended solids concentrations in the MBR system led to increased removal in the liquid stream.

Bench scale studies were completed to test the effectiveness of GAC and biological activated carbon (BAC) for removing PCBs (Ghosh, Weber, Jensen, & Smith 1999). The effluent from the

GAC system was 800 ng/L. The biological film in the BAC system was presumed to support higher PCB removal with effluent concentrations of 200 ng/L. High suspended sediment in the GAC influent can affect performance. It is recommended that filtration be installed upstream of a GAC system to reduce solids and improve effectiveness.

Based on limited available data, it appears that existing municipal secondary treatment facilities in Washington state are able to reduce effluent PCBs to the range approximately 0.10 to 1.5 ng/L. It appears that the best performing existing municipal treatment facility in Washington state with a microfiltration membrane is able to reduce effluent PCBs to the range approximately 0.00019 to 0.00063 µg/L. This is based on a very limited data set and laboratory blanks covered a range that overlapped with the effluent results (blanks 0.000058 to 0.00061 µg/L).

Addition of advanced treatment processes would be expected to enhance PCB removal rates, but the technical literature does not appear to provide definitive information for guidance. A range of expected enhanced removal rates might be assumed to vary widely from level of the reference microfiltration facility of 0.19 to 0.63 ng/L.

Summary of PCB Technologies

The literature review revealed there are viable technologies available to reduce PCBs **but no research was identified with treatment technologies capable of meeting the anticipated human health criteria based limits for PCB removal**. Based on this review, a tertiary process was selected to biologically reduce PCBs and separate the solids using tertiary filtration. Alternately, GAC was investigated as an option to reduce PCBs, although it is not proven that it will meet revised effluent limits.

4.2.2 Mercury

Mercury removal from wastewater can be achieved using precipitation, adsorption, filtration, or a combination of these technologies. There is limited information available about achieving ultra-low effluent mercury concentrations near the 5 ng/L range under consideration in the proposed rulemaking process. This review provides a summary of treatment technology options and anticipated effluent mercury concentrations.

Precipitation (and co-precipitation) involves chemical addition to form a particulate and solids separation, using sedimentation or filtration. Precipitation includes the addition of a chemical precipitant and pH adjustment to optimize the precipitation reaction. Chemicals can include metal salts (ferric chloride, ferric sulfate, ferric hydroxide, or alum), pH adjustment, lime softening, or sulfide. A common precipitant for mercury removal is sulfide, with an optimal pH between 7 and 9. The dissolved mercury is precipitated with the sulfide to form an insoluble mercury sulfide that can be removed through clarification or filtration. One disadvantage of precipitation is the generation of a mercury-laden sludge that will require dewatering and disposal. The mercury sludge may be considered a hazardous waste and require additional treatment and disposal at a hazardous waste site. The presence of other compounds, such as other metals, may reduce the effectiveness of mercury precipitation/co-precipitation. For low-level mercury treatment requirements, several treatment steps will likely be required in pursuit of very low effluent targets.

EPA compiled a summary of facilities that are using precipitation/co-precipitation for mercury treatment (EPA 2007). Three of the full-scale facilities were pumping and treating groundwater and the remaining eight facilities were full-scale wastewater treatment plants. One of the pump and treat systems used precipitation, carbon adsorption, and pH adjustment to treat groundwater to effluent concentrations of 300 ng/L.

Adsorption treatment can be used to remove inorganic mercury from water. While adsorption can be used as a primary treatment step, it is frequently used for polishing after a preliminary treatment step (EPA 2007). One disadvantage of adsorption treatment is that when the adsorbent is saturated, it either needs to be regenerated or disposed of and replaced with new adsorbent. A common adsorbent is GAC. There are several patented and proprietary adsorbents on the market for mercury removal. Adsorption effectiveness can be affected by water quality characteristics, including high solids and bacterial growth, which can cause media blinding. A constant and low flow rate to the adsorption beds increases effectiveness (EPA 2007). The optimal pH for mercury adsorption on GAC is pH 4 to 5; therefore, pH adjustment may be required.

EPA compiled a summary of facilities that are using adsorption for mercury treatment (EPA 2007). Some of the facilities use precipitation and adsorption as described above. The six summarized facilities included two groundwater treatment and four wastewater treatment facilities. The reported effluent mercury concentrations were all less than 2,000 ng/L (EPA 2007).

Membrane filtration can be used in combination with a preceding treatment step. The upstream treatment is required to precipitate soluble mercury to a particulate form that can be removed through filtration. According to the EPA summary report, ultrafiltration is used to remove high-molecular weigh contaminants and solids (EPA 2007). The treatment effectiveness can depend on the source water quality since many constituents can cause membrane fouling, decreasing the effectiveness of the filters. One case study summarized in the EPA report showed that treatment of waste from a hazardous waste combustor treated with precipitation, sedimentation, and filtration achieved effluent mercury concentrations less than the detection limit of 200 ng/L.

Bench-scale research performed at the Oak Ridge Y-12 Plant in Tennessee evaluated the effectiveness of various adsorbents for removing mercury to below the NPDES limit of 12 ng/L and the potential revised limit of 51 ng/L (Hollerman et al. 1999). Several proprietary adsorbents were tested, including carbon, polyacrylate, polystyrene, and polymer adsorption materials. The adsorbents with thiol-based active sites were the most effective. Some of the adsorbents were able to achieve effluent concentrations less than 51 ng/L but none of the adsorbents achieved effluent concentrations less than 12 ng/L.

Bench-scale and pilot-scale testing performed on refinery wastewater was completed to determine treatment technology effectiveness for meeting very low mercury levels (Urgun-Demirtas, Benda, Gillenwater, Negri, Xiong & Snyder 2012) (Urgun-Demirtas, Negri, Gillenwater, Agwu Nnanna & Yu 2013). The Great Lakes Initiative water quality criterion for mercury is less than 1.3 ng/L for municipal and industrial wastewater plants in the Great Lakes region. This research included an initial bench scale test including membrane filtration, ultrafiltration, nanofiltration, and reverse osmosis to meet the mercury water quality criterion. The nanofiltration and reverse osmosis required increased pressures for filtration and resulted in increased mercury concentrations in the permeate. Based on this information and the cost difference between the filtration technologies, a pilot-scale test was performed. The 0.04 um PVDF GE ZeeWeed 500 series membranes were tested. The 1.3 ng/L water quality criterion was met under all pilot study operating conditions. The mercury in the refinery effluent was predominantly in particulate form which was well-suited for removal using membrane filtration.

Based on available data, it appears that existing municipal treatment facilities are capable of reducing effluent mercury to near the range of the proposed HHWQC on an average basis. Average effluent mercury in the range of 1.2 to 6.6 ng/L for existing facilities with secondary treatment and enhanced treatment with cloth filters and membranes. The Spokane County plant data range is an average of 1.2 ng/L to a maximum day of 3 ng/L. Addition of advanced treatment processes such as GAC or RO would be expected to enhance removal rates. Data from the West Basin treatment facility in California suggests that at a detection limit of 7.99 ng/L mercury is not detected in the effluent from this advanced process train. A range of expected enhanced removal rates from the advanced treatment process trains might be expected to ranged from meeting the proposed standard at 5 ng/L to lower concentrations represented by the Spokane County performance level (membrane filtration) in the range of 1 to 3 ng/L, to perhaps even lower levels with additional treatment. For municipal plants in Washington, this would suggest that effluent mercury values from the two advanced treatment process alternatives might range from 1 to 5 ng/L (0.001 to 0.005 µg/L) and perhaps substantially better, depending upon RO and GAC removals. It is important to note that industrial plants may have higher existing mercury levels and thus the effluent quality that is achievable at an industrial facility would be of lower quality.

Summary of Mercury Technologies

The literature search revealed limited research on mercury removal technologies at the revised effluent limit of 0.005 µg/L. Tertiary filtration with membrane filters or reverse osmosis showed the best ability to achieve effluent criteria less than 0.005 µg/L.

4.2.3 Arsenic

A variety of treatment technologies can be applied to capture arsenic (Table 3). Most of the information in the technical literature and from the treatment technology vendors is focused on potable water treatment for compliance with a Safe Drinking Water Act (SDWA) maximum contaminant level (MCL) of 10 µg/L. The most commonly used arsenic removal method for a wastewater application (tertiary treatment) is coagulation/ flocculation plus filtration. This method by itself could remove more than 90 to 95 percent of arsenic. Additional post-treatment through adsorption, ion exchange, or reverse osmosis is required for ultra-low arsenic limits in the 0.018 µg/L range under consideration in the proposed rulemaking process. In each case it is recommended to perform pilot-testing of each selected technology.

Table 3: Summary of Arsenic Removal Technologies[1]

Technology	Advantages	Disadvantages
Coagulation/filtration	• Simple, proven technology • Widely accepted • Moderate operator training	• pH sensitive • Potential disposal issues of backwash waste • As^{+3} and As^{+5} must be fully oxidized
Lime softening	• High level arsenic treatment • Simple operation change for existing lime softening facilities	• pH sensitive (requires post treatment adjustment) • Requires filtration • Significant sludge operation
Adsorptive media	• High As^{+5} selectivity • Effectively treats water with high total dissolved solids (TDS)	• Highly pH sensitive • Hazardous chemical use in media regeneration • High concentration SeO_4^{-2}, F^-, Cl^-, and SO_4^{-2} may limit arsenic removal

Table 3: Summary of Arsenic Removal Technologies[1]

Technology	Advantages	Disadvantages
Ion exchange	• Low contact times • Removal of multiple anions, including arsenic, chromium, and uranium	• Requires removal of iron, manganese, sulfides, etc. to prevent fouling • Brine waste disposal
Membrane filtration	• High arsenic removal efficiency • Removal of multiple contaminants	• Reject water disposal • Poor production efficiency • Requires pretreatment

[1]Adapted from WesTech

The removal of arsenic in activated sludge is minimal (less than 20 percent) (Andrianisa et al. 2006), but biological treatment can control arsenic speciation. During aerobic biological process As (III) is oxidized to As (V). Coagulation/flocculation/filtration removal, as well as adsorption removal methods, are more effective in removal of As(V) vs. As (III). A combination of activated sludge and post-activated sludge precipitation with ferric chloride (addition to MLSS and effluent) results in a removal efficiency of greater than 95 percent. This combination could decrease As levels from 200 µg/L to less than 5 µg/L (5,000 ng/L) (Andrianisa et al. 2008) compared to the 0.018 µg/L range under consideration in the proposed rulemaking process.

Data from the West Basin facility (using MF/RO/AOP) suggests effluent performance in the range of 0.1 to 0.2 µg/L, but it could also be lower since a detection limit used there of 0.15 µg/l is an order of magnitude higher than the proposed HHWQC. A range of expected enhanced removal rates might be assumed to equivalent to that achieved at West Basin in 0.1 to 0.2 µg/L range.

Review of Specific Technologies for Arsenic Removal

Coagulation plus Settling or Filtration

Coagulation may remove more than 95 percent of arsenic through the creation of particulate metal hydroxides. Ferric sulfite is typically more efficient and applicable to most wastewater sources compared to alum. The applicability and extent of removal should be pilot-tested, since removal efficiency is highly dependent on the water constituents and water characteristics (i.e., pH, temperature, solids).

Filtration can be added after or instead of settling to increase arsenic removal. Example treatment trains with filtration are shown in Figures 1 and 2, respectively.

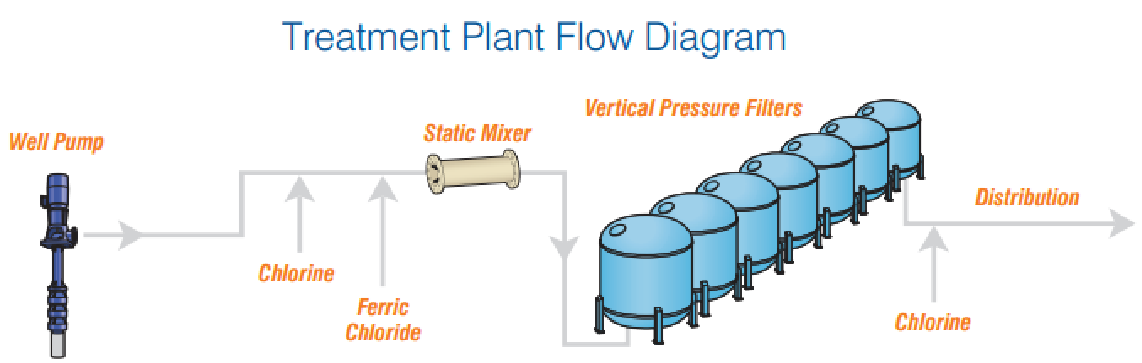

Figure 1. Water Treatment Configuration for Arsenic Removal (WesTech)

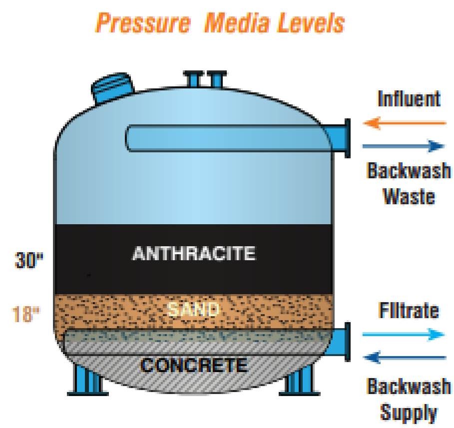

Figure 2. WesTech Pressure Filters for Arsenic Removal

One system for treatment of potable water with high levels of arsenic in Colorado (110 parts per million [ppm]) consists of enhanced coagulation followed by granular media pressure filters that include anthracite/silica sand/garnet media (WesTech). The arsenic levels were reduced to less than the drinking water MCL, which is 10 µg/L (10,000 ng/L). The plant achieves treatment by reducing the pH of the raw water to 6.8 using sulfuric acid, and then adding approximately 12 to 14 mg/L ferric sulfate. The water is filtered through 16 deep bed vertical pressure filters, the pH is elevated with hydrated lime and is subsequently chlorinated and fed into the distribution system. (http://www.westechinc.com/public/uploads/global/2011/3/Fallon%20NV%20Installation%20ReportPressureFilter.pdf).

Softening (with lime)

Removes up to 90 percent arsenic through co-precipitation, but requires pH to be higher than 10.2.

Adsorption processes

Activated alumina is considered an adsorptive media, although the chemical reaction is an exchange of arsenic ions with the surface hydroxides on the alumina. When all the surface hydroxides on the alumina have been exchanged, the media must be regenerated. Regeneration consists of backwashing, followed by sodium hydroxide, flushing with water and neutralization with a strong acid. Effective arsenic removal requires sufficient empty bed contact time. Removal efficiency can also be impacted by the water pH, with neutral or slightly acidic conditions being considered optimum. If As (III) is present, it is generally advisable to increase empty bed contact time, as As (III) is adsorbed more slowly than As (V). Alumina dissolves slowly over time due to contact with the chemicals used for regeneration. As a result, the media bed is likely to become compacted if it is not backwashed periodically.

Granular ferric hydroxide works by adsorption, but when the media is spent it cannot be regenerated and must be replaced. The life of the media depends upon pH of the raw water, the concentrations of arsenic and heavy metals, and the volume of water treated daily. Periodic backwashing is required to prevent the media bed from becoming compacted and pH may need to be adjusted if it is high, in order to extend media life. For maximum arsenic removal, filters operate in series. For less stringent removal, filters can operate in parallel.

One type of adsorption media has been developed for application to non-drinking water processes for arsenic, phosphate and for heavy metals removal by sorption (Severent Trent Bayoxide® E IN-20). This granular ferric oxide media has been used for arsenic removal from mining and industrial wastewaters, selenium removal from refinery wastes and for phosphate polishing of municipal wastewaters. Valley Vista drinking water treatment with Bayoxide® E IN-20 media achieves removal from 31-39 µg/L (31,000-39,000 ng/L) to below 10 µg/L MCL (http://www.severntrentservices.com/News/Successful_Drinking_Water_Treatment_in_an_Arsenic__Hot_Spot__nwMFT_452.aspx).

Another adsorptive filter media is greensand. Greensand is available in two forms: as glauconite with manganese dioxide bound ionically to the granules and as silica sand with manganese dioxide fused to the granules. Both forms operate in pressure filters and both are effective. Greensand with the silica sand core operates at higher water temperatures and higher differential pressures than does greensand with the glauconite core. Arsenic removal requires a minimum concentration of iron. If a sufficient concentration of iron is not present in the raw water, ferric chloride is added.

WesTech filters with greensand and permanganate addition for drinking water systems can reduce As from 15-25 µg/L to non-detect. Sodium hypochlorite and/or potassium permanganate are added to the raw water prior to the filters. Chemical addition may be done continuously or intermittently, depending on raw water characteristics. These chemicals oxidize the iron in the raw water and also maintain the active properties of the greensand itself. Arsenic removal is via co-precipitation with the iron.

Ion Exchange

Siemens offers a potable ion exchange (PIX) arsenic water filtration system. PIX uses ion exchange resin canisters for the removal of organic and inorganic contaminants, in surface and groundwater sources to meet drinking water standards.

Filtronics also uses ion exchange to treat arsenic. The technology allows removal for below the SWDA MCL for potable water of 10 µg/L (10,000 ng/L).

Reverse osmosis

Arsenic is effectively removed by RO when it is in oxidative state As(V) to approximately 1,000 ng/L or less (Ning 2002).

Summary of Arsenic Technologies

The current state of the technology for arsenic removal is at the point where all the processes target the SWDA MCL for arsenic in potable water. Current EPA maximum concentration level for drinking water is 10 ug/l; much higher than 0.0018 µg/L target for arsenic in this study. The majority of the methods discussed above are able to remove arsenic to either EPA maximum contaminant level or to the level of detection. The lowest detection limit of one of the EPA approved methods of arsenic measurements is 20 ng/l (0.020 µg/l) (Grosser, 2010), which is comparable to the 0.018 µg/L limit targeted in this study.

4.2.1 Polycyclic Aromatic Hydrocarbons

BAP During Biological Treatment

During wastewater treatment process, BAP tends to partition into sludge organic matter (Melcer et al. 1993). Primary and secondary processing could remove up to 60 percent of incoming PAHs and BAP in particular, mostly due to adsorption to sludge (Kindaichi et al., NA, Wayne et al. 2009). Biodegradation of BAP is expected to be very low since there are more than five benzene rings which are resistant to biological degradation. Biosurfactant addition to biological process could partially improve biodegradation, but only up to removal rates of 50 percent (Sponza et al. 2010). Existing data from municipal treatment facilities in Washington state have influent and effluent concentrations of BAP of approximately 0.30 ng/L indicating that current secondary treatment has limited effectiveness at BAP removal.

Methods to Enhance Biological Treatment of BAP

Ozonation prior to biological treatment could potentially improve biodegradability of BAP (Zeng et al. 2000). In the case of soil remediation, ozonation before biotreatment improved biodegradation by 70 percent (Russo et al. 2012). The overall removal of BAP increased from 23 to 91 percent after exposure of water to 0.5 mg/L ozone for 30 minutes during the simultaneous treatment process and further to 100 percent following exposure to 2.5 mg/L ozone for 60 minutes during the sequential treatment mode (Yerushalmi et al. 2006). In general, to improve biodegradability of BAP, long exposure to ozone might be required (Haapea et al. 2006).

Sonication pre-treatment or electronic beam irradiation before biological treatment might also make PAHs more bioavailable for biological degradation..

Recent studies reported that a MBR is capable of removing PAHs from wastewater (Rodrigue and Reilly 2009; Gonzaleza et al. 2012). None of the studies listed the specific PAHs constituents removed.

Removal of BAP from Drinking Water

Activated Carbon

Since BAP has an affinity to particulate matter, it is removed from the drinking water sources by means of adsorption, such as granular activated carbon (EPA). Similarly, Oleszczuk et al. (2012) showed that addition of 5 percent activated carbon could remove 90 percent of PAHs from the wastewater.

Reverse Osmosis

Light (1981) (referenced by Williams, 2003) studied dilute solutions of PAHs, aromatic amines, and nitrosamines and found rejections of these compounds in reverse osmosis to be over 99 percent for polyamide membranes. Bhattacharyya et al. (1987) (referenced by Williams, 2003) investigated rejection and flux characteristics of FT30 membranes for separating various pollutants (PAHs, chlorophenols, nitrophenols) and found membrane rejections were high (>98 percent) for the organics under ionized conditions.

Summary of BAP Technologies

Current technologies show that BAP removal may be 90 percent or greater. The lowest detection limit for BAP measurements is 0.006 µg/L, which is also the assumed secondary effluent BAP concentration assumed for this study. If this assumption is accurate, it appears technologies may exist to remove BAP to a level below the proposed criteria applied as an effluent limit of 0.0013 µg/L; however, detection limits exceed this value and it is impossible to know this for certain. A municipal wastewater treatment plant study reported both influent and effluent BAP concentrations less than the HHWQC of 0.0013 ug/L (Ecology, 2010).

4.3 Unit Processes Evaluated

Based on the results of the literature review, a wide range of technologies were evaluated for toxic constituent removal. A listing of the technologies is as follows:

- Chemically enhanced primary treatment (CEPT): this physical and chemical technology is based on the addition of a metal salt to precipitate particles prior to primary treatment, followed by sedimentation of particles in the primary clarifiers. This technology has been shown to effectively remove arsenic but there is little data supporting the claims. As a result, the chemical facilities are listed as optional.

- Activated sludge treatment (with a short SRT of approximately 8 days or less): this biological technology is commonly referred to as secondary treatment. It relies on converting dissolved organics into solids using biomass. Having a short SRT is effective at removing degradable organics referred to as BOD compounds for meeting existing discharge limits. Dissolved constituents with a high affinity to adsorb to biomass (e.g., metals, high molecular weight organics, and others) will be better removed compared to smaller molecular weight organics and recalcitrant compounds which will have minimal removal at a short SRT.
- Enhanced activated sludge treatment (with a long SRT of approximately 8 days or more): this technology builds on secondary treatment by providing a longer SRT, which enhances sorption and biodegradation. The improved performance is based on having more biomass coupled with a more diverse biomass community, especially nitrifiers, which have been shown to assist in removal of some of the more recalcitrant constituents not removed with a shorter SRT (e.g., lower molecular weight PAHs). There is little or no data available on the effectiveness of this treatment for removing BAP.

  Additional benefits associated with having a longer SRT are as follows:

  - Lower BOD/TSS discharge load to receiving water
  - Improved water quality and benefit to downstream users
  - Lower effluent nutrient concentrations which reduce algal growth potential in receiving waters
  - Reduced receiving water dissolved oxygen demand due to ammonia removal
  - Reduced ammonia discharge, which is toxic to aquatic species
  - Improved water quality for habitat, especially as it relates to biodiversity and eutrophication
  - Secondary clarifier effluent more conditioned for filtration and disinfection
  - Greater process stability from the anaerobic/anoxic zones serving as biological selectors
- Coagulation/Flocculation and Filtration: this two-stage chemical and physical process relies on the addition of a metal salt to precipitate particles in the first stage, followed by the physical removal of particles in filtration. This technology lends itself to constituents prone to precipitation (e.g., arsenic).
- Lime Softening: this chemical process relies on increasing the pH as a means to either volatilize dissolved constituents or inactivate pathogens. Given that none of the constituents being studied are expected to volatilize, this technology was not carried forward.
- Adsorptive Media: this physical and chemical process adsorbs constituents to a combination of media and/or biomass/chemicals on the media. There are several types of media, with the most proven and common being GAC. GAC can also serve as a coarse roughing filter.
- Ion Exchange: this chemical technology exchanges targeted constituents with a resin. This technology is common with water softeners where the hard divalent cations are

exchanged for monovalent cations to soften the water. Recently, resins that target arsenic and mercury removal include activated alumina and granular ferric hydroxides have been developed. The resin needs to be cleaned and regenerated, which produces a waste slurry that requires subsequent treatment and disposal. As a result, ion exchange was not considered for further.

- Membrane Filtration: This physical treatment relies on the removal of particles larger than the membranes pore size. There are several different membrane pore sizes as categorized below.
    - Microfiltration (MF): nominal pore size range of typically between 0.1 to 1 micron. This pore size targets particles, both inert and biological, and bacteria. If placed in series with coagulation/flocculation upstream, dissolved constituents precipitated out of solution and bacteria can be removed by the MF membrane.
    - Ultrafiltration (UF): nominal pore size range of typically between 0.01 to 0.1 micron. This pore size targets those solids removed with MF (particles and bacteria) plus viruses and some colloidal material. If placed in series with coagulation/flocculation upstream, dissolved constituents precipitated out of solution can be removed by the UF membrane.
    - Nanofiltration (NF): nominal pore size range of typically between 0.001 to 0.010 micron. This pore size targets those removed with UF (particles, bacteria, viruses) plus colloidal material. If placed in series with coagulation/flocculation upstream, dissolved constituents precipitated out of solution can be removed by the NF membrane.
- MBR (with a long SRT): this technology builds on secondary treatment whereby the membrane (microfiltration) replaces the secondary clarifier for solids separation. As a result, the footprint is smaller, the mixed liquor suspended solids concentration can be increased to about 5,000 – 10,000 mg/L, and the physical space required for the facility reduced when compared to conventional activated sludge. As with the activated sludge option operated at a longer SRT, the sorption and biodegradation of organic compounds are enhanced in the MBR process. The improved performance is based on having more biomass coupled with a more diverse biomass community, especially nitrifiers which have been shown to assist in removal of persistent dissolved compounds (e.g., some PAHs). There is little or no data available on effectiveness at removing BAP. Although a proven technology, MBRs were not carried further in this technology review since they are less likely to be selected as a retrofit for an existing activated sludge (with a short SRT) secondary treatment facility. The MBR was considered to represent a treatment process approach more likely to be selected for a new, greenfield treatment facility. Retrofits to existing secondary treatment facilities can accomplish similar process enhancement by extending the SRT in the activated sludge process followed by the addition of tertiary membrane filtration units.
- RO: This physical treatment method relies on the use of sufficient pressure to osmotically displace water across the membrane surface while simultaneously rejecting most salts. RO is very effective at removing material smaller than the size ranges for the membrane filtration list above, as well as salts and other organic compounds. As a result, it is expected to be more effective than filtration and MBR methods described above at removing dissolved constituents. Although effective, RO produces a brine reject water that must be managed and disposed.

- Advanced Oxidation Processes (AOPs): this broad term considers all chemical and physical technologies that create strong hydroxyl-radicals. Examples of AOPs include Fenton's oxidation, ozonation, ultraviolet/hydrogen peroxide (UV-H2O2), and others. The radicals produced are rapid and highly reactive at breaking down recalcitrant compounds. Although effective at removing many complex compounds such as those evaluated in this study, AOPs does not typically have as many installations as membranes and activated carbon technologies. As a result, AOPs were not carried forward.

Based on the technical literature review discussed above, a summary of estimated contaminant removal rated by unit treatment process is presented in Table 4.

Table 4. Contaminants Removal Breakdown by Unit Process

Unit Process	Arsenic	BAP	Mercury	Polychlorinated Biphenyls
Activated Sludge Short SRT	No removal	Partial Removal by partitioning		80% removal; effluent <0.88 ng/L
Activated Sludge Long SRT	No removal	Partial removal by partitioning and/or partially biodegradation; MBR could potentially remove most of BAP		>90% removal with a membrane bioreactor, <0.04 ng/L (includes membrane filtration)
Membrane Filtration (MF)	More than 90 % removal (rejection of bound arsenic)	No removal	<1.3 ng/L	>90% removal with a membrane bioreactor, <0.04 ng/L (includes membrane filtration)
Reverse Osmosis (RO)	More than 90% removal (rejection of bound arsenic and removal of soluble arsenic)	More than 98% removal		
Granular Activated Carbon (GAC)	No removal, removal only when carbon is impregnated with iron	90 % removal	<300 ng/L (precipitation and carbon adsorption) <51 ng/L (GAC)	<800 ng/L Likely requires upstream filtration
Disinfection	--	--	--	--

4.4 Unit Processes Selected

The key conclusion from the literature review was that there is limited, to no evidence, that existing treatment technologies are capable of simultaneously meeting all four of the revised discharge limits for the toxics under consideration. Advanced treatment using RO or GAC is expected to provide the best overall removal of the constituents of concern. It is unclear whether these advanced technologies are able to meet revised effluent limits, however these processes may achieve the best effluent quality of the technologies reviewed. This limitation in the findings is based on a lack of an extensive dataset on treatment removal effectiveness in the technical literature for the constituents of interest at the low levels relevant to the proposed criteria, which approach the limits of reliable removal performance for the technologies. As Table 4 highlights, certain unit processes are capable of removing a portion, or all, of the removal requirements for each technology. The removal performance for each constituent will vary from facility to facility and require a site-specific, detailed evaluation because the proposed criteria are such low concentrations. In some cases, a facility may only have elevated concentrations of a single constituent of concern identified in this study. In other cases, a discharger may have elevated concentrations of the four constituents identified in this study, as well as others not identified in this study but subject to revised water quality criteria. This effort is intended to describe a planning level concept of what treatment processes are required to comply with discharge limits for all four constituents. Based on the literature review of unit processes above, two different treatment trains were developed for the analysis that are compared against a baseline of secondary treatment as follows:

- Baseline: represents conventional secondary treatment that is most commonly employed nationwide at wastewater treatment plants. A distinguishing feature for this treatment is the short solids residence time (SRT) (<8 days) is intended for removal of BOD with minimal removal for the toxic constituents of concern.
- Advanced Treatment – MF/RO: builds on baseline with the implementation of a longer SRT (>8 days) and the addition of MF and RO. The longer SRT not only removes BOD, but it also has the capacity to remove nutrients and a portion of the constituents of concern. This alternative requires a RO brine management strategy which will be discussed in sub-sections below.
- Advanced Treatment – MF/GAC: this alternative provides a different approach to advanced treatment with MF/RO by using GAC and avoiding the RO reject brine water management concern. Similar to the MF/RO process, this alternative has the longer SRT (>8 days) with the capacity to remove BOD, nutrients, and a portion of the toxic constituents of concern. As a result, the decision was made to develop costs for both advanced treatment options.

A description of each alternative is provided in Table 5. The process flowsheets for each alternative are presented in Figure 3 to Figure 5.

4.4.1 Baseline Treatment Process

A flowsheet of the baseline treatment process is provided in Figure 3. The baseline treatment process assumes the current method of treatment commonly employed by dischargers. For this process, water enters the headworks and undergoes primary treatment, followed by conventional activated sludge (short SRT) and disinfection. The solids wasted in the activated sludge process are thickened, followed by mixing with primary solids prior to entering the anaerobic digestion process for solids stabilization. The digested biosolids are dewatered to produce a cake and hauled off-site. Since the exact process for each interested facility in Washington is unique, this baseline treatment process was used to establish the baseline capital and O&M costs. The baseline costs will be compared against the advanced treatment alternatives to illustrate the magnitude of the increased costs and environmental impacts.

Table 5. Unit Processes Description for Each Alternative

Unit Process	Baseline	Advanced Treatment – MF/RO	Advanced Treatment - GAC
Influent Flow	5 mgd	5 mgd	5 mgd
Chemically Enhanced Primary Treatment (CEPT); Optional	--	• Metal salt addition (alum) upstream of primaries	• Metal salt addition (alum) upstream of primaries
Activated Sludge	• Hydraulic Residence Time (HRT): 6 hrs • Short Solids Residence Time (SRT): <8 days	• Hydraulic Residence Time (HRT): 12 hrs (Requires more tankage than the Baseline) • Long Solids Residence Time (SRT): >8 days (Requires more tankage than the Baseline)	• Hydraulic Residence Time (HRT): 12 hrs (Requires more tankage than the Baseline) • Long Solids Residence Time (SRT): >8 days (Requires more tankage than the Baseline)
Secondary Clarifiers	Hydraulically Limited	Solids Loading Limited (Larger clarifiers than Baseline)	Solids Loading Limited (Larger clarifiers than Baseline)
Microfiltration (MF)	--	Membrane Filtration to Remove Particles and Bacteria	Membrane Filtration to Remove Particles and Bacteria
Reverse Osmosis (RO)	--	Treat 50% of the Flow by RO to Remove Metals and Dissolved Constituents. Sending a portion of flow through the RO and blending it with the balance of plant flows ensures a stable non-corrosive, non-toxic discharge.	--
Reverse Osmosis Brine Reject Mgmt	--	Several Options (All Energy or Land Intensive)	--
Granular Activated Carbon (GAC)	--	--	Removes Dissolved Constituents
Disinfection	Not shown to remove any of the constituents	Not shown to remove any of the constituents	Not shown to remove any of the constituents

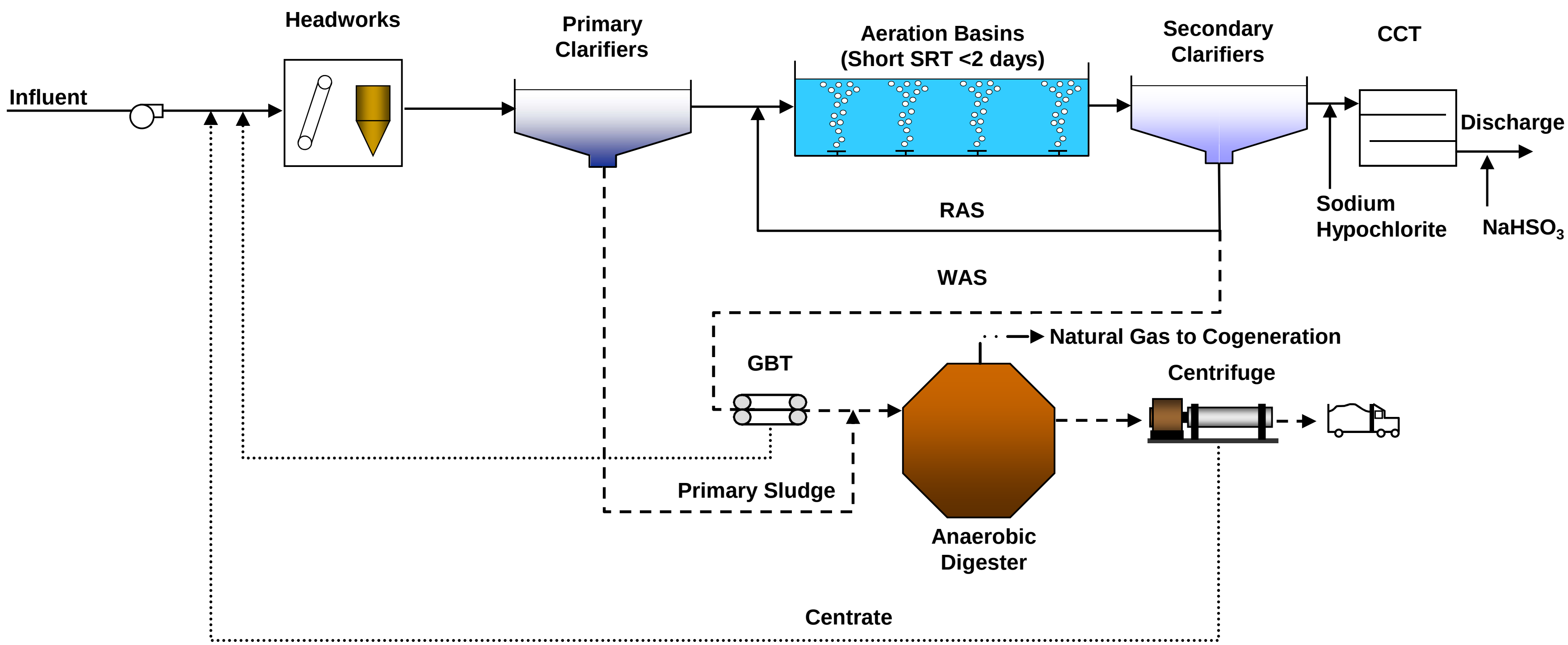

Figure 3. Baseline Flowsheet – Conventional Secondary Treatment

4.4.2 Advanced Treatment – MF/RO Alternative

A flowsheet of the advanced treatment – MF/RO alternative is provided in Figure 4. This alternative builds on the baseline secondary treatment facility, whereby the SRT is increased in the activated sludge process, and MF and RO are added prior to disinfection. The solids treatment train does not change with respect to the baseline. Additionally, a brine management strategy must be considered.

The RO process concentrates contaminants into a smaller volume reject stream. Disposing of the RO reject stream can be a problem because of the potentially large volume of water involved and the concentration of contaminants contained in the brine. For reference, a 5 mgd process wastewater flow might result in 1 mgd of brine reject requiring further management. The primary treatment/handling options for RO reject are as follows:

- Zero liquid discharge
- Surface water discharge
- Ocean discharge
- Haul and discharge to coastal location for ocean discharge
- Sewer discharge
- Deep well injection
- Evaporate in a pond
- Solar pond concentrator

Many of the RO brine reject management options above result in returning the dissolved solids to a “water of the state” such as surface water, groundwater, or marine waters. Past rulings in Washington State have indicated that once pollutants are removed from during treatment they are not to be re-introduced to a water of the state. As a result, technologies with this means for disposal were not considered viable options for management of RO reject water in Washington.

Zero Liquid Discharge

Zero liquid discharge (ZLD) is a treatment process that produces a little or no liquid brine discharge but rather a dried residual salt material. This process improves the water recovery of the RO system by reducing the volume of brine that must be treated and disposed of in some manner. ZLD options include intermediate treatment, thermal-based technologies, pressure driven membrane technologies, electric potential driven membrane technologies, and other alternative technologies.

Summary

There are many techniques which can be used to manage reject brine water associated with RO treatment. The appropriate alternative is primarily governed by geographic and local constraints. A comparison of the various brine management methods and potential costs are provided in Table 6.

Of the listed options, ZLD was considered for this analysis as the most viable approach to RO reject water management. An evaporation pond was used following ZLD. The strength in this combination is ZLD reduces the brine reject volume to treat, which in turn reduces the required evaporation pond footprint. The disadvantage is that evaporation ponds require a substantial amount of physical space which may not be available at existing treatment plant sites. It is also important to recognize that the greenhouse gas (GHG) emissions vary widely for the eight brine management options listed above based on energy and chemical intensity.

Table 6. Brine Disposal Method Relative Cost Comparison

Disposal Method	Description	Relative Capital Cost	Relative O&M Cost	Comments
Zero Liquid Discharge (ZLD)	Further concentrates brine reject for further downstream processing	High	High	This option is preferred as an intermediate step. This rationale is based on the reduction in volume to handle following ZLD. For example, RO reject stream volume is reduced on the order of 50-90%.
Surface Water Discharge	Brine discharge directly to surface water. Requires an NPDES permit.	Lowest	Lowest	Both capital and O&M costs heavily dependent on the distance from brine generation point to discharge. Not an option for nutrient removal.
Ocean Discharge	Discharge through a deep ocean outfall.	Medium	Low	Capital cost depends on location and availability of existing deep water outfall.
Sewer Discharge	Discharge to an existing sewer pipeline for treatment at a wastewater treatment plant.	Low	Low	Both capital and O&M costs heavily dependent on the brine generation point to discharge distance. Higher cost than surface water discharge due to ongoing sewer connection charge. Not an option for wastewater treatment.
Deep Well Injection	Brine is pumped underground to an area that is isolated from drinking water aquifers.	Medium	Medium	Technically sophisticated discharge and monitoring wells required. O&M cost highly variable based on injection pumping energy.
Evaporation Ponds	Large, lined ponds are filled with brine. The water evaporates and a concentrated salt remains.	Low – High	Low	Capital cost highly dependent on the amount and cost of land.
Salinity Gradient Solar Ponds (SGSP)	SGSPs harness solar power from pond to power an evaporative unit.	Low – High	Lowest	Same as evaporation ponds plus added cost of heat exchanger and pumps. Lower O&M cost due to electricity production.
Advanced Thermal Evaporation	Requires a two-step process consisting of a brine concentrator followed by crystallizer	High	Highest	Extremely small footprint, but the energy from H_2O removal is by far the most energy intensive unless waste heat is used.

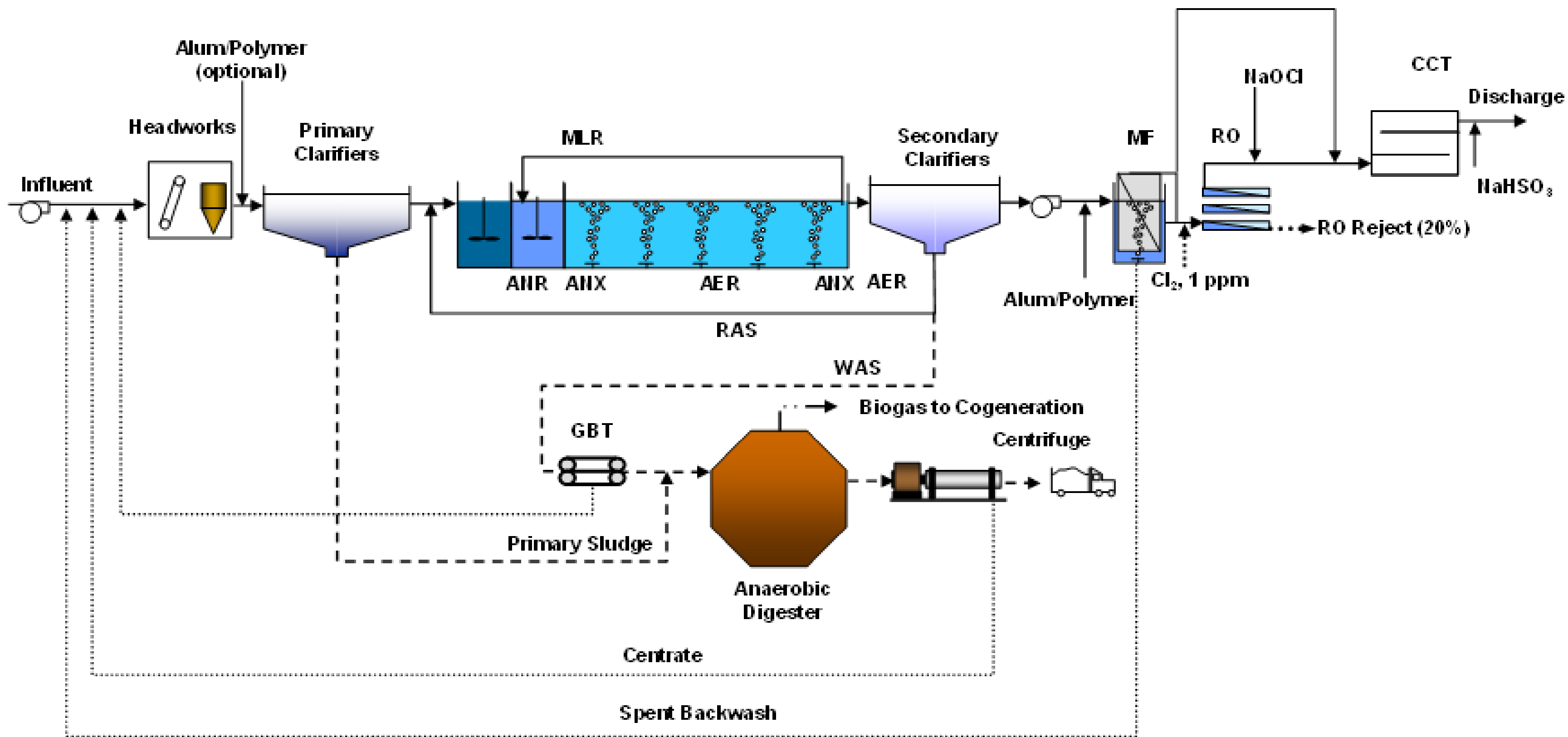

Figure 4. Advanced Treatment Flowsheet – Tertiary Microfiltration and Reverse Osmosis

4.4.3 Advanced Treatment – MF/GAC Alternative

A flowsheet of the advanced treatment – MF/GAC alternative is provided in Figure 5. Following the MF technology, a GAC contactor and media are required.

This alternative was developed as an option that does not require a brine management technology (e.g., ZLD) for comparison to the MF/RO advanced treatment alternative. However, this treatment alternative does require that the GAC be regenerated. A baseline secondary treatment facility can be retrofitted for MF/GAC. If an existing treatment facility has an extended aeration lagoon, the secondary effluent can be fed to the MF/GAC. The longer SRT in the extended aeration lagoon provides all the benefits associated with the long SRT in an activated sludge plant as previously stated:

- Lower BOD/TSS discharge load
- Higher removal of recalcitrant constituents and heavy metals
- Improved water quality and benefit to downstream users
- Less downstream algal growth
- Reduced receiving water dissolved oxygen demand due to ammonia removal
- Reduced ammonia discharge loads, which is toxic to several aquatic species
- Improved water quality for habitat, especially as it relates to biodiversity and eutrophication
- Secondary clarifier effluent more conditioned for filtration and disinfection
- Greater process stability from the anaerobic/anoxic zones serving as a selector

If an existing treatment facility employs a high rate activated sludge process (short SRT) similar to the baseline, it is recommended that the activated sludge process SRT be increased prior to the MF/GAC unit processes. The longer SRT upstream of the MF is preferred to enhance the membrane flux rate, reduce membrane biofouling, increase membrane life, and reduce the chemicals needed for membrane cleaning.

The key technical and operational challenges associated with the tertiary add-on membrane filtration units are as follows:

- The membrane filtration technology is a proven and reliable technology. With over 30 years of experience, it has made the transition in recent years from an emerging technology to a proven and reliable technology.
- Membrane durability dependent on feed water quality. The water quality is individual facility specific.
- Membranes are sensitive to particles, so upstream screening is critical. The newer generations of membranes have technical specifications that require a particular screen size.
- Membrane area requirements based on peak flows as water must pass through the membrane pores. Additionally, membranes struggle with variable hydraulic loading. Flow equalization upstream can greatly reduce the required membrane surface area and provide uniform membrane loading.

- Membrane tanks can exacerbate any foam related issues from the upstream biological process. Foam entrapment in the membrane tank from the upstream process can reduce membrane filtration capacity and in turn result in a plant-wide foam problem.
- Reliable access to the membrane modules is key to operation and maintenance. Once PLC is functionary properly, overall maintenance requirements for sustained operation of the system are relatively modest.
- The membranes go through frequent membrane relaxing or back pulse and a periodic deep chemical clean in place (CIP) process.
- Sizing of membrane filtration facilities governed by hydraulic flux. Municipal wastewaters have flux values that range from about 20 to 40 gallons per square foot per day (gfd) under average annual conditions. The flux associated with industrial applications is wastewater specific.

Following the MF is the activated carbon facilities. There are two kinds of activated carbon used in treating water: powdered activated carbon (PAC) and GAC. PAC is finely-ground, loose carbon that is added to water, mixed for a short period of time, and removed. GAC is larger than PAC, is generally used in beds or tanks that permit higher adsorption and easier process control than PAC allows, and is replaced periodically. PAC is not selective, and therefore, will adsorb all active organic substances making it an impractical solution for a wastewater treatment plant. As a result, GAC was considered for this analysis. The type of GAC (e.g., bituminous and subbituminous coal, wood, walnut shells, lignite or peat), gradation, and adsorption capacity are determined by the size of the largest molecule/ contaminant that is being filtered (AWWA, 1990).

As water flows through the carbon bed, contaminants are captured by the surfaces of the pores until the carbon is no longer able to adsorb new molecules. The concentration of the contaminant in the treated effluent starts to increase. Once the contaminant concentration in the treated water reaches an unacceptable level (called the breakthrough concentration), the carbon is considered "spent" and must be replaced by virgin or reactivated GAC.

The capacity of spent GAC can be restored by thermal reactivation. Some systems have the ability to regenerate GAC on-site, but in general, small systems haul away the spent GAC for off-site regeneration (EPA 1993). For this study, off-site regeneration was assumed.

The basic facilities and their potential unit processes included in this chapter are as follows:

- GAC supply and delivery
- Influent pumping
  - Low head feed pumping
  - High head feed pumping (assumed for this study as we have low limits so require high beds)
- Contactors and backwash facilities
  - Custom gravity GAC contactor
  - Pre-engineered pressure GAC contactor (Used for this study)
  - Backwash pumping
- GAC transport facilities
  - Slurry pumps
  - Eductors (Used for this study)

- Storage facilities
  - Steel tanks
  - Concrete tanks (Used for this study; larger plants would typically select concrete tanks)
- Spent carbon regeneration
  - On-site GAC regeneration
  - Off-Site GAC regeneration

Following the MF is the GAC facility. The GAC contactor provides about a 12-min hydraulic residence time for average annual conditions. The GAC media must be regenerated about twice per year in a furnace. The constituents sorbed to the GAC media are removed during the regeneration process. A typical design has full redundancy and additional storage tankage for spent and virgin GAC. Facilities that use GAC need to decide whether they will regenerate GAC on-site or off-site. Due to challenges associated with receiving air emission permits for new furnaces, it was assumed that off-site regeneration would be evaluated.

The key technical and operational challenges associated with the tertiary add-on GAC units are as follows:

- Nearest vendor to acquire virgin GAC – How frequently can they deliver virgin GAC and what are the hauling costs?
- Contactor selection is typically based on unit cost and flow variation. The concrete contactor is typically more cost effective at higher flows so it was used for this evaluation. The pre-engineered pressure contactor can handle a wider range of flows than a concrete contactor. Additionally, a pressure system requires little maintenance as they are essentially automated
- Periodical contactor backwashing is critical for maintaining the desired hydraulics and control biological growth
- Eductors are preferred over slurry pumps because they have fewer mechanical components. Additionally, the pump with eductors is not in contact with the carbon, which reduces wear.
- Off-site GAC regeneration seems more likely due to the challenges with obtaining an air emissions permit.

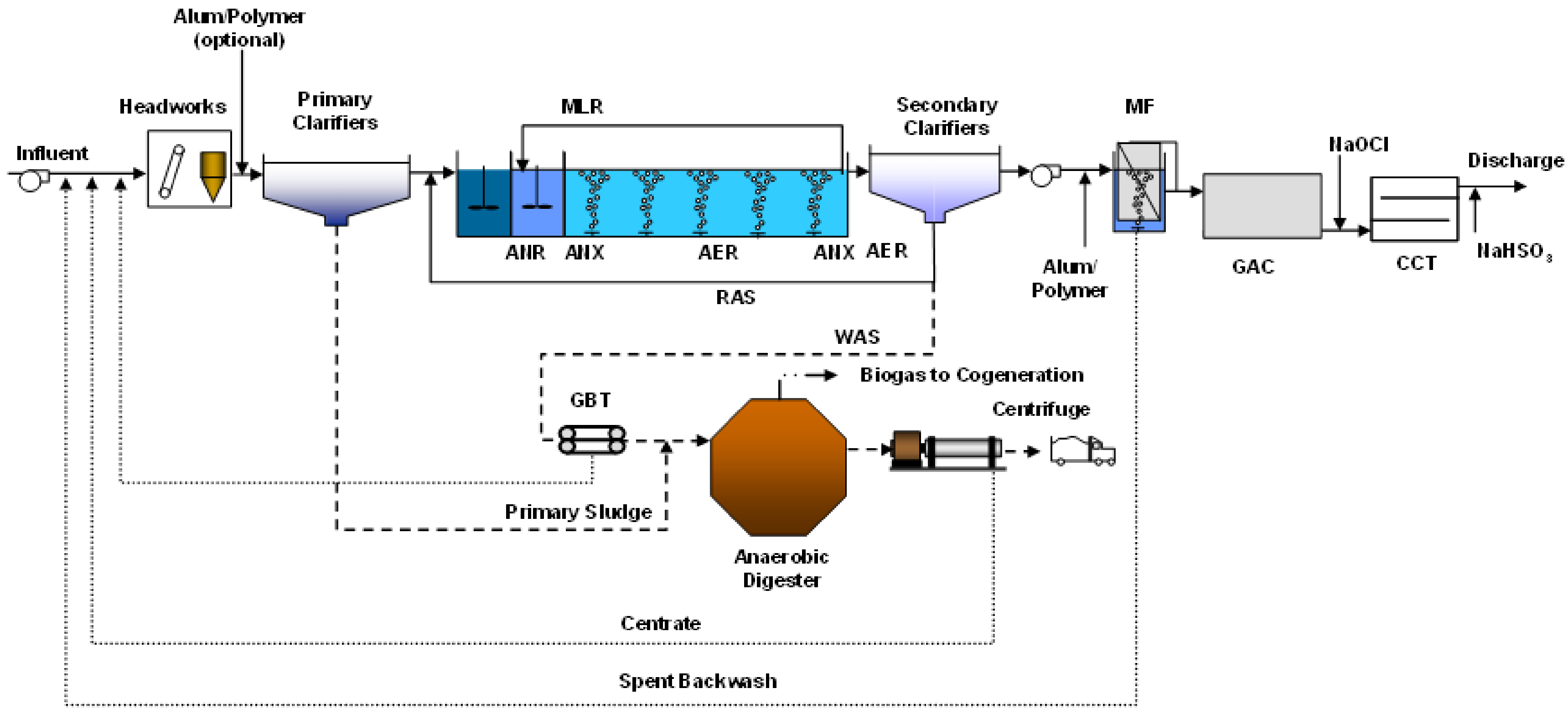

Figure 5. Advanced Treatment Flowsheet – Tertiary Microfiltration and Granular Activated Carbon

4.5 Steady-State Mass Balance

HDR used its steady-state mass balance program to calculate the flows and loads within the candidate advanced treatment processes as a means to size facilities. The design of wastewater treatment facilities are generally governed by steady-state mass balances. For a steady-state mass balance, the conservation of mass is calculated throughout the entire wastewater treatment facility for defined inputs. Dynamic mass balance programs exist for designing wastewater facilities, but for a planning level study such as this, a steady state mass balance program is adequate. A dynamic program is generally used for detailed design and is site-specific with associated requirements for more detailed wastewater characterization.

The set of model equations used to perform a steady-state mass balance are referred to as the model. The model equations provide a mathematical description of various wastewater treatment processes, such as an activated sludge process, that can be used to predict unit performance. The program relies on equations for each unit process to determine the flow, load, and concentration entering and leaving each unit process.

An example of how the model calculates the flow, load, and concentration for primary clarifiers is provided below. The steady-state mass balance equation for primary clarifiers has a single input and two outputs as shown in the simplified Figure 6. The primary clarifier feed can exit the primary clarifiers as either effluent or sludge. Solids not removed across the primaries leave as primary effluent, whereas solids captured leave as primary sludge. Scum is not accounted for.

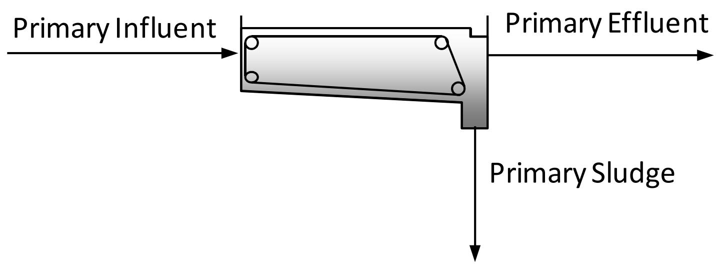

Figure 6. Primary Clarifier Inputs/Outputs

The mass balance calculation requires the following input:

- Solids removal percentage across the primaries (based on average industry accepted performance)
- Primary solids thickness (i.e., percent solids) (based on average industry accepted performance)

The steady-state mass balance program provides a reasonable first estimate for the process performance, and an accurate measure of the flows and mass balances at various points throughout the plant. The mass balance results were used for sizing the facility needs for each alternative. A listing of the unit process sizing criterion for each unit process is provided in Appendix A. By listing the unit process sizing criteria, a third-party user could redo the analysis and end up with comparable results. The key sizing criteria that differ between the baseline and treatment alternatives are as follows:

- Aeration basin mixed liquor is greater for the advanced treatment alternatives which in turn requires a larger volume
- The secondary clarifiers are sized based on hydraulic loading for the baseline versus solids loading for the advanced treatment alternatives

- The MF/GAC and MF/RO sizing is only required for the respective advanced treatment alternatives.

4.6 Adverse Environmental Impacts Associated with Advanced Treatment Technologies

The transition from the baseline (conventional secondary treatment) to either advanced treatment alternatives has some environmental impacts that merit consideration, including the following:

- Land area for additional system components (which for constrained facility sites, may necessitate land acquisition and encroachment into neighboring properties with associated issues and challenges, etc.).
- Increased energy use and atmospheric emissions of greenhouse gases and criteria air contaminants associated with power generation to meet new pumping requirements across the membrane filter systems (MF and RO) and GAC.
- Increased chemical demand associated with membrane filters (MF and RO).
- Energy and atmospheric emissions associated with granulated charcoal regeneration.
- RO brine reject disposal. The zero liquid discharge systems are energy intensive energy and increase atmospheric emissions as a consequence of the electrical power generation required for removing water content from brine reject.
- Increase in sludge generation while transitioning from the baseline to the advanced treatment alternatives. There will be additional sludge captured with the chemical addition to the primaries and membrane filters (MF and RO). Additionally, the GAC units will capture more solids.
- Benefits to receiving water quality by transitioning from a short SRT (<2 days) in the baseline to a long SRT (>8 days) for the advanced treatment alternatives (as previously stated):
    - Lower BOD/TSS discharge load
    - Higher removal of recalcitrant constituents and heavy metals
    - Improved water quality and benefit to downstream users
    - Reduced nutrient loadings to receiving waters and lower algal growth potential
    - Reduced receiving water dissolved oxygen demand due to ammonia removal
    - Reduced ammonia discharge loads, which is toxic to aquatic species
    - Improved water quality for habitat, especially as it relates to biodiversity and eutrophication
    - Secondary clarifier effluent better conditioned for subsequent filtration and disinfection
    - Greater process stability from the anaerobic/anoxic zones serving as a biological selectors

HDR calculated GHG emissions for the baseline and advanced treatment alternatives. The use of GHG emissions is a tool to normalize the role of energy, chemicals, biosolids hauling, and fugitive emissions (e.g., methane) in a single unit. The mass balance results were used to quantify energy demand and the corresponding GHG emissions for each alterative. Energy demand was estimated from preliminary process calculations. A listing of the energy demand for each process stream, the daily energy demand, and the unit energy demand is provided in Table 7. The advanced treatment options range from 2.3 to 4.1 times greater than the baseline. This large increase in energy demand is attributed to the energy required to pass water through the membrane barriers and/or the granular activated carbon. Additionally, there is energy required to handle the constituents removed as either regenerating the GAC or handling the RO brine reject water. This additional energy required to treat the removed constituents is presented in Table 7.

Table 7. Energy Breakdown for Each Alternative (5 mgd design flow)

Parameter	Units	Baseline	Advanced Treatment – MF/GAC	Advanced Treatment – MF/RO
Daily Liquid Stream Energy Demand	MWh/d	11.6	23.8	40.8
Daily Solids Stream Energy Demand	MWh/d	-1.6	-1.1	-1.1
Daily Energy Demand	MWh/d	10.0	22.7	39.7
Unit Energy Demand	kWh/MG Treated	2,000	4,500	7,900

MWh/d = megawatt hours per day
kWh/MG = kilowatt hours per million gallons

Details on the assumptions used to convert between energy demand, chemical demand and production, as well as biologically-mediated gases (i.e., CH4 and N2O) and GHG emissions are provided in Appendix B.

A plot of the GHG emissions for each alternative is shown in Figure 7. The GHG emissions increase from the baseline to the two advanced treatment alternatives. The GHG emissions increase about 50 percent with respect to baseline when MF/GAC is used and the GHG emissions increase over 100 percent with respect to baseline with the MF/RO advanced treatment alternative.

The MF/GAC energy demand would be larger if GAC regeneration was performed on-site. The GHG emissions do not include the energy or air emissions that result from off-site GAC regeneration. Only the hauling associated with moving spent GAC is included. The energy associated with operating the furnace would exceed the GHG emissions from hauling spent GAC.

The zero liquid discharge in the MF/RO alternative alone is comparable to the Baseline. This contribution to increased GHG emissions by zero liquid discharge brine system highlights the importance of the challenges associated with managing brine reject.

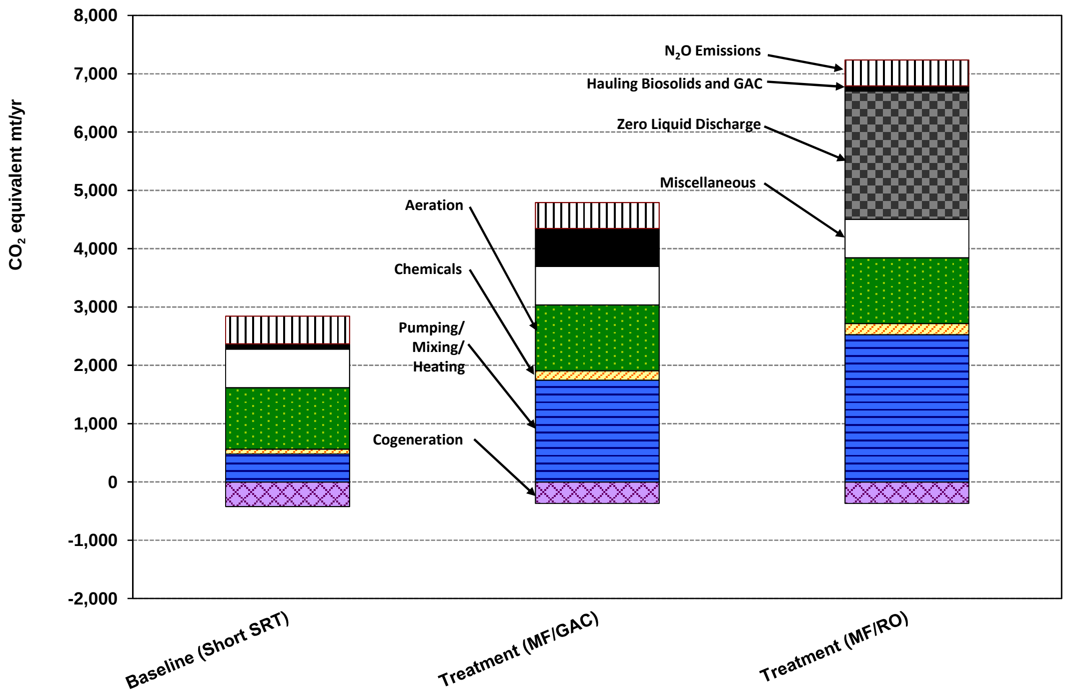

Figure 7. Greenhouse Gas Emissions for Each Alternative

The use of GHG emissions as a measure of sustainability does not constitute a complete comparison between the baseline and advanced treatment alternatives. Rather, it is one metric that captures the impacts of energy, chemical demand and production, as well as biologically-mediated gases (i.e., CH_4 and N_2O). The other environmental impacts of advanced treatment summarized in the list above should also be considered in decision making beyond cost analysis.

4.7 Costs

Total project costs along with the operations and maintenance costs were developed for each advanced treatment alternative for a comparison with baseline secondary treatment.

4.7.1 Approach

The cost estimates presented in this report are planning level opinions of probable construction costs for a nominal 5 mgd treatment plant design flow representing a typical facility without site specific details about local wastewater characteristics, physical site constraints, existing infrastructure, etc. The cost estimates are based on wastewater industry cost references, technical studies, actual project cost histories, and professional experience. The costs presented in this report are considered planning level estimates. A more detailed development of the advanced treatment process alternatives and site specific information would be required to further refine the cost estimates. Commonly this is accomplished in the preliminary design phase of project development for specific facilities following planning.

The cost opinion includes a range of costs associated with the level of detail used in this analysis. Cost opinions based on preliminary engineering can be expected to follow the Association for the Advancement of Cost Engineering (AACE International) Recommended Practice No. 17R-97 Cost Estimate Classification System estimate Class 4. A Class 4 estimate is based upon a 5 to 10 percent project definition and has an expected accuracy range of -30 to +50 percent and typical end usage of budget authorization and cost control. It is considered an "order-of-magnitude estimate." The life-cycle costs were prepared using the net present value (NPV) method.

The cost associated for each new unit process is based on a unit variable, such as required footprint, volume, demand (e.g., lb O_2/hr), and others. This approach is consistent with the approach developed for the EPA document titled "Estimating Water Treatment Costs: Volume 2-Cost Curves Applicable to 1 to 200 mgd Treatment Plants" dated August 1979. The approach has been updated since 1979 to account for inflation and competition, but the philosophy for estimating costs for unit processes has not changed. For example, the aeration system sizing/cost is governed by the maximum month airflow demand. Additionally, the cost associated constructing an aeration basin is based on the volume. The cost considers economies of scale.

The O&M cost estimates were calculated from preliminary process calculations. The operations cost includes energy and chemical demand. For example, a chemical dose was assumed based on industry accepted dosing rates and the corresponding annual chemical cost for that particular chemical was accounted for. The maintenance values only considered replacement equipment, specifically membrane replacement for the Advanced Treatment Alternatives.

4.7.2 Unit Cost Values

The life-cycle cost evaluation was based on using the economic assumptions shown in Table 8. The chemical costs were based on actual values from other projects. To perform detailed cost evaluations per industry, each selected technology would need to be laid out on their respective site plan based on the location of the existing piping, channels, and other necessary facilities.

Table 8. Economic Evaluation Variables

Item	Value
Nominal Discount Rate	5%
Inflation Rate:	
General	3.5%
Labor	3.5%
Energy	3.5%
Chemical	3.5%
Base Year	2013
Project Life	25 years
Energy	$0.06/kWh
Natural Gas	$0.60/therm
Chemicals:	
Alum	$1.1/gal
Polymer	$1.5/gal
Hypochlorite	$1.5/gal
Salt	$0.125/lb
Antiscalant	$12.5/lb
Acid	$0.35/lb
Deionized Water	$3.75/1,000 gal
Hauling:	

Table 8. Economic Evaluation Variables

Item	Value
Biosolids Hauling Distance	100 miles (one way)
Biosolids Truck Volume	6,000 gal/truck
Biosolids Truck Hauling	$250/truck trip
GAC Regeneration Hauling Distance	250 miles (round trip)
GAC Regeneration Truck Volume	$20,000 lb GAC/truck
GAC Regeneration Truck Hauling	Included in cost of Virgin GAC

kWh= kilowatt hours; lbs=pounds; GAC=granulated activated carbon; gal=gallon

4.7.3 Net Present Value of Total Project Costs and Operations and Maintenance Cost in 2013 Dollars

An estimate of the net present value for the baseline treatment process and the incremental cost to implement the advanced treatment alternatives is shown in Table 9. The cost for the existing baseline treatment process was estimated based on new construction for the entire conventional secondary treatment process (Figure 3). The incremental cost to expand from existing baseline secondary treatment to advanced treatment was calculated by taking the difference between the baseline and the advanced treatment alternatives. These values serve as a benchmark for understanding the prospective cost for constructing advanced treatment at the planning level of process development.

Table 9. Treatment Technology Total Project Costs in 2013 Dollars for a 5 mgd Facility

Alternative	Total Construction Cost, 2013 dollars ($ Million)	O&M Net Present Value, 2013 dollars ($ Million)*	Total Net Present Value, 2013 dollars ($ Million)	NPV Unit Cost, 2013 dollars ($/gpd)
Baseline (Conventional Secondary Treatment)*	59 - 127	5 - 11	65 – 138	13 - 28
Advanced Treatment – MF/RO**	108 - 231	31 - 67	139 - 298	28 - 60
Advanced Treatment – MF/GAC	131 - 280	50 - 108	181 - 388	36 - 78
Incremental Increase to Advanced Treatment MF/RO	48 - 104	26 - 56	75 - 160	15 - 32
Incremental Increase to Advanced Treatment MF/GAC	71 - 153	45 - 97	117 - 250	23 - 50

* The additional cost to increase the SRT to upwards of 30-days is about $12 - 20 million additional dollars in total project cost for a 5 mgd design flow

** Assumes zero liquid discharge for RO brine management, followed by evaporation ponds. Other options are available as listed in Section 4.4.2.

O&M=operations and maintenance; MF/RO=membrane filtration/reverse osmosis; MF/GAC=membrane filtration/granulated activated carbon; gpd=gallons per day

4.7.4 Unit Cost Assessment

Costs presented above are based on a treatment capacity of 5.0 mgd, however, existing treatment facilities range dramatically across Washington in size and flow treated. Table 9 indicates that the unit capital cost for baseline conventional secondary treatment for 5.0 mgd ranges between $13 to 28 per gallon per day of treatment capacity. The unit cost for the advanced treatment alternatives increases the range from the low $20s to upper $70s on a per-gallon per-day of capacity. The increase in cost for the advanced treatment alternatives is discussed in the sub-sections below.

Advanced Treatment MF/RO

The advanced treatment MF/RO alternative has a total present worth unit cost range of $28 to $60 million in per gallon per day of capacity. This translates to an incremental cost increase with respect to the baseline of $15 to $32 million dollars in per gallon per day treatment capacity. The key differences in cost between the baseline and the advanced treatment MF/RO are as follows:

- Larger aeration basins than the baseline to account for the longer SRT (<8 days versus >8 days).
- Additional pumping stations to pass water through the membrane facilities (MF and RO). These are based on peak flows.
- Membrane facilities (MF and RO; equipment, tanks chemical feed facilities, pumping, etc.) and replacement membrane equipment.
- Additional energy and chemical demand to operate the membrane facilities (MF and RO) and GAC.
- Zero liquid discharge facilities to further concentrate the brine reject.
- Zero liquid discharge facilities are energy/chemically intensive and they require membrane replacement every few years due to the brine reject water quality.
- An evaporation pond to handle the brine reject that has undergone further concentration by zero liquid discharge.

The advanced treatment MF/RO assumes that 100 percent of the flow is treated by MF, followed by 50 percent of the flow treated with RO. Sending a portion of flow through the RO and blending it with the balance of plant flows ensures a stable water to discharge. The RO brine reject (about 1.0 mgd) undergoes ZLD pre-treatment that further concentrates the brine reject to about 0.1-0.5 mgd. The recovery for both RO and ZLD processes is highly dependent on water quality (e.g., silicate levels).

ZLD technologies are effective at concentrating brine reject, but it comes at a substantial cost ($17.5 per gallon per day of ZLD treatment capacity of brine reject). The zero liquid discharge estimate was similar in approach to the demonstration study by Burbano and Brandhuber (2012) for La Junta, Colorado. The ability to further concentrate brine reject was critical from a management standpoint. Although 8 different options were presented for managing brine reject in Section 4.4.2, none of them is an attractive approach for handling brine reject. ZLD provides a viable pre-treatment step that requires subsequent downstream treatment. Evaporation ponds following ZLD were used for this study. Without ZLD, the footprint would be 3-5 times greater.

Roughly 30 acres of evaporation ponds, or more, may be required to handle the ZLD concentrate, depending upon concentrator effectiveness, local climate conditions, residuals accumulation, residual removal, etc. Precipitation throughout Washington is highly variable which can greatly influence evaporation pond footprint. The approach for costing the evaporation pond was in accordance with Mickley et al. (2006) and the cost was about $2.6 million.

Recent discussions with an industry installing evaporation ponds revealed that they will use mechanical evaporators to enhance evaporation rates. The use of mechanical evaporators was not included in this study, but merits consideration if a facility is performing a preliminary design that involves evaporation ponds. The mechanical evaporators have both a capital costs and annual energy costs.

Advanced Treatment MF/GAC

The advanced treatment MF/GAC alternative has a total present worth unit cost range of $36 to $78 million in per gallon per day capacity. This translates to an incremental cost increase with respect to the baseline of $23 to $50 million dollars on a per gallon per day of treatment capacity basis. The key differences in cost between the baseline and the advanced treatment MF/GAC are as follows:

- Larger aeration basins than the baseline to account for the longer SRT (<8 days versus >8 days).
- Additional pumping stations to pass water through the MF membrane and GAC facilities. These are based on peak flows.
- GAC facilities (equipment, contact tanks, pumping, GAC media, etc.)
- Additional energy to feed and backwash the GAC facilities.
- GAC media replacement was the largest contributor of any of the costs.
- Additional hauling and fees to regenerate GAC off-site.

The advanced treatment MF/GAC assumes that 100 percent of the flow is treated by MF, followed by 100 percent of the flow treated with GAC. The GAC technology is an established technology. The costing approach was in accordance with EPA guidelines developed in 1998.

The critical issue while costing the GAC technology is whether a GAC vendor/regeneration facility is located within the region. On-site regeneration is an established technology with a furnace.

However, there are several concerns as listed in Section 4.4.3:

- Ability to obtain an air emissions permit
- Additional equipment to operate and maintain
- Energy and air emissions to operate a furnace on-site
- Operational planning to ensure that furnace is operating 90-95 percent of the time. Otherwise, operations is constantly starting/stopping the furnace which is energy intensive and deleterious to equipment
- If not operated properly, the facility has the potential to create hazardous/toxic waste to be disposed

If located within a couple hundred miles, off-site regeneration is preferred. For this study, off-site regeneration was assumed with a 250-mile (one-way) distance to the nearest vendor that can provide virgin GAC and a regeneration facility.

Incremental Treatment Cost

The difference in costs between the baseline and the advanced treatment alternatives is listed in Table 10. The incremental cost to retrofit the baseline facility to the advanced treatment was calculated by taking the difference between the two alternatives. These values should serve as a planning level benchmark for understanding the potential cost for retrofitting a particular facility. The incremental cost is unique to a particular facility. Several reasons for the wide range in cost in retrofitting a baseline facility to advanced treatment are summarized as follows:

- Physical plant site constraints. A particular treatment technology may or may not fit within the constrained particular plant site. A more expensive technology solution that is more compact may be required. Alternately, land acquisition may be necessary to enlarge a plant site to allow the addition of advanced treatment facilities. An example of the former is stacking treatment processes vertically to account for footprint constraints. This is an additional financial burden that would not be captured in the incremental costs presented in Table 10.
- Yard piping. Site specific conditions may prevent the most efficient layout and piping arrangement for an individual facility. This could lead to additional piping and pumping to convey the wastewater through the plant. This is an additional financial burden that would not be captured in the incremental costs presented in Table 10.
- Pumping stations. Each facility has unique hydraulic challenges that might require additional pumping stations not captured in this planning level analysis. This is an additional financial burden that would not be captured in the incremental costs presented in Table 10.

A cursory unit cost assessment was completed to evaluate how costs would compare for facilities with lower (0.5 mgd) and higher capacity (25 mgd), as presented in Table 10. Capital costs were also evaluated for a 0.5 mgd and 25 mgd facility using non-linear scaling equations with scaling exponents. The unit capital cost for baseline conventional secondary treatment for 0.5 mgd and 25 mgd is approximately $44 and $10 per gallon per day of treatment capacity, respectively. The incremental unit costs to implement an advanced treatment retrofit for 0.5 mgd would range between $30 to $96 per gallon per day of treatment capacity and would be site and discharger specific. The incremental unit costs to implement an advanced treatment retrofit for 25 mgd would range between $10 to 35 per gallon per day of treatment capacity and would be site and discharger specific. The larger flow, 25 mgd, is not as expensive on a per gallon per day of treatment capacity. This discrepancy for the 0.5 and 25 mgd cost per gallon per day of treatment capacity is attributed to economies of scale. Cost curve comparisons (potential total construction cost and total net present value) for the baseline and the two tertiary treatment options (MF/RO and MF/GAC) are shown in Figure 8 and Figure 9 between the flows of 0.5 and 25 mgd. It is important to note that while the economies of scale suggest lower incremental costs for the larger size facilities, some aspects of the advanced treatment processes may become infeasible at larger capacities due to factors such as physical space limitations and the large size requirements for components such as RO reject brine management.

Table 10. Treatment Technology Total Project Costs in 2013 Dollars for a 0.5 mgd Facility and a 25 mgd Facility

Alternative	Total Construction Cost, 2013 dollars ($ Million)	O&M Net Present Value, 2013 dollars ($ Million)*	Total Net Present Value, 2013 dollars ($ Million)	NPV Unit Cost, 2013 dollars ($/gpd)
0.5 mgd:				
Baseline (Conventional Secondary Treatment)	15 - 32	0.5 - 1.1	15 - 33	31 - 66
Advanced Treatment – MF/RO**	27 - 58	3.2 - 6.8	30 - 65	60 - 130
Advanced Treatment – MF/GAC	33 - 70	5 - 10.8	38 - 81	76 - 162
Incremental Increase to Advanced Treatment MF/RO	12 - 26	2.7 - 5.7	15 - 32	30 - 64
Incremental Increase to Advanced Treatment MF/GAC	18 - 38	4.6 - 9.8	22 - 48	45 - 96
25 mgd:				
Baseline (Conventional Secondary Treatment)	156 - 335	25 - 54	182 - 389	7 - 16
Advanced Treatment – MF/RO**	283 - 606	157 - 336	440 - 942	18 - 38
Advanced Treatment – MF/GAC	343 - 735	252 - 541	595 - 1276	24 - 51
Incremental Increase to Advanced Treatment MF/RO	127 - 272	131 - 281	258 - 553	10 - 22
Incremental Increase to Advanced Treatment MF/GAC	187 - 401	226.9 - 486	414 - 887	17 - 35

* Does not include the cost for labor.
** Assumes zero liquid discharge for RO brine management, followed by evaporation ponds. Other options are available as listed in Section 4.4.2.
MF/RO=membrane filtration/reverse osmosis
MF/GAC=membrane filtration/granulated activated carbon
O&M=operations and maintenance
gpd=gallons per day

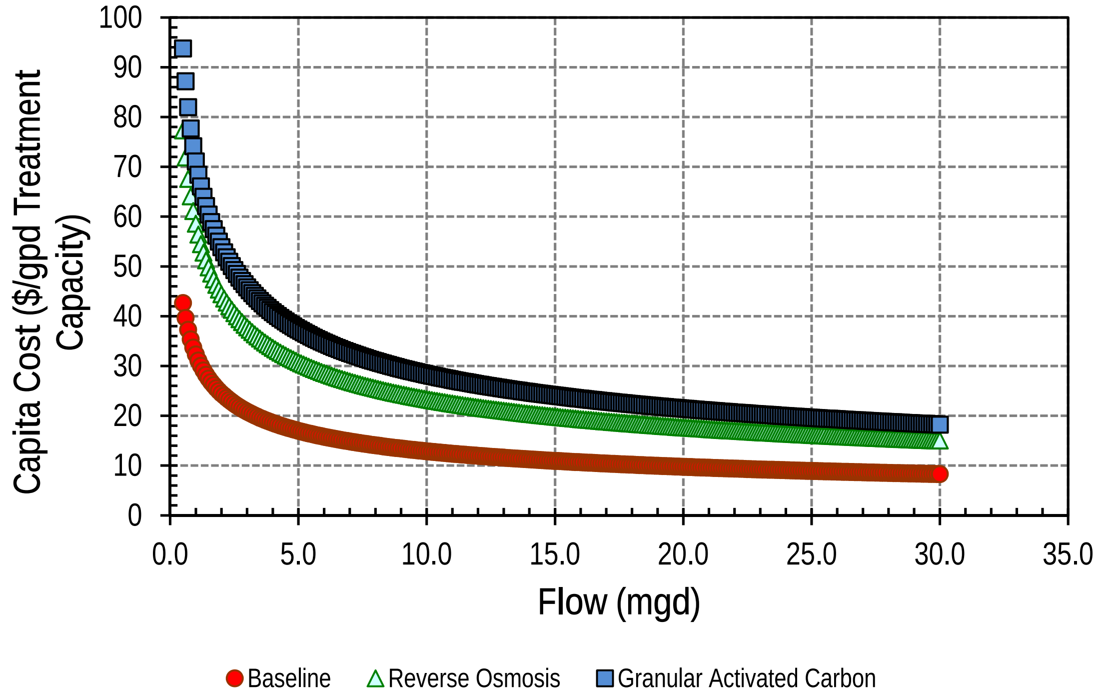

Figure 8: Capital Cost Curve Comparison for Baseline Treatment, MF/RO, and MF/GAC

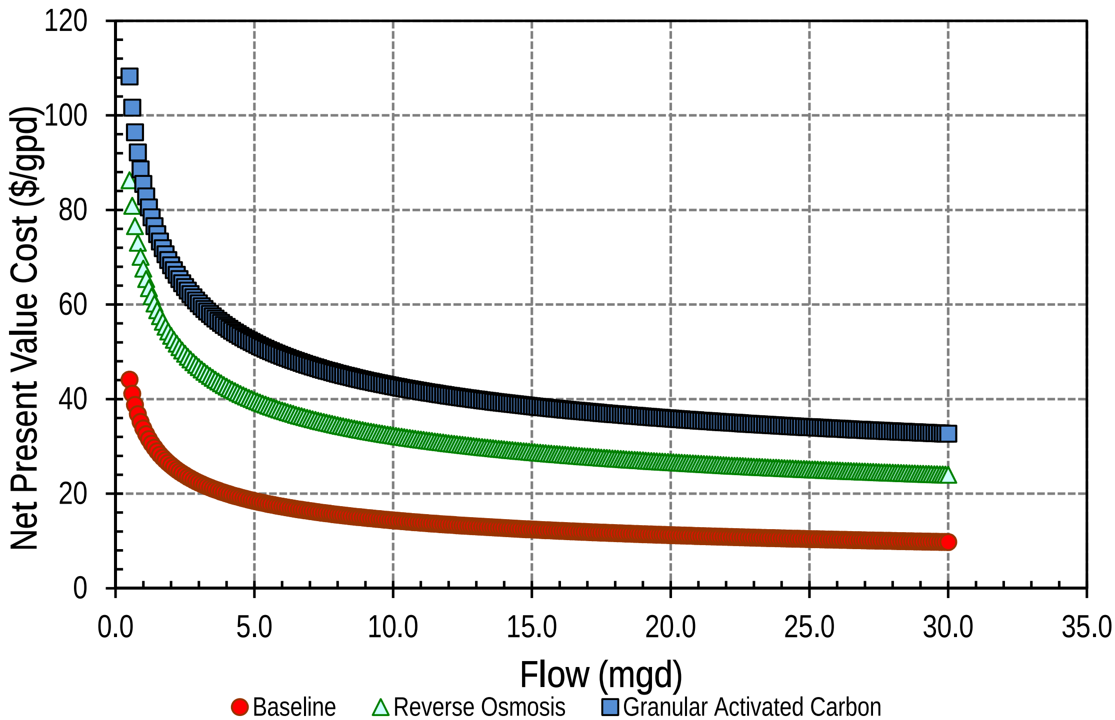

Figure 9: NPV Cost Curve Comparison for Baseline Treatment, MF/RO, and MF/GAC

4.8 Pollutant Mass Removal

An estimate of the projected load removal for the four constituents of concern was developed and is presented in Table 11. The current secondary effluent and advanced treatment effluent data is based on the only available data to HDR and is from municipal treatment plant facilities. Data is not available for advanced treatment facilities such as MF/RO or MF/GAC. Due to this lack of data, advanced treatment using MF/RO or MF/GAC was assumed to remove an additional zero to 90 percent of the constituents presented resulting in the range presented in Table 11. It is critical to note these estimates are based on limited data and are presented here simply for calculating mass removals. Current secondary effluent for industrial facilities would likely be greater than the data presented here and as a result, the projected effluent quality for industrial facilities would likely be higher as well. Based on the limited actual data from municipal treatment facilities, Table 11 indicates that mercury and BAP effluent limits may potentially be met using advanced treatment at facilities with similar existing secondary effluent quality.

Table 11. Pollutant Mass Removal by Contaminant for a 5 mgd Facility

Component	PCBs	Mercury	Arsenic	BAP
Required HHWQC based Effluent Quality (µg/L)	0.0000064	0.005	0.018	0.0013
Current Secondary Effluent Concentration (µg/L)*	0.0015	0.025	7.5	0.00031
Projected Effluent Quality (µg/L) from Advanced Treatment (MF/RO or MF/GAC)*	0.000041 – 0.00041	0.00012 – 0.0012	0.38 – 3.8	0.000029 - 0.00029
Mass Removed (mg/d)**	21 - 28	451 - 471	71,000 – 135,000	0.4 – 5.0
Mass Removed (lb/d)**	0.000045 – 0.000061	0.00099 – 0.0010	0.16 – 0.30	0.0000010 – 0.0000012

* Based on or estimated for actual treatment plant data from municipal facilities. Data sets are limited and current secondary effluent for industrial facilities would likely be greater than the data presented here.
** 1 lb = 454,000 mg
HHWQC=human health-based water quality criteria
MF/RO=membrane filtration/reverse osmosis
MF/GAC=membrane filtration/granulated activated carbon
µg/L=micrograms per liter
mg/d=milligrams per day
lb/d=pounds per day

Unit costs were developed based on required mass removal from a 5 mgd facility for each of the four constituents of concern to reduce discharges from current secondary effluent quality to the assumed required effluent quality (HHWQC). It important to note that this study concludes it is unclear if existing technology can meet the required effluent quality, however, the information presented in Table 12 assumes HHWQC would be met for developing unit costs. The unit costs are expressed as dollars in NPV (over a 25 year period) per pound of constituent removed over the same 25 year period using advanced treatment with MF/RO. The current secondary effluent quality data presented are based on typical secondary effluent quality expected for a municipal/industrial discharger. Table 12 suggests unit costs are most significant in meeting the PCB, mercury, and PAH required effluent quality.

Table 12. Unit Cost by Contaminant for a 5 mgd Facility Implementing Advanced Treatment using MF/RO

Component	PCBs	Mercury	Arsenic	PAHs
Required HHWQC based Effluent Quality (µg/L)	0.0000064	0.005	0.018	0.0013
Current Secondary Effluent Concentration (µg/L)*	0.002	0.025	7.5	0.006
Total Mass Removed (lbs) over 25-year Period	0.76	7.6	2,800	1.8
Unit Cost (NPV per total mass removed in pounds over 25 years)	$290,000,000	$29,000,000	$77,000	$120,000,000

*Derived from data presented in Table 3.
**Based on assumed 25-year NPV of $219,000,000 (average of the range presented in Table 10) and advanced treatment using MF/RO.
NPV=net present value
HHWQC=human health-based water quality criteria
µg/l=micrograms per liter

4.9 Sensitivity Analysis

The ability of dischargers to meet a HHWQC one order of magnitude less stringent (than HHWQC presented in Table 3 and used in this report) was considered. The same advanced treatment technologies using MF/RO or MF/GAC would still be applied to meet revised effluent quality one order-of-magnitude less stringent despite still not being able to meet less stringent effluent limits. As a result, this less stringent effluent quality would not impact costs. Based on available data, it appears the mercury and BAP limits would be met at a less stringent HHWQC. PCB effluent quality could potentially be met if advanced treatment with RO or GAC performed at the upper range of their projected treatment efficiency. It does not appear the less stringent arsenic HHWQC would be met with advanced treatment. It is important to note that a discharger's ability to meet these less stringent limits depends on existing secondary effluent characteristics and is facility specific. Facilities with higher secondary effluent constituent concentrations will have greater difficulty meeting HHWQC.

5.0 Summary and Conclusions

This study evaluated treatment technologies potentially capable of meeting revised effluent discharge limits associated with revised HHWQC. HDR completed a literature review of potential technologies and engineering review of their capabilities to evaluate and screen treatment methods for meeting revised effluent limits for four constituents of concern: arsenic, BAP, mercury, and PCBs. HDR selected two alternatives to compare against a baseline, including enhanced secondary treatment, enhanced secondary treatment with MF/RO, and enhanced secondary treatment with MF/GAC. HDR developed capital costs, operating costs, and a NPV for each alternative, including the incremental cost to implement from an existing secondary treatment facility.

The following conclusions can be made from this study.

- Revised HHWQC based on state of Oregon HHWQC (2001) and EPA "National Recommended Water Quality Criteria" will result in very low water quality criteria for toxic constituents.
- There are limited "proven" technologies available for dischargers to meet required effluent quality limits that would be derived from revised HHWQC.
  - Current secondary wastewater treatment facilities provide high degrees of removal for toxic constituents; however, they will not be capable of compliance with water quality-based NPDES permit effluent limits derived from revised HHWQC.
  - Advanced treatment technologies have been investigated and candidate process trains have been conceptualized for toxics removal.
    - Advanced wastewater treatment technologies may enhance toxics removal rates, however they will not be capable of compliance with HHWQC based effluent limits for PCBs. The lowest levels achieved based on the literature review were between <0.00001 and 0.00004 µg/L, as compared to a HHWQC of 0.0000064 µg/L.
    - Based on very limited performance data for arsenic and mercury from advanced treatment information available in the technical literature, compliance with revised criteria may or may not be possible, depending upon site specific circumstances.
      - Compliance with a HHWQC for arsenic of 0.018 µg/L appears unlikely. Most treatment technology performance information available in the literature is based on drinking water treatment applications targeting a much higher SDWA MCL of 10 µg/L.
      - Compliance with a HHWQC for mercury of 0.005 µg/L appears to be potentially attainable on an average basis but perhaps not if effluent limits are structured on a maximum monthly, weekly or daily basis. Some secondary treatment facilities attain average effluent mercury levels of 0.009 to 0.066 µg/L. Some treatment facilities with effluent filters attain average effluent mercury levels of 0.002 to 0.010 µg/L. Additional advanced treatment processes are expected to enhance these removal rates, but little mercury performance data is available for a definitive assessment.
    - Little information is available to assess the potential for advanced technologies to comply with revised benzo(a)pyrene criteria. A municipal wastewater treatment plant study reported both influent and effluent BAP concentrations less than the HHWQC of 0.0013 ug/L (Ecology, 2010).

- o Some technologies may be effective at treating identified constituents of concern to meet revised limits while others may not. It is therefore even more challenging to identify a technology that can meet all constituent limits simultaneously.
- o A HHWQC that is one order-of-magnitude less stringent could likely be met for mercury and PAHs however it appears PCB and arsenic limits would not be met.

- Advanced treatment processes incur significant capital and operating costs.
  - o Advanced treatment process to remove additional arsenic, benzo(a)pyrene, mercury, and PCBs would combine enhancements to secondary treatment with microfiltration membranes, reverse osmosis, and granular activated carbon and increase the estimated capital cost of treatment from $17 to $29 in dollars per gallon per day of capacity (based on a 5.0 mgd facility).
  - o The annual operation and maintenance costs for the advanced treatment process train will be substantially higher (approximately $5 million - $15 million increase for a 5.0 mgd capacity facility) than the current secondary treatment level.
- Implementation of additional treatment will result in additional collateral impacts.
  - o High energy consumption.
  - o Increased greenhouse gas emissions.
  - o Increase in solids production from chemical addition to the primaries. Additionally, the membrane and GAC facilities will capture more solids that require handling.
  - o Increased physical space requirements at treatment plant sites for advanced treatment facilities and residuals management including reverse osmosis reject brine processing.
- It appears advanced treatment technology alone cannot meet all revised water quality limits and implementation tools are necessary for discharger compliance.
  - o Implementation flexibility will be necessary to reconcile the difference between the capabilities of treatment processes and the potential for HHWQC driven water quality based effluent limits to be lower than attainable with technology

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7.0 Appendices

- Appendix A - Unit Process Sizing Criteria
- Appendix B - Greenhouse Gas Emissions Calculation Assumptions

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APPENDIX A - UNIT PROCESS SIZING CRITERIA

Table A-1. Unit Processes Sizing Criteria for Each Alternative

Unit Process	Units	Baseline Treatment	Advanced Treatment	Comment
Influent Pumping Station	unitless	3 Times Ave Flow	3 Times Ave Flow	This is peaking factor used to size the pumps (peak flow:average flow)
Alum Dose for CEPT (optional)	mg/L	20	20	This is the metal salt upstream of the primaries
Primary Clarifiers	gpd/sf	1000	1000	This is for average annual flows
Primary Solids Pumping Station	unitless	1.25 Times Ave Flow	1.25 Times Ave Flow	This is peaking factor used to size the pumps (maximum month flow:average flow)
Aeration System Oxygen Uptake Rate (OUR)	mg/L/hr	25	25	Average annual OUR is used in tandem with mixed liquor to determine the required aeration basin volume (the limiting parameter governs the activated sludge basin volume)
Aeration Basin Mixed Liquor	mg/L	1250	2500	Average annual mixed liquor is used in tandem with OUR (see next row) to determine the required aeration basin volume (the limiting parameter governs the activated sludge basin volume)
Secondary Clarifiers Hydraulic Loading	gpd/sf	650	--	Only use for Baseline as clarifiers governed hydraulically with short SRT (<2 days)
Secondary Clarifiers Solids Loading	lb/d/sf	--	24	Only use for Advanced Treatment as clarifiers governed by solids with long SRT (>8 days)
Return Activated Sludge (RAS) Pumping Station	unitless	1.25 Times Ave Flow	1.25 Times Ave Flow	RAS must have capacity to meet 100% influent max month Flow. The influent flow is multiplied by this peaking factor to determine RAS pumping station capacity.
Waste Activated Sludge (WAS) Pumping Station	gpm	1.25 Times Ave Flow	1.25 Times Ave Flow	WAS must have capacity to meet max month WAS flows. The average annual WAS flow is multiplied by this peaking factor to determine WAS pumping station capacity.
Microfiltration (MF) Flux	gfd	--	25	Based on average annual pilot experience in Coeur D'Alene, ID
MF Backwash Storage Tank	unitless	--	1.25	Storage tanks must have capacity to meet maximum month MF backwash flows. The average annual MF backwash volume is multiplied by this peaking factor to determine required volume.

Table A-1. Unit Processes Sizing Criteria for Each Alternative

Unit Process	Units	Baseline Treatment	Advanced Treatment	Comment
MF Backwash Pumps	unitless	--	1.25	Backwash pumps must have capacity to meet maximum month MF backwash flows. The average annual MF backwash flow is multiplied by this peaking factor to determine required flows.
Reverse Osmosis (RO)	gallon per square foot per day (gfd)	--	10	
RO Reject	%	--	20	This represents the percentage of feed flow that is rejected as brine
Chlorination Dose	mg/L	15	15	
Chlorination Storage Capacity	days	14	14	
Chlorine Contact Tank	min	30	30	This is for average annual conditions.
Dechlorination Dose	mg/L	15	15	
Dechlorination Storage Capacity	days	14	14	
Gravity Belt Thickener	gpm/m	200	200	This is for maximum month conditions using the 1.25 peaking factor from average annual to maximum month
Anaerobic Digestion	Hydraulic residenc e time (HRT)	18	18	This is for average annual conditions
Dewatering Centrifuge	gpm	120	120	This is for maximum month conditions using the 1.25 peaking factor from average annual to maximum month

gpd=gallons per day; sf=square feet; gpm=gallons per minute

Appendix B – Greenhouse Gas Emissions Calculation Assumptions

The steady state mass balance results were used to calculate GHG emissions. The assumptions used to convert between energy demand, chemical demand and production, as well as biologically-mediated gases (i.e., CH4 and N2O) and GHG emissions are provided in Table B-1. The assumptions are based on EPA (2007) values for energy production, an adaptation of the database provided in Ahn et al. (2010) for N2O emissions contribution, Intergovernmental Panel on Climate Change (IPCC) (2006) for fugitive CH4 emissions, and various resources for chemical production and hauling from production to the wastewater treatment plant (WWTP). Additionally, the biogas produced during anaerobic digestion that is used as a fuel source is converted to energy with MOP8 (2009) recommended waste-to-energy values.

Table B-1. Greenhouse Gas Emissions Assumptions

Parameters	Units	Value	Source
N_2O to CO_2 Conversion	lb CO_2/lb N_2O	296	IPCC, 2006
CH_4 to CO_2 Conversion	lb CO_2/lb CH_4	23	IPCC, 2006
Energy Production			
CO_2	lb CO_2/MWh	1,329	USEPA (2007)
N_2O	lb N_2O/GWh	20.6	USEPA (2007)
CH_4	lb CO_2/GWh	27.3	USEPA (2007)
Sum Energy Production	lb CO_2/MWh	1336	USEPA (2007)
GHGs per BTU Natural Gas			
CO_2	lb CO_2/MMBTU Natural Gas	52.9	CA Climate Action Registry Reporting Tool
N_2O	lb N_2O/MMBTU Natural Gas	0.0001	CA Climate Action Registry Reporting Tool
CH_4	lb CO_2/MMBTU Natural Gas	0.0059	CA Climate Action Registry Reporting Tool
Sum Natural Gas		53.1	CA Climate Action Registry Reporting Tool
Non-BNR N_2O Emissions	g N_2O/PE/yr	32	Ahn et al. (2010)
BNR N_2O Emissions	g N_2O/PE/yr	30	Ahn et al. (2010)
Biogas Purity	% Methane	65	WEF, 2009
Biogas to Energy	BTU/cf CH4	550	WEF, 2009
Digester Gas to Electrical Energy Transfer Efficiency	%	32	HDR Data

Table B-1. Greenhouse Gas Emissions Assumptions

Parameters	Units	Value	Source
Chemical Production			
Alum	lb CO_2/lb Alum	0.28	SimaPro 6.0 - BUWAL250, Eco-indicator 95
Polymer	lb CO_2/lb Polymer	1.18	Owen (1982)
Sodium Hypochlorite	lb CO_2/lb Sodium Hypochlorite	1.07	Owen (1982)
Building Energy Efficiency	kBTU/sf/yr	60	Calif. Commercial End-Use Survey (2006)
Hauling Distance		-	
Local	miles	100	-
Hauling Emissions			
Fuel Efficiency	miles per gallon	8	
CO_2	kg CO_2/gal diesel	10.2	CA Climate Action Registry Reporting Tool
N_2O	kg N_2O/gal diesel	0.0001	CA Climate Action Registry Reporting Tool
CH_4	kg CH_4/gal diesel	0.003	CA Climate Action Registry Reporting Tool
Sum Hauling Fuel	kg CO_2/gal diesel	10.2	CA Climate Action Registry Reporting Tool

GWh = Giga Watt Hours
MWh = Mega Watt Hours
MMBTU = Million British Thermal Units
BTU = British Thermal Unit
PE = Population Equivalents
kBTU/sf/yr = 1,000 British Thermal Units per Square Foot per Year
cf = cubic feet
lb = pound
kg = kilogram
gal = gallon

Valley View
SEWER DISTRICT

DEPARTMENT OF ECOLOGY

APR 12 2016

WATER QUALITY PROGRAM

April 7, 2016

Becca Conklin
Department of Ecology
PO Box 47600
Olympia, WA 98503-7600

Re: Proposed water quality standards for protecting human health, Chapter 173-201A WAC

Dear Ms. Conklin:

We are writing to offer comments on the Department of Ecology's proposed rule regarding water quality standards for protecting human health, Chapter 173-201A WAC. The Valley View Sewer District provides wastewater services to its 37,568 residents. We contract with the King County Wastewater Treatment Division for wastewater treatment; the County serves 1.6 million residents in the Puget Sound region. Valley View Sewer District is a member of the Metropolitan Water Pollution Abatement Advisory Committee (MWPAAC) that provides recommendations to the King County Executive and King County Council regarding water pollution abatement. MWPAAC's membership includes the 34 local sewer agencies served by King County's regional wastewater treatment system.

Generally, the Valley View Sewer District is supportive of the State retaining control of the water quality standards updates and its approach toward setting human health criteria. Along with King County, we remain committed to improving public health and water quality in the region and want to see the best approach to help us achieve our water quality and human health outcomes.

Because King County's regional service area includes combined sewer systems, we are particularly interested in the language of the proposed rule as it relates to combined sewer overflow (CSO) treatment plants. The State is proposing to use narrative water quality standards and require a set of best practices specifically for these intermittent CSO treatment plants. These plants are critical investments that move us towards improved water quality. We support the State approach as it will ensure intermittently treated discharges are protective of human health and that the County's long-term CSO control plan will be successful.

The Valley View Sewer District is also supportive of the State's recognition of the unique nature of ubiquitous chemicals in our region, (such as PCB, mercury, arsenic) and it's proposed ways to address these chemicals, and it's well thought through set of implementation tools.

MICHAEL J. WEST
DEBORAH McCASLIN
PAM CARTER
COMMISSIONERS

P.O. Box 69550
SEATTLE, WA 98168
3460 SOUTH 148TH STREET SUITE 100

DANA DICK
GENERAL MANAGER
206/242-3236 FAX 206/242-1527

Thank you in advance for your consideration of our comments on the proposed rule. If you have any questions regarding our comments, please contact the Sewer District Manager, Dana Dick, at 206-242-3236.

Sincerely,

Deborah McCaslin
Board of Commissioner's President
Valley View Sewer District

Nisqually Tribal Council
4820 She-Nah-Num Dr. SE
Olympia, WA 98513
Phone: (360) 456-5221

April 22, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments on the State's 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon,

The Nisqually Indian Tribe has been working with the State of Washington and the U.S. Environmental Protection Agency for many years to develop and adopt revised water quality standards that will protect the health of our tribal people and respect our treaty-reserved rights to the harvest of fish and shellfish.

The Department of Ecology has now proposed a second draft rule for human health criteria and implementation tools, and we offer the following comments on the state's proposed rule, issued in February, 2016. The proposed rule is not protective of our tribal people by failing to protect people who consume fish and shellfish. The Nisqually Tribe supports the more protective draft rule for human health issued to Washington State by the U.S. EPA on September 14, 2015. The Nisqually Tribe supports, adopts, and incorporates by reference the complete Northwest Indian Fisheries Commission comments submitted to Ecology in April, 2016.

The Nisqually Tribe, along with the other regional Tribes, believes that the current 6.5 grams per day under-represents tribal fish consumption and is not protective of the health of our tribal people. The harvest and consumption of fish and shellfish remains at the heart of tribal communities, and is a cultural, nutritional, and economic necessity as well as a treaty right. The proposed FCR of 175 g/day is low compared to fish consumption rates at many tribes. Additionally, in reviewing the impact on public health from toxic chemicals in the food chain, we have learned that many other provisions of the rule proposed by the Department of Ecology may greatly diminish the protective benefit of a higher fish consumption rate.

Ecology proposes other human health criteria that do not incorporate best available science and fail to account for other sources of toxic chemicals, and the Nisqually Tribe urges the adoption of the criteria proposed by the EPA. Additionally, the State's proposal will allow the criteria for several highly toxic chemicals including PCBs, arsenic, and dioxin to remain at status quo or to get substantially worse. The State's proposed implementation tools should be adjusted so that they are directed towards accountability and attainment of water quality standards, and not a set of tools to help dischargers avoid compliance. The State should also focus on the WQS and fish consumption being protective of the State's most vulnerable citizens including our children and our tribal communities.

Washington State is required to meet the provisions of the Clean Water Act to preserve the beneficial uses of water, including fishing. The public health issues that are determined by these standards affect everyone in Washington who eats fish. The State cannot impair the tribes' treaty-reserved rights to harvest and consume fish at their usual and accustomed grounds and protecting the water and marine sources is critical for the tribal exercise of treaty rights. The Tribes should not be faced with weighing the exercise of their treaty rights against the risk of cancer because the State has prioritized industry over human health.

The proposed rule by the State of Washington do not meet these requirements and the Nisqually Tribe urges the State to adopt the criteria the EPA put forward. The health of all its citizens should be the highest priority of the State of Washington.

Sincerely,

Farron McCloud
Nisqually Tribal Chair

CC:
Lorraine Loomis, Chair; Northwest Indian Fisheries Commission
Dennis McLerran, EPA Region 10 Administrator
Dan Opalski, EPA Region 10 Director for the Office of Water and Watersheds

Commenter ID: 37

Commenter Name: Nazune Menka

Commenter Association: Seattle University Native American Student Association President

Comment received via online comment form

Comment:

This proposed rule making fails to protect beneficial uses of water under the Clean Water Act, a responsibility delegated to the state from the US Environmental Protection Agency (EPA) and fails to respect the state's obligation to honor the treaty rights of Pacific Northwest tribes.

PUBLIC WORKS

April 21, 2016

Becca Conklin
Dept. of Ecology
P.O. Box 4760
Olympia, WA 98503-7600

RE: Ecology's Proposed Water Quality Standards for Protecting Human Health (173-201A WAC)

The City of Everett thanks Ecology for the reasonable approach taken for mercury, arsenic and PCBs in its proposed rule. We recognize that with the exception of arsenic, the new human health criteria are more protective, or equally protective when compared to the currently applicable criteria. We find the reasons for replacing the National Toxics Rule (NTR) arsenic criterion with the drinking water MCL are well stated by Ecology and are very compelling. If it's good enough to drink, it should be good enough to discharge into the natural environment.

We are sorry that some groups and EPA Region X have essentially forced Ecology to switch to 10-6 risk level (compared to the earlier proposed 10-5 risk level) based on 175 g/day fish consumption. The earlier proposal was well justified, complied with EPA guidance and reflects the City of Everett's position. The issue was politically charged and public opinion easily influenced by sound-bites rather than comprehensive understanding.

Part of the problem is that it is incorrect to assign a single risk value to the criteria. For cancer risk, the criteria represent a range of risks covering a range of fish consumption values. This is true for the current NTR criteria, EPA's National Recommended Water Quality Criteria, EPA's proposed criteria for Washington, the state's earlier proposed new criteria, and the state's current proposed criteria.

Rather than saying the criteria are based on a one in a million cancer risk rate, the water quality standards need to state that the criteria provide a range of protection for a wide range of fish consumption rates. In the proposed rule Ecology should provide this explanation in order to prevent confusion in the future.

We agree with the use of a Relative Source Contribution (RSC) of 1, and agree with Ecology's wanting to keep the criteria relevant to water exposures and the associated Clean Water Act (CWA) tools. We are pleased that Ecology eloquently voiced this position in their comments to EPA concerning EPA's proposed revisions to EPA's national recommended human health water quality criteria.

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We agree that for some toxics, CWA tools are not able to address significant sources, and that alternative tools, such as Chemical Action Plans (CAPs) are more appropriate. Such plans can, and have in the past, lead to some bans, and also to some push for alternative assessments, and that is appropriate. In the past, the bans have been imposed by the legislature. The Governor linked the earlier proposed rule- making to a legislative proposal to address toxics. We disagreed with any requirement that the two activities must be linked. The legislative proposal did not pass, and the earlier rule was pulled and this new proposed rule is now available for review and comment. This proposed rule, like the earlier proposed rule, is well thought out. The combined process (earlier proposed rule and this proposed rule) was extensive and open, and the decisions made are well explained.

We are concerned about the possible impacts of these proposed human health criteria in the situation where newer test methods come along that then find some substances that were not known to be exceeding criteria in receiving waters. This is the situation that could suddenly drive end-of-pipe effluent limits with no dilution benefit, while the CWA regulatory tools might be ineffective because of non-CWA regulated sources (much like for PCBs). The economic analysis acknowledged there could be possible future impacts associated with new methods, but that there was no way to quantify that now. The effects of revised analytical methods is well known for PCBs. There are many other criteria set well below currently approved analytical methods. Consider benzidine, with a freshwater HHC of 0.00002 ug/l and a method detection limit of 24 ug/l. We have no data indicating problems in receiving waters due to benzidine, but given a 6 order of magnitude difference between the HHC and the analytical methods, we simply have no idea whether benzidine is a potential future compliance problem.

To protect against this concern, we strongly recommend that the applicable test methods for each of these toxicants be spelled out and adopted in a table in this rule. The applicable methods are already known and identified by DOE in Appendix B in the DEIS accompanying this rule-making. The applicable test methods could be presented either as 1) a table immediately following table 240, 2) another column in table 240, or it could go into WAC 173-201A-260(h). In either event, WAC 173-201A-260(h) needs to be changed to preclude imposition of new methods approved by EPA before the state and permittees have had a chance to review and evaluate them, and adopt the methods into WAC173-201A through rule-making. With this strategy, the economic analysis would not have to consider the effect of future test methods, as those would be considered when such methods were adopted into the rule.

We appreciate that the carcinogenic PAH criteria have recognized that the carcinogenicity varies and that they are not all equal to Benzo(a)pyrene. This was a needed change we had asked for earlier.

We believe that there is an additional implementation tool that needs to be specifically recognized in the rule. That is the use of Chemical Action Plans (CAPs) in lieu of a TMDL. The TMDL approach is limited to CWA tools focused on NPDES permitted discharges. Sometimes, that isn't going to accomplish much, while it could impose great costs and liability if unable to comply. The TMDL imposed PCB limit for the City of Walla Walla of 1 gram per year is an example of an ineffective action, as the POTW loadings account for less than 2% of the total. A CAP approach can recognize the bigger picture, identify what is feasible to do and also identify what is not feasible. The mercury CAP and the proposed PCB CAP are good examples. CAPs such as for mercury and PCBs should count in the 303(d) process as a Category 4(b) action. There should be a new section in the rule that acknowledges that non-TMDL implementation

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tools should be allowed and encouraged, especially where traditional TMDL and CWA tools will not be very useful.

The following pages include comments tied to specific sections in the regulation and the supporting documents.

Thank you for the opportunity to participate meaningfully in this process.

Sincerely,

James W. Miller, P.E.
Engineering Superintendent

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Specific Comments re regulatory language.

WAC 173-201A-240(5)(b) human health protection. Delete the third sentence which says:

> *"The human health criteria in the tables were calculated using a fish consumption rate of 175 g/day."*

And replace it with the following:

> *"The human health criteria for non-carcinogens are based on a hazard quotient of 1 and a fish consumption rate of 175 grams/day (11.6 pounds/month). The human health criteria for carcinogens covers a range of fish consumption rates and associated risk levels such that 17.5 grams/day (1.2 pounds/month) is protected at one in ten million risk level, 175 grams/day (11.6 pounds/month) at one in a million risk level, and 1750 grams/day (116 pounds/month) at one in a hundred thousand risk level."*

The reason for this recommendation is to better convey information about the criteria.

Table 240. Acute and chronic freshwater cadmium criteria have a reference to footnote "I". There is no footnote "I" at the end of the table. Either remove the reference, or identify the reference.

Table 240. Acute marine copper criteria should have listed footnote "b" instead of "c".

Table 240. There are 17 compounds included on the list for which there are no criteria. These compounds should be removed, as including them on the list serves no purpose. [Or, if there is a purpose, then there should be a footnote applied to each compound explaining the purpose for including it in the table.]

Table 240, footnote "dd". Remove the second sentence which pertains to cyanide. Footnote "dd" is not used for cyanide. Footnote "ee" is used for cyanide and has the same observation as the sentence in "dd", which is appropriate.

Table 240, footnote "B". Change to read,

> *"This criterion was calculated based on an additional lifetime cancer risk of one in one million (1 x 10-6) risk level for an average fish consumption rate of 175 grams/day. The criterion is protective over a range of fish consumption such that 17.5 grams/day is protected at one in ten million (1 x 10-7) risk level and 1,750 grams/day is protected at one in one hundred thousand (1 x 10-5) risk level."*

This better conveys that the criteria relate to a range of risk levels for a range of fish consumption rates. (See comment re WAC 173-201A-240(5)(b) above.)

Table 240, footnote "E". Add *"....which is a 2.3 x 10-5 risk level."* at the end of the last sentence.

Table 240, footnote "G". The footnote pertains to the mercury criteria. Consider adding a sentence noting

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"The chronic aquatic life criteria are more stringent, are actually based on human health (see footnote "s") and are more protective of human health than the criteria in 40 CFR 131.36."

<u>WAC 173-201A-420(3)(f)(iii)</u> says that

"If the variance is for a water body, or stretch of water, the following information must also be provided to the department." ..... "(iii) Best management practices for nonpermitted sources that meet the requirements of chapter 90.48 RCW."

What does this mean? Is atmospheric transport and deposition included? Is groundwater included? What about bacteria contributions from wildlife? How is an entity initiating a variance request supposed to provide this information? It clearly goes beyond what the entity has operational control over. Perhaps this is where a Chemical Action Plan could be referred to, if the state has prepared one for the parameter of concern.

Specific comments re DEIS

<u>Page 26, Comparison of alternatives – Arsenic, Table describing Usability</u>

The Note in the table says that Alternative 2 criteria concentrations are <u>exceeded frequently</u> in the state, but less frequently than Alternatives 1 and 2.

Assuming the statement is intended to pertain to surface waters, it is incorrect to say that the Alternative 2 criteria (10 ug/l) is exceeded frequently. It is not. On page 25 the DEIS says that in Washington, natural levels of inorganic arsenic in surface waters, based on discrete samples, <u>may infrequently exceed</u> the SDWA MCL of 10 ug/l. In actuality, exceedances will be very rare and where found may have just been because Ecology failed to note that they were less than a detection level.

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Puyallup Tribe of Indians

April 22, 2016

Via E-Mail

Becca Conklin
Department of Ecology
PO Box 47600
Olympia, WA 98503-7600
swqs@ecy.wa.gov

RE: Puyallup Tribe of Indians' Comments RE: 2016 (Proposed) Water Quality Standards for Surface Waters of the State of Washington—Chapter 173-201A WAC (WQS)

Dear Ms. Conklin:

Attached are the Puyallup Tribe's Comments on Ecology's 2016 (Proposed) Water Quality Standards for Surface Waters of the State of Washington—Chapter 173-201A WAC (WQS) ("the Proposed Rule"). As a co-manager of the fishery and regulator of water quality within the 7 miles of the 1873 Survey Area of the Puyallup Reservation, drafting human health standards that "are set at levels that will adequately protect Washington residents, including tribes with treaty protected rights, from exposure to toxic pollutants" is vitally important to us. 80 Fed. Reg. 55063.

Essential to setting levels that are sufficiently protective of all citizens of Washington State that consume fish, we agree with Ecology's proposed use of a fish consumption rate (FCR) of *at least* 175 grams per day and a cancer risk level of 10^{-6} (one excess cancer in a million). However, we also agree with EPA that an FCR of 175 grams per day does not reflect unsuppressed consumption rates of Tribes or heritage rates within the State of Washington. The proposed water quality standards at issue in these comments are required under the Clean Water Act to protect the most sensitive applicable uses in Washington's waters, which include the tribes' reserved rights to take fish for subsistence, ceremonial, religious and commercial purposes in Usual and Accustomed fishing places.

The Puyallup Tribe, a sovereign nation, signed the Treaty of Medicine Creek, 10 Stat. 1132 (1855), with the United States reserving rights to harvest fish and other natural resources both within and outside of its reservation boundaries. The Treaty Right of the Puyallup Tribe to harvest fish both within and outside reservation boundaries was re-affirmed in the 1974 decision in *U.S. v. Washington,* 384 F.Supp. 312, (W.D. Wash., 1974). For time immemorial, the Puyallup Tribe has fished the waters both within and outside its current reservation boundaries as a subsistence fishery, with the salmon being a traditional food source and cultural staple. The Tribe has a Treaty Right to fish and consume fish that are safe for consumption. The resulting Proposed Rule fails to reach any reasonable protection that demonstrates the States acknowledgment of, much less protection of, the Tribe's Treaty Rights. Finalizing the Proposed Rule without significant revisions will result in a violation of the Tribe's Treaty Rights.

Furthermore, the Tribe is both disappointed and frustrated that Washington's proposed rule has failed to do all it can and is obligated to do under the Clean Water Act to protect the health of Tribal members and Washington citizens. There certainly has been ample opportunity to make revisions that reflect best available science, based on recent publication of EPA's Revision of Certain Federal Water Quality Criteria Applicable to Washington (September 14, 2015, "Draft Federal Rule") and finalization in August 2015 of EPA's 304(a) Nationally Recommended Criteria. Tribal scientists have worked tirelessly with the State Department of Ecology to analyze the best available science to arrive at criteria that would protect the health of people as required under the Clean Water Act. Yet that work has largely been displaced and disregarded because in the end Washington has allowed politics to override sound science and interfere with its obligations to base this rule upon the best available science and obligations set forth in the Clean Water Act.

While the attached technical comments will provide the details of the inadequacies of the proposed rule and provide science based recommendations in detail, the State has failed, by letting political pressures by those who stand to reap purely economic benefit from weaker pollution protections, to offer human health criteria and, therefore, enforceable water quality standards, that meet today's best available science based requirements to ensure the state's citizens are protected from pollution in our waters. The State has attempted to offer a more reasonable, albeit still inadequate, fish consumption rate as an indicator that it is strengthening protections for people and fish. It also has reconsidered, after discussions with EPA and others, to change the cancer risk rate in the existing standards to a less protective level. However, at the same time, most of the gains achieved in protection have been nullified by adjusting other inputs that go into the derivation of the standard (i.e. relative source contribution). The State's arbitrary and capricious actions have not gone unnoticed by Tribes, citizens, or the U.S. Environmental Protection Agency.

In addition to the proposed human health criteria lacking the strength to provide acceptable and measurable improvements to the water quality we all depend upon, the State proposes going even further in allowing polluters "off ramps" from meeting water quality standards for undetermined periods of time, through undefined variances, from compliance with the already weak standards through implementation tools that are ambiguous at best, leaving open the possibility that polluters will escape compliance all-together resulting in continued long-term degradation and pollution of already impaired waters. So too does the State abdicate its responsibility to address some of the most persistent and dangerous chemicals in our waters – PCB, methylmercury, and arsenic. This is a wholly unacceptable concession to Washington's most egregious polluters. With ever increasing pollution loads and resulting impacts, tribal people and the fishery don't have the time to wait for the State to get it right. (See Russ Ladley's analysis of the Coho Run, attached at the end of this cover letter for reference.) To prevent the non-attainment of water quality standards and full exercise of treaty reserved rights in our watershed, the Tribe will oppose any and all variances.

Again, while the Tribe appreciates the opportunity to comment on the Proposed Rule, the Tribe requests that the State of Washington (or EPA) finalize a substantially more protective rule that uses best available science to meet the State's obligations under the Clean Water Act as fully described in the attached comments. We offer the following comments in support of our request. The Puyallup Tribe further adopts and incorporates by this reference, the comments submitted by the Northwest Indian Fisheries Commission.

Sincerely,

Char L. Naylor

Char Naylor,
Puyallup Tribal
Water Quality Manager

Puyallup Tribe of Indians

Puyallup Tribe's Comments On and Recommendations For Revisions to the Department of Ecology's 2016 (Proposed) Water Quality Standards for Surface Waters of the State of Washington—Chapter 173-201A WAC (WQS)

Introduction

This document contains the basis for the Puyallup Tribe's comments on and recommendations to revise the Draft 2016 Department of Ecology's (Proposed) Water Quality Standards for Surface Waters of the State of Washington – Chapter 173-201S WAC (the "Proposed Rule") which sets out human health criteria to be used in Washington's water quality standards and implementation tools. In addition to specific citations herein, please see the attached list of references and documents submitted along with this document. Specifically, we are providing the methodology and input variables recommended by the Tribe in the derivation of the human health criteria; recommendations for the so-called problem toxics, including arsenic, mercury, and PCBs; recommendations for implementation tools including variances, compliance schedules and intakes credits; and protection of downstream uses.

The guiding principles forming the basis of the Puyallup Tribe's recommendations are:

1. To use the comprehensive body of technical information, policy and guidance available as developed by the agency with expertise in the derivation of water quality standards that are sufficiently protective of human health.

2. To use local and regional data or guidance where available to reflect local conditions and protect highly exposed populations, including tribes.

3. To protect the treaty right of the Puyallup Tribe to take fish in all Usual and Accustomed fishing areas.

4. To protect the health of *all tribal members* of the State of Washington, whose Usual and Accustomed fishing areas

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comprise most of the waters of Washington State.

5. To protect downstream designated uses within the boundary of the Puyallup Reservation, in which the Tribe regulates water quality, as approved by EPA in 1994. Downstream uses of water designated by the Tribe include, but are not limited to, the use of water for the purposes of ceremony.

6. To protect a key function of the Tribe's and Washington's economy which necessitates our ability to catch and sell fish that are not contaminated with toxic pollutants.

7. To protect access to traditional foods for ceremonial, religious and sustenance purposes, but also for preventing health ailments associated with non-traditional diets such as diabetes, heart attack and stroke.

The Puyallup Tribe, a sovereign nation, signed the Treaty of Medicine Creek, 10 Stat. 1132 (1855), with the United States reserving rights to harvest fish and other natural resources both within and outside of its reservation boundaries. The Treaty Right of the Puyallup Tribe to harvest fish both within and outside reservation boundaries was re-affirmed in the 1974 decision in *U.S. v. Washington,* 384 F.Supp. 312, (W.D. Wash., 1974). For time immemorial, the Puyallup Tribe has fished the waters both within and outside its current reservation boundaries as a subsistence fishery, with the salmon being a traditional food source and cultural staple. The Tribe has a Treaty Right to fish and consume fish that are safe for consumption.

The Clean Water Act requires Washington to promulgate water quality standards that protect designated uses of water. 33 U.S.C. §1313. In developing water quality standards, Washington is required to include criteria that are often numeric and are necessary to ensure designated uses are attained and protected. These uses are often referred to as fishable and swimmable uses, which include providing water from which people can drink, consume fish, and recreate safely. 40 C.F.R. § 131.10(a). Federal regulations require Washington State's water quality criteria to be based on sound scientific rationale and must contain sufficient parameters or constituents to protect designated uses. 40 C.F.R §131.11(a). If Washington fails to develop adequate water quality standards then the Environmental Protection Agency ("EPA") must step in and develop the required standards in a timely manner. 33 U.S.C. § 1313. The Tribe's comments and recommendations herein are based on the existing most current scientific evidence, policy, guidance, and court decisions.

Under the Clean Water Act, the fishing use includes the ability of people to harvest fish and shellfish that are safe to use in the amounts those people would normally consume. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.* U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 822-B-00-004 (2000), available at: http://www.epa.gov/waterscience/criteria/humanhealth/method/complete.pdf ("*2000 Methodology*"). This requirement coexists with the Puyallup Tribe's Treaty right to harvest fish and shellfish that are safe for consumption at the rate at which the Puyallup Tribe has historically consumed those fish and shellfish. A recent decision by the EPA reaffirms this requirement, finding that in evaluating a state's water quality standards and associated human health criteria, EPA must evaluate whether the proposed criteria are adequate to protect fishing rights of tribes. *Analysis Supporting EPA's February 2, 2015 Decision to Approve, Disapprove, and Make No Decision on, Various Maine Water Quality Standards, Including Those Applied to Waters of Indian Lands in Maine,* U.S. Environmental Protection Agency, Office of Water. February 2, 2015. Available at: https://turtletalk.files.wordpress.com/2015/02/2015-2-2-me-wqs-epa-decision-letter-attachment-a.pdf ("*Maine Decision*").

Statutory and Regulatory Background

Over two decades have passed since EPA established Washington's existing criteria for the protection of human health under the National Toxics Rule (NTR). The Agency's recommended criteria values were promulgated at that time. EPA established chemical specific, numeric criteria for 85 priority toxic pollutants for Washington and 13 other states and territories that were not in compliance the requirements of CWA section 303(c) (2)(B). Washington has not adopted its own criteria for the protection of human health and, and thus the applicable criteria that EPA promulgated Back in 1992 remain applicable to waters of the State.

In June of 2015, EPA updated the 1993 National Toxics Rule (NTR) by publishing a final rule that included national recommended ambient water quality criteria (AWQC) for human health for 94 chemical pollutants (80 Fed. Reg. 36986 (June 29, 2015)). As the agency with expertise and regulatory authority, under the Clean Water Act section 304(a), EPA publishes criteria recommendations for states to consider when adopting water quality criteria for particular pollutants to meet the CWA section 101(a)(2) "swimmable, fishable goals". If states modify these criteria to reflect local conditions or use other methodologies, these criteria must protect the designated use and be based on sound scientific rationale (40CFR 131.11(a)(1)).

EPA's human health criteria reflect the most up-to-date science as well as implementation of existing EPA policies found in *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000). In turn, this document provides the foundation and guidance in deriving the most recent criteria. EPA's new human health criteria also reflect updated body weight information, drinking water consumption rate, fish consumption rate, bioaccumulation factors, health toxicity values, and relative source contribution.

EPA's recommended Section 304(a) criteria provide the most recent technical information for states and authorized tribes to consider and use in adopting water quality standards that ultimately provides the basis for assessing water body health and controlling discharges of pollutants into waters of the United States. Although states and authorized tribes are not required to use these criteria, they *are* required to ensure the protection of all applicable designated uses as well as provide a scientific rationale for all criteria in their proposed water quality standards. A key part of protecting the designated use is updating all the factors or parts of the equation used to derive criteria. That is, updating all the "sufficient parameters or constituents to protect the designated use", as required by the federal water quality standard regulation. 40 CRF 131.11(a) EPA recently proposed revisions to its water quality standards regulation that *require* states during their triennial reviews to consider new or updated section 304(a) nationally recommended criteria, and if they do not adopt these criteria, provide an explanation as to why the state did not do so.

The Clean Water Act requires Washington to promulgate water quality standards that protect designated uses of water. 33 U.S.C. §1313. In developing water quality standards, Washington is required to include criteria that are often numeric and are necessary to ensure designated uses are attained and protected. These uses are often referred to as fishable and swimmable uses, which include providing water from which people can drink, consume fish, and recreate safely. 40 C.F.R. § 131.10(a). Federal regulations require Washington State's water quality criteria to be based on sound scientific rationale and must contain sufficient parameters or constituents to protect designated uses. 40 C.F.R §131.11(a). If Washington fails to develop adequate water quality standards then the Environmental Protection Agency ("EPA") must step in and develop the required standards in a timely manner. 33 U.S.C. § 1313.

EPA Federal Rule Promulgation

On January 12, 2015, after over a decade of delay and constant urging by EPA, tribes and citizens, Ecology finally proposed revised human health criteria water quality standards for Washington State's surface waters. This was after EPA made a Determination of Necessity under 33 U.S.C. § 1313(c)(4)(B) that the State's existing standards were not protective of designated uses of waters in the State of Washington, including the Tribes' treaty rights to take fish.

In Section III(B) of the proposed draft rule, EPA makes the following statement regarding the CWA determination of necessity as required in CWA 303(c)(4)(B):

> Because Washington's existing human health criteria, as promulgated by EPA in the NTR, are no longer protective of the applicable designated uses per the CWA and EPA's regulations at 40 CFR 131.11, EPA determines under CWA section 303(c)(4)(B) that new or revised WQS for the protection of human health are necessary to meet the requirements of the CWA for Washington. EPA, therefore, proposes the revised human health criteria for Washington in this rule in accordance with this 303(c)(4)(B) determination. (p. 55066)

The Puyallup Tribe commented extensively on the proposed federal rule in December, 2015. Our comments are mostly incorporated herein by reference. In determining whether water quality standards comply with the Clean Water Act and EPA's regulations, other applicable laws must be considered including federal treaties when setting criteria to support applicable designated uses in Washington waters. This includes the treaty-reserved right to take fish and the right not to be exposed to unacceptable levels of pollutants be eating those fish. EPA's draft Water Quality Rule explains:

> In Washington, many Tribes hold reserved rights to take fish for subsistence, ceremonial, religious, and commercial purposes, including treaty-reserved rights to fish at all usual and accustomed fishing grounds and stations in waters under state jurisdiction, which cover the majority of waters

> in the state. Such rights include not only a right to take those fish, but necessarily include an attendant right not be exposed to unacceptable health risks by consuming those fish. (p.55066)

EPA also determined that the federal human health criteria in the NTR applied to Washington no longer protected the relevant uses of Washington's waters based on the inadequacy of the fish consumption rate used in the state standards of 6.5 grams per day (no more than about a thimble full of fish per day). In 1992, EPA used national data available on the average per-capita consumption rate of fish from inland and near shore waters for the U.S. population to estimate an average fish consumption rate of 6.5 g/day. To update the woefully inaccurate rate for all of Washington's residents that consume considerably more fish than a thimble full per day of fish, peer-reviewed tribal consumption surveys and recreational angler rates reflect much higher levels of both fish and shellfish. The average FCR's from these surveys range from 63 to 214 grams per day (2.2 to 7.5 ounces per day). The 90th percentile from these surveys range from 3.9 113 to 489 grams per day (4.0 to 17.2 ounces per day). These numbers not only far exceed the current rate of 6.5 grams per day but also EPA's current national FCR of 22 grams per day, which represents the 90th percentile national FCR. The existing FCR not only doesn't account for newer local data from the tribes and others, but also EPA's guidance recommendations in the *2000 Human Health* Methodology to use an upper percentile of fish consumption data for the target population rather than the average. The Puyallup Tribe noted in its comments that studies of contemporary rates of fish consumption were not nearly representative of heritage or unsuppressed rates of fish consumption.

In addition to the use of regional fish consumption data, the Puyallup Tribe supported EPA's decision to update human health criteria for Washington using EPA's 304(a) Nationally Recommended Criteria that were updated in 2015. These criteria were developed by the agency with expertise (EPA) using the most recent and reputable science available today. By contrast, Washington State chose to selectively adopt only some of the revised criteria that were typically less protective. The EPA's federal rule provides more stringent criteria in about 80% of the pollutants included in the rule and therefore provides more protections of designated uses, including tribal reserved treaty rights to take fish in quantities safe for consumption.

The issuance of the proposed rule triggered EPA's duty to finalize a protective rule within ninety days. 33 U.S.C. § 1313(c)(4). EPA has not finalized a rule revising Washington's water quality standards, violating its mandatory duty under the Clean Water Act, 33 U.S.C. §

1313(c)(4). For that reason, the Puyallup Tribe has filed a 60-day notice under the CWA to urge EPA to fulfill its statutory duty to promulgate a final water quality standards rule.

On February 1, 2016, Ecology again proposed its own revised water quality standards and an accompanying package of discretionary implementation tools or flexibilities to allow polluters to not meet water quality standards. The proposed State's rule does not protect designated uses as required by the CWA, is not scientifically sound, is contrary to EPA guidance and is far less protective than the EPA proposed rule. While Ecology has proposed a 175 g/day fish consumption rate (a rate below what surveys show certain consumers such as members of Native American tribes eat) and protective 10^{-6} cancer risk rate, it uses other inputs selectively to weaken standards and is significantly under-protective for three of the most problematic pollutants in Washington State: mercury, arsenic, and PCBs. Similarly, the so-called implementation tools or allowances for polluters not to meet water quality standards would would undo much of the progress made through the minimal strengthening of the underlying rule. Moreover these proposed tools would be far reaching, weakening compliance with other, existing water quality standards as well.

Treaty Reserved Rights and Washington's Designated Uses

The Puyallup Tribe is a signatory of the Medicine Creek Treaty. 10 Stat. 1132 (1855). The state is party to the treaty and has an obligation to not foreclose the ability of the Tribe to fully exercise the full extent of the treaty right. The exercise of this right is to take fish and safely consume fish throughout the Tribes Usual and Accustomed fishing areas for subsistence, ceremonial, and commercial purposes. The courts have defined the extent of these rights to include a 50% allocation of the fishery as necessary to prevent the Tribes a moderate standard of living *U.S. v. Washington,* 384 F.Supp. 312, (W.D. Wash., 1974). Because treaties are binding and the supreme law of the land, the state in the rulemaking process and EPA who will review and approve or disapprove these rules must not interfere with the full exercise of this right by both protecting the beneficiaries of the right (the consumers to safely consume fish) as well as the safety of the food source (the fishery) to ensure continued reliance to feed their families and secure a moderate living. *See Maine Decision.*

The Tribes' usual and accustomed fishing grounds throughout Washington State compromise a majority of the waters of the state and it is the duty of the state under the Clean Water Act to protect designated uses of these waters which include the fishing use. EPA determined in the recent Maine disapproval action that "to protect the function of these waters to preserve the Tribe's unique culture and to provide for the safe exercise of their sustenance practices, EPA must interpret the fishing use to include sustenance fishing.'' *Maine Decision* at 26. EPA determined it was their duty to include the concept of sustenance fishing as provided for in the tribal settlement acts, as to do otherwise "would run the risk that state WQS could be based on assumptions about fish consumption rates that could lead to criteria that fail to protect the Tribe's ability to safely consume fish for their sustenance". *Id.* at 32. Accordingly, EPA concluded that the State of Maine had a duty to protect the sustenance use. "To adequately protect the sustenance fishing use, EPA reasoned, the State of Maine was required to revisit two aspects of its technical analysis supporting the human health criteria that determine how clean waters must be to allow the Tribes to safely consume fish for their sustenance." *Id.*

EPA continued that the State of Maine's analysis must treat the tribal population exercising the sustenance fishing use as the target general population, not as a high consuming subpopulation of the State. *Id.* EPA guidance calls for WQS that provide a high level of protection for the general population, while recognizing that small subpopulations may face greater levels of risk. However, the Tribes are not a subpopulation using the waters on their own lands; they are the population for which that land base was established and set aside. Second, the data used to determine the fish consumption rate for tribal sustenance consumers must reasonably represent tribal consumers taking fish from tribal waters and fishing practices unsuppressed by concerns about the safety of the fish available to them to consume. The data on which the State relied to develop the fish consumption rates for the Maine water quality standards did not include information about the sustenance practices of tribal members fishing in their own water, nor did they represent consumption levels that were unsuppressed by concerns about pollution. EPA concluded that the best available data that represent the unsuppressed fishing practices of tribal members fishing in tribal waters are contained in the Wabanaki Lifeways study, which looked at the historic sustenance practices of the Tribes in Maine." *Id.* at 39. Based on the Maine decision, Tribes in the State of Washington should be viewed by the State as *the target population for making risk management decisions, not a highly exposed subpopulation* as most the waters for which this rule applies throughout the state are Usual and Accustomed fishing grounds. The State of Washington, like in Maine, has a duty to protect the sustenance use in these waters so that tribal members can safely consume fish.

Thus, under the Clean Water Act, protecting the designated uses of Washington's waters includes protecting the sustenance use. In the draft Federal Rule, EPA states:

> EPA proposes to consider the tribal population exercising
> their reserved rights in Washington as the target general

population for the purposes of deriving protective criteria that allow the tribes to harvest and consume fish consistent with their reserved rights. (p. 55067)

EPA further explains in the draft Federal Rule:

> A majority of waters under Washington's jurisdiction are covered by reserve rights, including tribal reserved rights....Many areas where reserved rights are exercised cannot be directly protected or regulated by tribal governments and, therefore, the responsibility to the state and federal governments to ensure their protection. In order to effectuate and harmonize these reserved rights with the CWA, EPA determined that such rights appropriately must be considered when determining which criteria are necessary to protect Washington's fish and shellfish harvesting designated uses.... (p. 55067)

Thus in Washington, harvesting and consuming fish, including for subsistence purposes, is the designated use of most of Washington's waters that the Clean Water Act requires protection. Many toxic pollutants at issue in this rulemaking are persistent, carcinogenic, and/or accumulate in fish and shellfish tissue through biomagnifying up the food chain. This is a grave concern because low levels of bioaccumulative pollutants in surface waters can result in concentrations in fish tissue that can pose a human health risk."), available at http://water.epa.gov/scitech/swguidance/standards /handbook/chapter03.cfm#section13,m.

When setting the human health water quality criteria for toxic pollutants, regulators must determine the amount of fish people actually consume. EPA has made clear that states must use locally-accurate and protective fish consumption rates to set water quality standards. *See, e.g.*, EPA, Methodology for Deriving Ambient, Water Quality Criteria for the Protection of Human Health at 2-13 (Oct. 2000) ("EPA 2000 Guidance"). Accurately determining the fish consumption rate is integral to regulators' ability to set protective human health water quality standards such that the level of toxic pollutants are low enough that fish remain safe to eat, even for people who eat greater amounts of fish than others. *Id.*; *see generally* National Environmental Justice Advisory Council, Fish Consumption and Environmental Justice at 30-32 (Dec. 2001); *see also*, Maine Letter at 2-3 and 37-42. If a state sets the FCR lower than the amounts actually consumed, the human health water quality standards will not be protective for people consuming fish may ingest levels of toxins that will put them at increased risk for adverse health consequences. EPA 2000 Guidance. Failure to adopt human health water quality standards based on an accurate fish consumption rate, including a rate adequate to protect sustenance fishing by tribes and other cultures, is a failure to promulgate water quality standards that meet the requirements of the Clean Water Act.

Other components of the human health water quality standards equation are also critical to ensuring adequately protective standards, and must have sufficient rationale for their derivation. As important as the fish consumption rate is the acceptable cancer risk rate, or the "near zero" level recommended by EPA. The "near zero" level in Washington State has been set at 10^{-6}, a one in one million chance that the average fish consumer will get cancer sometime in his/her lifetime from eating fish . A $1x10^{-6}$ risk factor is generally considered protective by EPA. 40 C.F.R. § 131.36(b)(1). *See also* Maine Letter at 3.

Finally, there are several additional inputs that affect the outcome of the human health criteria equations for carcinogens and non-carcinogens, including body weight, relative source contribution or how much of the toxic pollutant loads come from fish relative to all other sources (the "relative source contribution" number), and the use of bioconcentration or bioaccumulation factors. Ecology has largely ignored the science of these "sufficient parameters or constituents (to protect the designated use" by often relying on state "risk management decisions" to the detriment of the protection of the public, including tribal members.

DERIVATION OF HUMAN HEALTH CRITERIA FOR NON-CARCINOGENS

The human health criteria equation for non-carcinogens is as follows:

$$AWQC = RfD \cdot RSC \cdot \frac{BW}{[DI + (FCR \cdot BAF)]}$$

where:

AW	Ambient Water Quality Criterion (milligrams per
Rf	Reference dose for noncancer effects (milligrams kilogram per day)
RS	Relative source contribution factor to account for water sources of exposure (unitless)
BW	Human body weight (kilograms)
DI	Drinking water intake (liters per day)
FC	Fish Consumption Rate (kilograms per day)
BA	Bioaccumulation factor (liters per kilogram)

PTI recommends the State use the most recent reference doses used in EPA's IRIS database and 2015 § 304(a) Nationally Recommended Criteria for both the "water + organism" and "organism only" criteria for non-carcinogens. *Draft Nationally Recommended Water Quality Criteria*, U.S. EPA, Office of Water, Washington D.C. Last updated on December 3, 2014. Available at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm#hhtable (*"Draft Criteria")*. The reference dose is EPA's maximum acceptable oral dose of a toxic substance, without the risk of "deleterious effects" over a lifetime. It is specific to the individual pollutant. EPA's 2000 Human Health Methodology recommends deriving human health criteria using the reference dose. *2000 Methodology*.

Body Weight

ADULTS

Ecology proposes 80 kilograms (176 pounds) for the body weight assumption to derive human health criteria. This value is based on updated survey data and is consistent with the average adult body weights of the Tulalip and Suquamish Tribes. *Region 10 Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia*, U.S. Environmental Protection Agency, 2007, Working Doc. Available at: http://yosemite.epa.gov/r10/CLEANUP.NSF/7780249be8f251538825650f0070bd8b/e12918970debc8e488256da6005c428e/$FILE/Tribal%20Shellfish%20Framework.pdf. Although this body weight is consistent with two tribal surveys, it isn't consistent with or reflective of all of the regional contemporary tribal consumption surveys, particularly the older surveys like the CRITFC survey. We believe all of the tribal surveys should be considered when assigning the appropriate body weight for the target population of tribal subsistence fishers. When all surveys are considered, in addition with other data below, the relatively lower 70 kilogram (154 pounds) body weight is more appropriate.

In EPA's 2011 *Exposure Factors Handbook*, the default body weight assumption for human health criteria was updated to 80 kilograms based on National Health and Nutrition Examination Survey (NHANES) data from 1999 to 2006. *Exposure Factors Handbook: 2011 Edition*, National Center for Environmental Assessment, Washington, DC; EPA/600/R-09/052F, 2001, available from the National Technical Information Service, Springfield, VA, and online at http://www.epa.gov/ncea/efh. This body weight represents the average US adult body weight, but this isn't appropriate here because the average US population isn't the target population to protect. The 2000 *Methodology* explains, "In general, exposure factor values specific *to adults (emphasis added)* and relevant to lifetime exposures are the most appropriate values to consider when determining criteria to protect against effects from *long-term exposure* (emphasis added) which, by and large, the human health criteria are derived to protect. *2000 Methodology* at p.3-17.

The 80 kilogram body weight is not representative of the higher fish consuming Pacific Islander populations who, based on King County survey data, have lower average body weights. Thus, usage of an 80 kilogram body weight in the derivation of a human health standard would be under protective for this population as well. For these reasons, the Puyallup Tribe recommends a body weight of 70 kilograms in the derivation of state human health criteria.

CHILDREN

In its draft rule, Ecology fails to recognize risks to children. The risks posed to children from toxics are substantial within the Puyallup Tribe. Most of the Tribe's families remain on or near the Puyallup Reservation, now heavily urbanized long after the WWII machinery and apparatus has left and been replaced by port, industrial, commercial and municipal infrastructure and development. It is recognized as the most urbanized Reservation in the United States. The demographics of the Tribe have recently shifted in recent generations with a higher proportionality of children who, unlike almost all other populations, stay on or near the Reservation and will be exposed to a myriad of increased toxics not only because they eat much more fish than the average Washingtonian, but also because they have additional exposure routes (i.e. inhalation via sweats) that may adversely impact their health.

To protect their most vulnerable, the Puyallup Tribe recommends the state use a body weight of 30 kg in a variety of circumstances to provide additional protection for children when the chemical of concern indicates health effects in children are of primary concern. EPA recommends this approach in the *2000 Methodology*. *2000 Methodology,* at 4-29. The exposure factor values provided in the *2000 Methodology* for women of childbearing age and children should be used in these situations and the state rule language should reflect this recommendation to provide certainty for the protection of women and children throughout our state.

For short-term exposures to toxics that pose a risk of developmental effects to children, EPA recommends the following:

Short-term exposure may include multiple intermittent or continuous exposures occurring over a week or so. Exposure factor values relevant for considering chronic toxicity, as well as exposure factor values relevant for short-term exposure developmental concerns, that could result in adverse health effects (should be considered).... EPA may consider developing criteria for developmental health effects based on exposure factor values specific to children or to women of childbearing age. EPA encourages States and Tribes to do the same when health risks are associated with short-term exposures. *2000 Methodology* at pp.4-17 – 4-18.

In addition to the EPA guidance above, Washington should also be using the 30kg standard as a result of the need to protect Tribal Treaty Rights throughout waters in Washington State. Washington must develop criteria in order to protect the target population of higher fish consumers and the most vulnerable or sensitive populations to meet its obligations under the Clean Water Act and Tribal Treaty Rights.

<u>Drinking Water Intake</u>

We agree with updating the drinking water intake rate to 2.4 liters per day, based on national survey data. This is consistent with EPA's proposed federal rules (September 2015) and EPA's 2015 Nationally Recommended Water Quality Criteria.

<u>Bioaccumulation/Bioconcentration Factor (BAF/BCF)</u>

Ecology has chosen to utilize bioconcentration factors (BCF) in the state's proposed human health criteria, which were used in the derivation of the National Toxics Rule criteria almost 15 years ago. Ecology's justification for the use of BCF is bizarrely based on a "risk management decision" that is wholly unsupported and contrary to EPA's 2000 Methodology and EPA's most recent (2015) Nationally Recommended Criteria. Ecology replaces the requirements to use the best available science and the overall hierarchy which calls for use of the most recent EPA data absent specific local data with a "policy decision" to utilize outdated national standards. *Id.* and *2000 Methodology*. Ecology's decision to utilize BCF is arbitrary and capricious.

Contrary to Ecology's arbitrary and capricious decision in the Proposed Rule, the Puyallup Tribe recommends the use of bioaccumulation factors in the derivation of the state's human health criteria to be more protective of human health consistent with EPA's updated 2015 nationally recommended criteria, EPA's draft Federal Water Quality Standards Rule (September 2015), and EPA's *2000 Methodology*. This methodology represents the newest and best science from the agency given the duty by Congress to establish national recommendations of water quality standards. This approach accounts for variation in bioaccumulation of pollutants based on trophic position of the organism. The draft Federal Rule accounts for trophic level 4 exposure, while the 2015 Nationally Recommended Criteria account for three trophic levels of fish. We agree with EPA's use of trophic level 4 BAF from the draft Federal Rule in conjunction with at least 175 grams per day FCR, because the surveyed population of which the FCR is based, consumed almost exclusively trophic level 4 fish (i.e. predator fish species). This is an important and significant leap in quantitatively and thus precisely accounting for more exposure pathways than direct contact accounts for and therefore will be more accurate in representing exposures to pollutants that affect human health. EPA's methodology for deriving human health criteria emphasizes using measured or estimated bioaccumulation factors, which account for chemical accumulation in aquatic organisms from all potential exposure routes. *National Recommend Ambient Water Quality Criteria for the Protection of Aquatic Life and Human Health,* Environmental Protection Agency, available at: http://www.epa.gov/waterscience/criteria/wqctable/index.html. Unlike bioconcentration, BAFs account for more exposure pathways than direct water contact.

The difference between bioconcentration and bioaccumulation and the consequence of this significant advancement in the science of toxicology, is discussed in the 2000 Human Methodology document:

> ... the term "bioaccumulation" refers to the uptake and retention of a chemical by an aquatic organism from all surrounding media (e.g., water, food, sediment). The term "bioconcentration" refers to the uptake and retention of a chemical by an aquatic organism from water only. For some chemicals (particularly those that are highly persistent and hydrophobic), the magnitude of bioaccumulation by aquatic organisms can be substantially greater than the magnitude of bioconcentration. Thus, an assessment of bioconcentration ***alone would underestimate the extent of accumulation in aquatic biota for these chemicals*** [for emphasis]. *2000 Methodology* at p.5-2.

According to EPA's assessment above, Ecology's risk management "policy decision" fails to account for chemical accumulation and biomagnifications as a result of multiple pathways, leading to a failure to protect designated uses by failing to accurately assess consumption of chemicals through consumption of fish. Ecology's Proposed Rule is arbitrary, capricious, contrary to law, and violates Tribal Treaty Rights.

Fish Consumption Rate (FCR)

As discussed above, Washington has a duty under the Clean Water Act to protect designated uses including fishing, and in conjunction with the Tribe's treaty right to harvest fish and shellfish, to protect Tribal members' right to safely consume those fish which they harvest under that treaty right. This necessitates, as EPA guidance has also determined, that Washington use local data to determine the appropriate level of fish protections to protect Tribal members.

It is well settled that the current fish consumption rate of 6.5 g/day is far below the actual amount of fish consumed per day per individual in Washington. EPA guidance is clear: local fish consumption data should be used over the outdated National Toxic rule for human health water quality standards. *2000 Methodology* at 1-12 and 4-25. EPA has warned Washington that its fish consumption rate is woefully inadequate. *Letter to Maia Bellon, Director of the Department of Ecology from Dennis McLerran, Region 10 EPA Administrator* dated April 8, 2014. Multiple surveys across the state that have been provided and reviewed by Ecology indicate fish consumption numbers as high as 796.9 g/day and suggest that historic consumption rates are in excess of 1000 g/day for adults. *Fish Consumption Rates. Technical Support Document. A Review of Data and Information about Fish Consumption in Washington. Version 2.0 Final.* Washington Department of Ecology, Publication No. 12-09-058, January 2013 at Attachment C: Statistical Analysis of National and Washington State Fish Consumption Data by Nyak Polissar et al, available at: https://fortress.wa.gov/ecy/publications/publications/1209058.pdf ("*Fish Consumption Technical Support Document*").

The simple fact is that the 175 g/day fish consumption rate was a negotiated rate reached after long discussions between Ecology and tribes in Washington. It was always clear that the tribes only meant for the 175 g/day to be an incremental step for this triennial review and was based upon a cancer risk rate of 10^{-6}. In fact, the fish consumption rate should be much higher to adequately protect the tribal subsistence right to take fish in their Usual and Accustomed fishing grounds. These rates as well as unsuppressed contemporary rates have been documented in Harper and Walker (2015).

Furthermore, the 175 grams per day FCR is the negotiated value used in Oregon's updated human health criteria, which is based on the 90-95th percentile of Oregon fish consuming populations. This rate is in between 225 grams per day (mean of the Suquamish

Tribe's survey) and 125 grams per day (mean of the means of the Suquamish, Tulalip and Squaxin Tribal FCR surveys), which are the other alternative FCRs the State considered in their public forum process while developing the draft water quality standards rule. *Handout RE: Rulemaking General Information*, Washington State Department of Ecology, 2014, Public meeting held on November 6, 2014, at 27. However, none of these values approximate the 95th percentile range of these tribal fish consumption studies. The mean of these studies at the 95th percentile range is about 448 grams per day. This value includes all fish (finfish, shellfish, and non-anadromous fish). *Fish Consumption Technical Support Document.* Still, these values don't come close to the historic, unsuppressed FCRs of the northwest's tribes, which are about 800-1000 grams per day. *Id.* On par with these rates, EPA recently approved the Spokane Tribe's historic fish consumption rate of rate of 865 grams per day. *Letter to Chairman Rudy Peone from Daniel D. Opalski, Director, Office of Water and Watersheds RE: EPA's Action on the Spokane Tribe of Indian's 2010 Revisions to their Surface Water Quality Standards,* dated December 19, 2013, available at http://www.epa.gov/region10/pdf/water/wqs/spokane_cover_letter_TSD_Dec192013.pdf. Ecology's use of 175 g/day is arbitrary and capricious, and a violation of law.

It is also important to note that using 175 g/day for the fish consumption rate is a single variable in a long multi-variable equation used to derive water quality standards. The FCR of at least 175 g/day must not only be coupled with a cancer risk rate of 10^{-6}, but the other inputs into the derivation of the criteria must also be sufficiently protective and justified using a sound scientific rationale. he Puyallup Tribe agrees with the state's decision to explicitly account for salmon in the FCR for the development of the draft human health criteria. This decision is consistent with the 2000 Methodology's four preference hierarchy to use local data and/or data reflecting similar populations groups before considering the use of data from national surveys or EPA default rates. *2000 Methodology*.

EPA has historically used a FCR that includes the intake of freshwater and estuarine species only, as salmon is excluded in the rate because of its marine life history. Conversely, the state made the appropriate determination to base the FCR on highly exposed populations, as strongly recommended in the EPA 2000 Methodology. The state supports its determination saying: "Since Washington has a strong tradition of fish and shellfish harvest and consumption form local waters, and with-in state survey information indicates that different groups of people harvest fish both recreationally and for subsistence, Ecology has made the risk management decision to base the fish consumption rate used in the HHC equation on "highly exposed populations...." *Rule Overview* at 16. The state further concludes that the FCR should include "all fish and shellfish," including all salmon, restaurant, locally caught, imported, and from other sources" for highly exposed populations including tribes "that consume both fish and shellfish from Puget Sound waters". *Id.* at 17.

Therefore, for the *purposes of this triennial review*, the Puyallup Tribe recommends a fish consumption rate of *at least* 175 grams per day[1], with a commitment in forthcoming triennial reviews, to review and adjust the fish consumption rate sufficiently to: 1) protect all tribal members throughout the State of Washington, including the subsistence use; and 2) fully protect treaty rights in tribal usual and accustomed fishing areas to fully exercise the right to take fish in the quantities entitled to them explicitly under the Boldt decision *U .S. v. Washington,* 384 F.Supp. 312, (W.D. Wash., 1974). The full protection of the treaty right to take fish necessitates derivation of a consumption rate that is not suppressed because of concerns about consuming fish and shellfish in Usual and Accustomed fishing and shellfish beds contaminated with toxic pollutants.

Relative Source Contribution (RSC)

Ecology proposes to retain an RSC of 1 in its Proposed Rule. Ecology discounts EPA's guidance that states in order to appropriately analyze the risk and protect health states must consider RSC values of .2-.8 to account for exposures other than drinking water and consuming fish to be sure those exposures from drinking water and consuming fish do not lead to an overall exceedance of a safe exposure. *Id.* and *2000 Methodology* at 1-7. In 2015, upon evaluation of chemical uses, properties, releases to the environment, EPA developed chemical specific RSCs for non-carcinogens and non-linear carcinogens ranging from 0.2 to 0.8 following the exposure Decision Tree approach described in the *2000 Methodology*. The Tribe recommends using the same RSCs to derive human health criteria for Washington. Where EPA did not update specific pollutants in the 2015 nationally recommended criteria, the Tribe recommends using an RSC of 0.2 to derive criteria for these pollutants, to ensure adequate human health protections.

The purpose of the RSC is to ensure that the level of a chemical allowed by a criterion will not result in exposures that exceed the reference or safe dose of a toxic substance. Human health water quality criteria address exposure only through drinking water and eating fish. The RSC identifies or estimates the portion of a person's total exposure attributed to water and fish consumption and thereby accounts for potential exposure of toxics from other sources such as

[1] The recommendation of 175 g/day is also based upon a cancer risk rate of 10-6.

skin absorption, inhalation from ceremonial uses and sweats in sweat lodges, other foods, and occupational exposures. All of these exposure pathways must be accounted for in order for a water quality criteria to be protective. Setting a relative source contribution of 1 means that only contaminant sources from water and fish and shellfish are accounted for in the derivation of the criterion, discounting all other exposure pathways. To be sufficiently protective of human health, contaminants from all sources must be accounted for and apportioned in the derivation of a water quality criterion. Such an approach is arbitrary and capricious and has no sound scientific or defensible basis. The state's argument that only those sources that can be controlled under the Clean Water Act (i.e. water and fish and shellfish) should be used in the derivation of the relative source contribution and thus the criterion is irrelevant. The derivation of the standard is based on protection of human health, not what pollutants can or can't be controlled under the authorities of the Clean Water Act.

EPA published final updated ambient water quality criteria for the protection of human health for 94 chemical pollutants. These updated recommendations reflect the latest scientific information and EPA policies, including updated body weight, drinking water consumption rate, fish consumption rate, bioaccumulation factors, health toxicity values, and relative source contributions.

Relative Source Contribution for Methylmercury

EPA found that the most significant source of exposure to methylmercury was the ingestion of marine fish. *Mercury Source Assessment,* United Nations Environment Program, Inter-organization Program for the Sound Management of Chemicals, Geneva, Switzerland, 2013, available at http://www.chem.unep.ch/mercury/Report/Chapter4.htm. Thus, the RSC of 2.7×10^{-5} mg methylmercury/kg/day is recommended by EPA as an estimated exposure from marine fish intake. EPA's recommendation is based on the assumption that the fish consumption rate does not include fish of marine origin. However, as part of the re-evaluation of local and regional data and the selection of a fish consumption rate of 175 grams per day, Washington did take into consideration the consumption of salmon and regional consumption rates that included estuarine finfish and shellfish. Therefore, in reviewing this information, it is not necessary to provide additional protection from ingestion of marine fish through the use of an RSC value. As a result, the exposure related to marine fish should be subtracted out, resulting in an RSC of zero. Ecology has failed to address this issue in the Proposed Rule.

Relative Source Contribution for Endrin

PTI agrees with the Oregon DEQ rationale for Endrin that routes of exposure other than drinking water and fish tissue are unlikely in Washington State as endrin was banned in the US in 1980s, USFDA declared in 1995 that exposure to endrin from foods was no longer a concern, and it is not mobile in soil and volatilizes rapidly in air. Thus, 80% is recommended. Where it can be demonstrated that other sources and routes of exposure are not anticipated for the chemical in question, EPA recommends a ceiling of 80%. *2000 Methodology*. Ecology has failed to address this issue in its proposed rule.

Ecology has failed to provide scientific justification for deviating from EPA's scientifically supported use of RSC values of .2-.8. Ecology attempts to couch their reasoning as a well thought out state policy, directly contradicting EPA guidance. Ecology's determination to utilize a RSC of 1 is arbitrary, capricious, contrary to law, and violates Tribal Treaty Rights.

Deriving the Human Health Criteria for Carcinogens

The *2000 Methodology* describes the procedures that can be used as guidance by states for deriving human health water criteria. The *2000 Methodology* includes an equation to be used in deriving the "water + organism" and "organism only" human health criteria for carcinogens to protect the fishing and drinking water uses. A simplified version of this equation is provided below.

The simplified equation for deriving the human health criteria for carcinogens is:

$$AWQC = \frac{\text{Risk Level} \bullet BW}{[CSF \bullet (DI \bullet (FCR \bullet BAF))]}$$

AWQC = Ambient Water Quality Criterion (milligrams per liter)
Risk Level = Risk level (unitless)
CSF = Cancer slope factor (milligrams per kilogram per day)
BW = Human body weight (kilograms)
DI = Drinking water intake (liters per day)
FCF = Fish Consumption Rate (kilograms per day)
BAF = Bioaccumulation factor (liters per kilogram)

Body Weight, Drinking Water Intake rate, Bioaccumulation/ Bioconcentration and Fish Consumption Rate

The Puyallup Tribe recommends the same input values for body weight, drinking water intake, bioaccumulation/bioconcentration, and fish consumption rate for carcinogens as those already discussed previously for non-carcinogens. See the discussion above for these quantitative assumptions. Consistent with the criteria for non-carcinogens, a fish consumption rate *at least* 175 grams per day is also recommended as discussed above. Use of a body weight of 30 kg when chemicals are of particular concern in children, and a drinking water intake of three liters per day are recommended based on the most up to date science, as described above. Additionally, the Puyallup Tribe also recommends use of bioaccumulation factors consistent with the 2015 Nationally Recommended Criteria with those used by EPA in deriving its national CWA § 304(a) human health criteria guidance values.

Cancer Slope Factor

In deriving human health criteria for carcinogens, the Puyallup Tribe recommends using the cancer slope factors recommended by EPA in the 2015 Nationally Recommended Criteria. EPA has updated the health risk factors, including the cancer slope factor and reference doses, using the most current toxicity information. EPA's Integrated Risk Information System (IRIS) is the primary recommended source for reference dose and cancer slope factor information. For some pollutants, more recent assessments may be found using other resources provided by EPA's Office of Water and other programs.

A cancer slope factor expresses incremental, lifetime risk of cancer as a function of the rate of intake of the contaminant, and is combined with exposure assumptions to express that risk in terms of an ambient water concentration. Cancer slope factors are specific to individual pollutants.

For toxic pollutants identified as carcinogens and assumed to exhibit a linear dose-response relationship at low doses, EPA derives its national CWA § 304(a) human health criteria recommendations to correspond to incremental lifetime cancer risk levels, applying a risk management decision that ensures a reasonable level of protection for the target population. A cancer slope factor is included in the calculation.

The Puyallup Tribe discusses its recommendations for arsenic in a separate section, below.

Carcinogenic Risk Level

Ecology has reconsidered their earlier 2015 draft proposal of lowering the cancer risk level from one excess cancer in a million (1×10^{-6}) to one excess cancer in one hundred thousand (1×10^{-5}). We agree with Ecology's revised cancer risk of one excess cancer risk in a million ($1X10^{-6}$). This is the "near zero", acceptable risk rate recommend by EPA and the risk rate currently in the state's NTR rule. The Puyallup Tribe agrees with the State of Washington retaining the existing excess cancer risk level of one excess cancer in a million (1×10^{-6}) that is in the state's water quality standards and has been since 1992.

The Puyallup Tribe is a signatory of the Medicine Creek Treaty. 10 Stat. 1132 (1855). The state is party to the treaty and has an obligation to not foreclose the ability of the Tribe to fully exercise the full extent of the treaty right. The exercise of this right is to take fish and safely consume fish throughout the Tribes Usual and Accustomed fishing areas for subsistence, ceremonial, and commercial purposes. The courts have defined the extent of these rights to include a 50% allocation of the fishery as necessary to prevent the Tribes a moderate standard of living *U.S. v. Washington,* 384 F.Supp. 312, (W.D. Wash., 1974). Because treaties are binding and the supreme law of the land, the state in the rulemaking process and EPA who will review and approve or disapprove these rules must not interfere with the full exercise of this right by both protecting the beneficiaries of the right (the consumers to safely consume fish) as well as the safety of the food source (the fishery) to ensure continued reliance to feed their families and secure a moderate living. *See Maine Decision.*

The Tribes' usual and accustomed fishing grounds throughout Washington State compromise a majority of the waters of the state and it is the duty of the state under the Clean Water Act to protect designated uses of these waters which include the fishing use. EPA determined in the recent Maine disapproval action that "to protect the function of these waters to preserve the Tribe's unique culture and to provide for the safe exercise of their sustenance practices, EPA must interpret the fishing use to include sustenance fishing.'' *Maine Decision* at 26. EPA determined it was their duty to include the concept of sustenance fishing as provided for in the tribal settlement acts, as to do otherwise "would run the risk that state WQS could be based on assumptions about fish consumption rates that could lead to criteria that fail to protect the Tribe's ability to safely consume fish for their sustenance". *Id.* at 32. Accordingly, EPA concluded that the State of Maine had a duty to protect the sustenance use. "To adequately protect the sustenance fishing use, EPA reasoned, the State of Maine was required to revisit two aspects of its technical analysis supporting the human health criteria that determine how clean waters must be to allow the Tribes to safely consume fish for their sustenance." *Id.*

EPA continued that the State of Maine's analysis must treat the tribal population exercising the sustenance fishing use as the target general population, not as a high consuming subpopulation of the State. *Id.* EPA guidance calls for WQS that provide a high level of protection for the general population, while recognizing that small subpopulations may face greater levels of risk. However, the Tribes are not a subpopulation using the waters on their own lands; they are the population for which that land base was established and set aside. Second, the data used to determine the fish consumption rate for tribal sustenance consumers must reasonably represent tribal consumers taking fish from tribal waters and fishing practices unsuppressed by concerns about the safety of the fish available to them to consume. The data on which the State relied to develop the fish consumption rates for the Maine water quality standards did not include information about the sustenance practices of tribal members fishing in their own water, nor did they represent consumption levels that were unsuppressed by concerns about pollution. EPA concluded that the best available data that represent the unsuppressed fishing practices of tribal members fishing in tribal waters are contained in the Wabanaki Lifeways study, which looked at the historic sustenance practices of the Tribes in Maine." *Id.* at 39. Based on the Maine decision, Tribes in the State of Washington should be viewed by the State as *the target population for making risk management decisions, not a highly exposed subpopulation* as most the waters for which this rule applies throughout the state are Usual and Accustomed fishing grounds. The State of Washington, like in Maine, has a duty to protect the sustenance use in these waters so that tribal members can safely consume fish.

Furthermore, EPA considers 10^{-6} is an appropriate risk level for the target population, which in this case are the Tribes of Washington. *2000 Methodology*, at 2-1. The 10^{-6} cancer risk level is an agency wide practice throughout EPA's programs as well. Although the FCR of 175 grams per day does not represent a historic, unsuppressed rate, it can only be considered a reasonable value based on the Washington tribal consumptions surveys which necessarily must be *in conjunction with* the 10^{-6} cancer risk level in order to be sufficiently protective for all tribes of the State of Washington to consume fish safely.[2]

[2] Again, the FCR of 175 g/day is a rate intended to be re-evaluated at the next triennial review by incorporating additional consumption data to reach an accurate historic consumption rate.

As we addressed in our letter of April 9, 2014 to Governor Inslee, while state managers often equate both cancer risk levels under consideration of 10^{-6} and 10^{-5}as *de minimus or* close to zero, and by extension equivalent in terms of effect, this simply is inaccurate. Only the excess cancer lifetime risk of 10^{-6} , currently used in the state water quality standards, is considered as the "safe dose" that is "negligible" in effect ("essentially zero"). This is considered "acceptable risk" – we agree. This is the basis of why it is this cancer risk level that is used in EPA's nationally recommended criteria. With both a significantly high cancer incidence rate in our own Tribal members and the highest cancer incidence in the west, changing the cancer risk rate to a less protective level would be reckless and certainly not in the interest of the Puyallup Tribe or Washington State. We expect the state to make risk management decisions to protect the designated uses of the waters of the state as required under the Clean Water Act, and the State must do so in ways that prevent increased risk of harm to all of us, but especially to those who eat significantly more fish. This must include consideration of those at increased risk such as children and elders. Retaining the cancer risk rate of 10^{-6} is not only the correct technical and legal conclusion, it is also the right decision since one in every two men and one in every three women can expect cancer in their lifetimes.

Washington State's Problem Chemicals – Arsenic, Mercury, and PCBs

Section 304(a)(1) of the Clean Water Act (CWA) requires EPA to develop, publish, and, from time to time, revise criteria for protection of water quality and human health that accurately reflect the latest scientific knowledge. Water quality criteria developed under section 304(a) are based solely on data and scientific judgments on the relationship between pollutant concentrations and environmental and human health effects. Unlike the Safe Drinking Water Act maximum contaminant levels (MCLs), Section 304(a) criteria do not reflect consideration of economic impacts or the technological feasibility of meeting pollutant concentrations in ambient water. *Nationally recommended Water Quality Criteria: 2002,* U.S. EPA Office of Water, Washington, D.C. EPA-822-R-02-047, November 2002.

In its 2015 update, EPA revised 94 of the existing human health criteria to reflect the latest scientific information, including updated exposure factors (body weight, drinking water intake, fish consumption rate), bioaccumulation factors, and toxicity factors (reference dose, cancer slope factor. *Fact Sheet: Human Health Ambient Water Quality Criteria: Draft 2015 Update.* U.S. EPA, Office of Water, Washington D.C.; EPA-820-F-15-001, 2015, available at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/upload/Human-Health-Ambient-Water-Quality-Criteria-Draft-2015-Update-Factsheet.pdf. The criteria have also been updated to follow the current EPA methodology for deriving human health criteria. *2000 Methodology*.

Arsenic

The existing state standard for arsenic under the NTR was established at 0.14 ppb (marine water) in 1992 using the hazard assessment in EPA's Integrated Risk Information System (IRIS) database (U.S. EPA, 1998) according to the 1980 methodology for developing ambient water quality criteria for human health. The criterion for water and fish consumption (freshwater) is 0.018 ppb. These arsenic water quality criteria represent a one in one million (10-6) cancer risk level for arsenic exposures, and apply as inorganic arsenic only. Ecology is now proposing a Safe Drinking Water Act standard (MCL) of 10 parts per million.

The State offers no scientific rationale on the subject of their use of the Safe Drinking Water Act maximum contaminant level (MCL) for the proposed arsenic criterion, other than to say there is state precedent. Ecology also cites naturally high backgrounds of arsenic in the Western states somehow justifies significantly adjusting the standard to be less protective than the existing standard. We find this argument to be a red herring in that re-stating the condition of state waters is irrelevant for the purposes of deriving a human health standard. The question about natural background is one of implementation, not for setting standards.

The Safe Drinking Water Act MCL is not protective of the designated uses of the State of Washington's waters, namely for "water + organisms" (or those waters designated for drinking water and fishing uses). The Safe Drinking Water standard is a technology standard and is not a human health based standard. Drinking water standards are based on technological and cost considerations that have nothing to do with section 304(a)(1) criteria. Under the Clean Water Act, the state is required to protect designated uses. Use of a SDWA criterion of 10 ppb does not protect the ingestion of water + organism, or tribes whose main route of exposure of arsenic is via ingestion of fish and shellfish. For most of the population, uptake of arsenic through food is the major source of exposure. Among foods, the highest concentrations of arsenic are generally found in fish and shellfish, existing primarily as organic compounds.

EPA's Draft Federal Water Quality Rule published in the FR in September of 2015 recalculates the standard to incorporate a cancer slope factor of 1.75 and a bioconcentration factor of 44, resulting in a standard for water and organisms (freshwater) of 0.0045 ppb and a standard for organisms only of .0059 parts per billion (marine waters). The EPA risk assessments for ambient arsenic human health criteria were based on the epidemiology study in Taiwan by

Tseng et al. (1968) and Tseng (1977) for the prevalence of skin cancer. EPA used the evidence of skin cancer reported in the Taiwan study as the basis for the arsenic hazard and dose response assessment. Using a time- and dose- dependent multistage model which assumes that any exposure to a compound such as arsenic could result in a cancer response, the cancer potency (q1*) estimated for ingested arsenic is 1.75 mg/kg/day. The carcinogenic potency estimate or the slope factor represents the upper bound cancer-causing potential resulting from lifetime exposure to a substance, arsenic in this case.

As the agency with expertise in developing water quality standards using best available science, we agree with and recommend EPA's draft arsenic WQC as published in EPA's Draft Water Quality Standards Federal Rule (September 14, 2015) and recommend it be incorporated into the State's Rule. EPA's draft WQC is more protective of human health, about 500-2000 times more stringent than the state's proposed standard for arsenic. We agree with and recommend this approach because arsenic is designated by EPA as a human carcinogen and there are several known dischargers of arsenic for which there are little to no controls in place to reduce and remove loadings in the Puyallup River watershed. And there could be, but for adequate controls that could be imposed by the state.

The proposed loosening of the state standard is particularly alarming in light of the fact that the former Asarco smelter's arsenic-laden slag was used for ballast on much of the land base in the Tacoma tideflats, including the Puyallup Reservation lands. We know, too, that groundwater in the vicinity of the former smelter has been adversely impacted. Thus, our tribal members have additional routes of exposure (i.e. dermal, inhalation) and as a result, are at increased risk. At this time, amendments should based on the sound science and only those that have the current best available science in place be included in any updates incorporated into the state rule.

Additionally, the state notes the AKART (i.e. pollution minimization plan) requirement to be applied in addition to the criterion. Yet AKART requirements are already required under state law so such a requirement does not provide any additional protections to human health. Based on low level arsenic monitoring in the watershed, background concentrations are at about 1 ppb. In addition to arsenic-laden slag ballast pervading upland areas on and adjacent to the Tribe's Reservation, there are many known polluters of arsenic in the Puyallup River watershed. Setting a protective level could include the implementation of pollutant minimization plans in order to capture the *controllable fraction* currently discharged to the Tribe's U&A fishing grounds.

Based on our 20+ years of implementation in the Puyallup watershed, we have found that even Oregon's WQS of 2.1 parts per million would mask many anthropogenic inputs we have detected through discharge monitoring. Through the Puyallup Tribe's direct experience with regulating arsenic, the Tribe has found cost-effective remedies such as product substitutions lead to significant improvements in water quality. Arsenic is discharged by POTWs, yet few have effluent limits for arsenic. Surprisingly, arsenic is also in a variety of compounds such as scalers, which control biological growth, and other products that don't include the word "arsenic" on the label. To address this, pollutant minimization plans including interim, enforceable benchmarks and timelines should be included in discharge permits and monitoring should be required in permits.

Ecology's decision on its treatment of arsenic is not protective of tribes nor is it based upon sound science, and relies on an incorrect interpretation of the SDWA and CWA. As such, it is arbitrary, capricious, contrary to law, and violates Tribal treaty rights.

Methylmercury

Ecology has chosen not to update the criteria on Methylmercury, unbelievably ignoring the fact that EPA, in its proposed Federal Rule (September 2015), already made a determination that Ecology's existing standards under the NTR are not protective of designated uses and therefore are not compliant with the CWA. Considerable new data has been provided since the State's last update, and been adopted by EPA. Yet Ecology has chosen not to utilize the best available data, without any sound scientific rationale.

In January 2001, EPA published a new recommended CWA section 304(a) water quality criterion for methylmercury based on fish tissue residues. Water Quality Criterion for the Protection of Human Health: Methylmercury. U.S. EPA , Office of Science and Technology, Office of Water, Washington D.C. EPA-823-R-01-001, January 1, 2001, available at http://water.epa.gov/scitech/swguidance/standards/criteria/health/upload/2009_01_15_criteria_methylmercury_mercury-criterion.pdf. This new criterion replaced the prior total mercury recommended criteria. Prior to 2001, the U.S. Environmental Protection Agency (EPA) recommended that states adopt mercury HHC as "total mercury" measured in surface waters. The updated, 2001 recommended water quality criterion [0.3 milligram (mg) methylmercury per kilogram (kg) fish tissue wet weight], is a limit for the concentration of methylmercury in freshwater and estuarine fish and shellfish tissue that EPA recommends not be exceeded in order to protect consumers of fish and shellfish. However, the EPA 2001 recommended national criterion (0.3 mg/kg) was calculated using a fish consumption rate of 17.5 g fish/day of freshwater and estuarine fish. *Id.*

The exposure pathway for methylmercury is consumption of contaminated fish. Dietary methylmercury is almost completely absorbed into the blood and is distributed to all tissues including the brain; it also readily passes through the placenta to the fetus and fetal brain. *Id.* at p. ix.

Sources of mercury include atmospheric deposition, erosion, urban discharges, agricultural materials, mining, combustion, and industrial discharges. *Sources and remediation for mercury contamination in aquatic systems – a literature review,* Wang, Q., D. Kim, D.D. Dionysiou, G.A. Sorial, and D. Timberlake, Environmental Pollution 131: 323-336 (2004). Methylmercury is the most important form of mercury toxicologically, because it can be readily taken up across lipid membrane surfaces. Methylmercury can also be bioconcentrated in fish tissues over a thousand times from water concentrations as low or lower than 1 micrograms per liter (µg/L). *Mercury: its occurrence and effects in the ecosystem,* Peakall, D.B. and R. J. Lovett, Bioscience 22: 20-25 (1972). Exposure to methyl mercury is usually through ingestion of fish and shellfish. The CRITFC survey revealed that methyl-mercury exposure risks to tribal women (consuming at the CRITFC average rate of 389 grams/day) compared to women in the general population (consuming at EPA's default rate of 17.5 grams/day) are shocking, evidencing that women consuming at the tribal consumption rate are exposed to methyl-mercury at levels nine to thirteen times the EPA's reference (safe) dose. Based on these facts, it is clear that the criterion should be updated to include the tissue-based limit in the 2001 EPA recommendations *and* include the revised FCR of 175 grams per day.

The state's reasoning for not updating the methylmercury criteria because of the absence of an implementation plan has no merit, is without sound scientific rationale and, therefore, arbitrary and capricious. Furthermore, the Proposed Rule is contrary to law and violates Tribal treaty rights regarding its failure to update the methylmercury criteria. The development of criteria is distinct from how the criteria get implemented under Sections 401 and 402 and other implementing regulations of the CWA. The problems that come from regulating methylmercury due to implementation issues are distinct from development of criteria. Ecology can address the difficulties through use of the April, 2010 EPA guidance for implementing the methylmercury criteria and work via a public process on closing data gaps, including questions regarding mixing zones, variances, and other provisions.

PCBs

Washington's cancer-based human health criteria for PCBs are based on revisions to the 1992 outdated NTR and adjustments to the cancer risk level. The State calculates the cancer risk rate at 4 per 100,000 rather than meeting the EPA standard of one-in-one-million. The State justifies its decision as a chemical specific risk management decision. EPA revised the 1992 NTR criteria to incorporate new science on the cancer potency factor based on the toxicity of PCB mixtures and different exposure pathways in 1999. This criterion is the one currently in Washington's rule and is 0.00017 ug/L for the protection of human health from consumption of aquatic organisms in marine and estuarine waters and 0.00017 ug/L for protection of human health from consumption of drinking water and organisms in most freshwaters. *Rule Overview.* In fact, in this regard Ecology utilized its policy for this rulemaking that no criteria should be less stringent that the criteria currently in place, which has been in place since 1992. In this case, Ecology had to go to this anti-backsliding default due to all the other criteria they wrongfully weakened (as discuss herein) after running the calculations with the other elements of the equation used to derive the criterion.

PCBs are ubiquitous, bioaccumulative carcinogens that are the culprit of many fish advisories throughout the State of Washington and impaired waters. PCBs are widespread in the environment, but have been decreasing since the 1979 ban was effectuated. *Rule Overview.*

PCBs are known endocrine disruptors and have been shown to cause cancer in animals. Research studies show "conclusive evidence that PCBs cause cancer" in animals and "the data strongly suggests that PCBs are probable human carcinogens." *Hazardous Waste PCBs Fact Sheet,* U.S. Environmental Protection Agency, 2014, available online at: http://www.epa.gov/solidwaste/hazard/tsd/pcbs/about.htm. PCBs concentrate in low trophic level organisms and through the gills of fish that filter large amounts of water. Bioaccumulation of PCBs takes place in predatory organisms as the body burden of prey is transferred to the predator including humans. *Id.* A prerequisite for a substance's strong bioaccumulation factor is an affinity for fat and persistence in the environment. This further highlights that bioaccumulation factors should be utilized when developing criteria for persistent, bioaccumulative, toxic pollutants, as discussed above, and it is critical with high bioaccumulation factors such as PCBs.

Ecology has recommended EPA standard method 608 for PCBs with a quantitation limit of 0.5 μg/L that is more than three orders of magnitude higher than the proposed standard of 0.00017 μg/L. In September 2010, EPA proposed to add EPA Method 1668C "Chlorinated

Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS" to 40 CFR Part 136. EPA's suggested method is a significant improvement in sensitivity. The reporting limits for congeners in aqueous samples using HRGC/HRMS are 0.0001- 0.0004 µg/L. Washington must recognize that analytical techniques for PCBs have evolved beyond method 608 and the state should require their use as part of a comprehensive effort to limit the release of PCBs into the environment, or at a minimum provide a clear scientific basis for failing to utilize the updated method.

The Puyallup Tribe recommends Washington's standards should be updated for PCBs using the 10^{-6} cancer risk level and updated bioaccumulation factors in EPA's draft Federal Rule because PCBs are bioaccumulative carcinogens. Using these inputs, the criterion is about 23 times more protective than the state proposal. Ecology needs to fully consider the health impacts of this bioaccumulative carcinogen and seriously evaluate opportunities for product substitution on the myriad materials that contain PCBs. Ecology's failure to implement those items above is not based upon science but a policy decision. Absent a sound scientific justification for Ecology's position on PCB's the Proposed Rule is arbitrary, capricious, contrary to law, and violates Tribal treaty rights.

2,3,7,8 TCDD (Dioxin)

The State of Washington proposes using the old 1992 NTR value for the dioxin criterion, ignoring more recent advancements on the subject. But for Governor Inslee's no backsliding provision, the criterion would be even less protective than the NTR. The Tribe recommends using the most recent Nationally Recommended Criteria Recommendation for dioxin which was published in 2002. At this time, we recommend using the same q_1 or cancer slope factor, BCF, and cancer risk level but to update the FCR in the derivation. EPA is currently working on updating the BCF and when the final revised criteria are published by EPA, we recommend the state follow suit. The section 304(a) water quality criteria for dioxin contained in this compilation is expressed in terms of 2,3,7,8-Tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) and should be used in conjunction with the national/international convention of toxicity equivalence factors (TEF/TEQs) to account for the additive effects of other dioxin-like compounds (dioxins). The Tribe agrees with EPA to use the 1998 WHO TEF scheme because it is based on more recent data and is internationally accepted. (See: *Update to the Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and -dibenzofurans*, EPA/625/3-89/016, March 1989 and Van den Berg M., 1998). By applying the TEF/TEQ approach, the other highly toxic dioxins will be properly taken into account.

The following facts about dioxin are taken from The Agent Orange Association of Canada http://www.agentorangecanada.com/dioxin.php and EPA's Environmental Assessment Unit:

- More than 90% of human exposure is through food, mainly meat and dairy products, fish and shellfish.

- 2,3,7,8 TCDD (Dioxin) is more commonly recognized as the toxic contaminant found in Agent Orange and at Love Canal, NY and Times Beach, Missouri.

- The average levels of dioxin in the U.S. population is about 25 parts per trillion (ppt) according to the US Environmental Protection Agency (EPA). Approximately 10% of the population may have tissue levels as much as 3 times higher than this level.

- Dioxin appears to act like an extremely persistent synthetic hormone, altering important signaling systems in humans and wildlife. This toxic mimicry leads to altered cell development, differentiation, and regulation.

- Dioxins also may result in reproductive and developmental effects in humans at levels already present in the body of the average person. (Based on their consumption of significantly more fish and shellfish, these affects are magnified in tribal people).

- The EPA has found that the body burden level of dioxin in animal studies can be related to adverse health effects observed in both animals and people. They have also found that the average level of dioxin found in the general US population is very close to these levels. EPA interprets this to mean that there is little or no "margin of exposure" left for most people. We see this as meaning that we are nearly "full" and that any additional exposure of dioxin can result in adverse health effects. Some people already have body burden levels that are above the average and they are likely already suffering adverse health effects.

- Tribal people, nursing infants, sand workers who live near dioxin release sources are at greater risk of developing adverse health effects from dioxin because they are exposed to higher concentrations.

- Dioxin's "half-life" in the human body is about seven years. In other words, it takes about seven years for half of the dioxin in your body to be removed and then another seven years for the half of that amount and so on. This means your body will never be free of dioxin contamination.

- As a carcinogen and endocrine receptor, exposure to dioxin can lead to a wide arrays of adverse health effects including cancer, birth defects, diabetes, learning and developmental delays, endometriosis, and immune system abnormalities.

- Dioxin binds very strongly to intracellular receptors in the nuclei of animal and human cells throughout the body. So dioxin can easily get into the nucleus, where the cell's DNA is located, and wreak havoc. If it damages the DNA, that could cause cancer or birth defects. It could also alter the DNA's instructions to make normal enzymes, hormones, and other proteins, which could lead to any of a number of diseases.

- Dioxin is a known carcinogen. TCDD is the most potent animal carcinogen ever tested. It causes tumors in both genders of every species and every strain of animal that's been tested. And the animals get different types of tumors, so it doesn't just initiate tumors, it also promotes the growth of tumors caused by other chemical initiators.

- In January 2001, the Department of Human Health and Services' National Toxicology Program classified dioxin as a known human carcinogen. The September 2000 draft of the USEPA's Health Assessment document on dioxin also classifies dioxin as a known human carcinogen. A: It is the most potent substance ever tested by the USEPA or by any private or government research center. Dioxin causes cancer in multiple species in multiple organs in both sexes. Cancer in animals has resulted from exposures as low as 200 ppt.

- The USEPA released a draft report last fall that projected an excess cancer risk of one in 100 for the most sensitive people who consume a diet high in animal fats. In other words, the risk of getting cancer from dioxin - over and above the risk of cancer from other sources - is one in 100 for some people. This is a worst-case scenario. It's for the most sensitive people among the five percent of the population who consume the most dioxin. Scientists refer to this as the "upper bound estimate." This is a shocking estimate and likely tribal members fall into this category based on their high intake of fish and shellfish.. A general "acceptable" risk level is one-in-one-million.

- Dioxin impairs the human reproductive system, birth defects, learning and developmental delays, endometriosis, immune system abnormalities, and diabetes. **Tribal nations are disproportionately affected because they eat more fish and shellfish than the average Washington consumer.**

Dioxins are produced as a result of combustion processes such as waste incineration (commercial or municipal) or from burning fuels (like wood, coal or oil). Dioxins produced by backyard burning. Dioxins are also produced by bleaching processes (pulp and paper).

Absent a sound scientific justification for Ecology's position on PCB's the Proposed Rule is arbitrary, capricious, contrary to law, and violates Tribal treaty rights.

IMPLEMENTATION TOOLS

Compliance Schedules

According to federal regulations, compliance schedules must require compliance "as soon as possible, but not later than the applicable statutory deadline under the CWA." 40

C.F.R. §122.47(a)(1). Existing Washington State regulations set compliance schedule limits at 10 years. This is consistent with most states' rule provisions and is based on the 5-year NPDES discharge permit durations.

The proposed draft rule language mandates compliance with "water quality standards in the shortest practicable time". *See* Proposed Rule. Instead, Ecology should revise its rule to utilize the federal language in 40 C.F.R. §122.47(a)(1) – "as soon as possible". There is a significant difference between "practicable" and "possible" as the impermissible subjective factors creep in with the use of "practicable" with regard to the regulated community. The Federal Regulations avoided this difficult issue in complying with the Clean Water Act's mandate and using "possible."

Not providing a time certain timeframe for compliance schedules is a significant and unacceptable deviation from existing rule language that provides a time certain deadline for complying with water quality standards. In fact, the draft rule language as written provides an open-ended off ramp from meeting water quality standards in a timely way and delays measurable progress in water quality in the interim. This is contrary to the Clean Water Act. The draft rule language as written misconstrues the intent of compliance schedules in the CWA. Notably, compliance schedules that are longer than one year in duration must set forth interim requirements and dates for their achievement. 40 C.F.R. §122.47(a)(3). Instead of a "schedule for compliance", the Proposed Rule grants polluters a wide berth to pollute and not meet effluent limits necessary to achieve water quality standards.

Even in those circumstances where a TMDL is in place, state statute allows for a compliance schedule to exceed 10 years but the terms for compliance are strictly constructed under the statute:

> (1)The permittee is meeting its requirements under the total maximum daily load as soon as possible;
> (2) The actions proposed in the compliance schedule are sufficient to achieve water quality standards as soon as possible;
> (3) A compliance schedule is appropriate; and
> (4) The permittee is not able to meet its waste load allocation solely by controlling and treating its own effluent. RCW 90.48.605.

The Hanlon Memo precisely defines the requirements of compliance schedules further:

> Any compliance schedule contained in an NPDES permit must *include an enforceable final effluent limitation and a date for its achievement* that is within the timeframe allowed by the applicable state or federal law provision authorizing compliance schedules as required by CWA sections 301(b)(1)(C); 502(17); the Administrator's decision in Star-Kist Caribe, Inc. 3 E.A.D. 172, 175, 177-178 (1990); and EPA regulations at 40 C.F.R. §§ 122.2, 122.44(d) and 122.44(d)(I)(vii)(A).

Memorandum from James A. Hanlon, Director of the EPA Office of Water to Alexi Strauss, Director of Water Division EPA Region 9, Re: compliance schedules for water quality based effluent limitations in NPDES permits, U.S. EPA, May 10, 2007, available at http://water.epa.gov/lawsregs/guidance/wetlands/upload/signed-hanlon-memo.pdf ("Hanlon Memo").

Although, EPA does not expressly state the limitations of the "timeframe allowed," everything in the CWA points to the fact that such schedules should be, at a minimum or "as soon as possible".

Furthermore, the rule language should include enforceable interim numeric limits and narrative limits when the narrative provisions are enforceable, as in the case of facility construction deadlines. This is consistent with the Hanlon Memo. *Hanlon Memo* at 2.

Therefore, based on the law and policy above, the Puyallup Tribe recommends that for non-TMDL Waters, Ecology require the shortest timeframe possible on a case-by-case basis. Ecology must mandate that schedules of compliance may not exceed ten years, and shall generally not exceed the term of any permit. When appropriate and as soon as possible, Ecology should require that the compliance schedule shall lead to compliance with the state water quality standards and the Clean Water Act and implementing regulations. For TMDL waters, Ecology must mandate that compliance schedules may not exceed the 10 year timeline, unless permittees meet the requirements of the four part test established in RCW 90.48.605, as discussed above. If the permittee meets the four part test requirements, compliance schedules must be the shortest timeframe possible, so long as it is not later than the applicable statutory deadline under the Clean Water Act 40 CFR §122.47(a)(1). When appropriate, and as soon as possible, the compliance schedule shall lead to compliance with the state water quality standards, Clean Water Act and implementing regulations.

The rule language for compliance schedules in both non-TMDL and TMDL waters alike should incorporate as much of the Hanlon Memorandum language or intent as possible. The Hanlon Memo specifically recommends

1. "When appropriate," NPDES permits may include "a schedule of compliance leading to compliance with CWA and regulations ... as soon as possible, but not later than the applicable statutory deadline under the CWA." (40 CFR 122.47(a)(1)). Compliance schedules that are longer than one year in duration must set forth interim requirements and dates for their achievement. (40 CFR 122.47(a)(3)).

2. Any compliance schedule contained in an NPDES permit must be an "enforceable sequence of actions or operations leading to compliance with a [water quality-based] effluent limitation ["WQBEL"]" as required by the definition of "schedule of compliance" in section 502(17) of the CWA. *See also* 40 CFR 122.2 (definition of schedule of compliance).

3. Any compliance schedule contained in an NPDES permit must include an enforceable final effluent limitation and a date for its achievement that is within the timeframe allowed by the applicable state or federal law provision authorizing compliance schedules as required by CWA sections 301(b)(1)(C); 502(17) and EPA regulations at 40 CFR 122.2, 122.44(d) and 122.44(d)(I)(vii)(A).

4. Any compliance schedule that extends past the expiration date of a permit must include the final effluent limitations in the permit in order to ensure enforceability of the compliance schedule as required by CWA section 502(17) and 40 CFR 122.2 (definition of schedule of compliance).

5. In order to grant a compliance schedule in an NPDES permit, the permitting authority has to make a reasonable finding, adequately supported by the administrative record, that the compliance schedule "will lead to compliance with an effluent limitation ... " "to meet water quality standards" by the end of the compliance schedule as required by sections 301(b)(I)(C) and 502(17) of the CWA. *See also 40* CFR 122.2, 122.44(d)(1)(vii)(A).

6. In order to grant a compliance schedule in an NPDES permit, the permitting authority has to make a reasonable finding, adequately supported by the administrative record and described in the fact sheet (40 CFR 124.8), that a compliance schedule is "appropriate" and that compliance with the final WQBEL is required "as soon as possible." *See* 40 CFR 122.47(a), 122.47(a)(I).

7. In order to grant a compliance schedule in an NPDES permit, the permitting authority has to make a reasonable finding, adequately supported by the administrative record, that the discharger cannot immediately comply with the WQBEL upon the effective date of the permit. 40 CFR 122.47, 122.47(a)(1).

8. Factors relevant to whether a compliance schedule in a specific permit is "appropriate" under 40 CFR 122.47(a) include: how much time the discharger has already had to meet the WQBEL(s) under prior permits; the extent to which the discharger has made good faith efforts to comply with the WQBELs and other requirements in its prior permit(s); whether there is any need for modifications to treatment facilities, operations or measures to meet the WQBELs and if so, how long would it take to implement the modifications to treatment, operations or other measures; or whether the discharger would be expected to use the same treatment facilities, operations or other measures to meet the WQBEL as it would have used to meet the WQBEL in its prior permit.

9. Factors relevant to a conclusion that a particular compliance schedule requires compliance with the WQBEL "as soon as possible," as required by 40 CFR 122.47(a)(I) include: consideration of the steps needed to modify or install treatment facilities, operations or

other measures and the time those steps would take. The permitting authority should not simply presume that a compliance schedule be based on the maximum time period allowed by a State's authorizing provision.

10. A compliance schedule based solely on time needed to develop a Total Maximum Daily Load i s not appropriate.

11. A compliance schedule based solely on time needed to develop a Use Attainability Analysis is also not appropriate.

Ecology's Proposed Rule fails to sufficiently limit compliance schedules. Based upon the items discussed above regarding compliance schedules, the Proposed Rule is arbitrary, capricious, contrary to law, and violates Treaty Rights.

Variances

Ecology proposes to provide variances for individual permittee, groups of permittees and even whole water bodies to avoid compliance with water quality standards. Variances may be applied to toxics or conventional parameters like temperature and dissolved oxygen that impact aquatic life. Variances under the state's rule are "time-limited", but so too was the time of the dinosaurs and they lasted over a million years. This "off-ramp" to the Clean Water Act and the new federal water quality regulations is a blatant disregard of the duty of the state to preserve water and aquatic resources for this and future generations under the Public Trust Doctrine. We have worked in good faith with Ecology long enough on the subject of variances to little avail. Time has run out, the Tribe will put the full force of its governmental authorities and duties to ensure variances do not get effectuated in its Treaty Usual & Accustomed fishing grounds. Ecology's proposed provisions for variances are outrageously over-reaching, ambiguous, arbitrary, capricious, and contrary to law and recent federal regulation.

Ecology's proposed rule establishes an explicit regulatory framework for the adoption of WQS variances that the state may use to implement adaptive management approaches to improve water quality. This policy, as a general policy, is discretionary under the Clean Water Act. We find it absolutely unconscionable that the state, using a discretionary policy, proposes to dismantle the protections of standards afforded by the CWA. Though a discretionary policy, the proposed variance provisions are subject to review and approval by EPA for consistency with the new federal water quality regulations published by EPA in August, 2015.

The variance provision is intended to effectuate incremental progress in water quality adaptively, while preventing a permanent downgrade in use. While apparently well intended, it will result in the unintended consequence of little to no improvements in water quality, while providing polluters shields from compliance for undetermined and extended periods of time. There is already a process under Section 303(d) of the CWA that provides for a better process for restoring waters of the state, that doesn't rely on "incremental" progress adaptively, but requires restoration to attain the designated use. And, it's enforceable. The risk, once again, is shifted to the resource and disproportionately on those peoples who consume and rely on the resource for subsistence, ceremonial, and other purposes.

Most importantly, the state's proposed variance policy will prevent the Tribe from fully exercising its treaty rights in its Usual and Accustomed fishing grounds as well as likely result in the non-attainment of downstream water quality standards within the 1873 Survey Area of the Puyallup Reservation. For these reasons, the Tribe will take the following actions:

1. We will oppose all variance applications applied for within the Tribe's Usual & Accustomed fishing grounds.

2. We will take necessary further actions to 1) make sure the final variance policy is at least consistent with the federal water quality standards regulation, including defining and achieving the "highest attainable use" as required.

3. We will take necessary further actions to ensure our treaty fishery and critical habitat are not harmed or adversely impacted.

4. We will make sure adequate safeguards are contained in the rule "to ensure the attainment and maintenance of downstream waters" within the 1873 Survey Area of the Puyallup Reservation.

5. We will request technical assistance from EPA to restore waters under the Tribe's jurisdiction under Section 303(d) of the CWA by effectuating water cleanup plans (Total Maximum Daily Loads – TMDLs).

Shifting uncertainty to the Tribe's treaty fishery and downstream waters is reckless and more importantly, needless because there are existing policies in place that provide sufficient flexibility for compliance with permits already. The state's existing variance policy provides sufficient flexibility to polluters while keeping with the intent of EPA's 1977 memorandum regarding variances as "temporary", limited to single dischargers, and requiring the same substantive and procedural rigor of removing a use.

The Clean Water Act provides no express authority for states to issue variances. The Act does allow states to authorize general policies for the implementation of water quality standards. The intent for allowing variances is to prevent a permanent downgrade of a use and provide a mechanism for maintaining standards "where attainable". *National Assessment of State Variance Procedures,* U.S. EPA, 1990, available at http://water.epa.gov/scitech/swguidance/standards/upload/1999_11_03_standards_variancereport.pdf. The underlying presumption is that by preventing a permanent downgrade in a designated use, further improvements in water quality will occur. Of course, this is not necessarily true, unless prescriptions are stipulated that define under what circumstances and for how long variances will be in effect. In fact, the legal basis for granting a variance is that the state has fulfilled the same regulatory requirement for removing a designated use. *Water Quality Standards Handbook: Second Edition*, U.S. EPA Office of Water, Washington D.C, 1994, as updated in 2014, available at http://www.epa.gov/waterscience/library/wqstandards/handbook.pdf.

The history of the concept of variances dates back to at least the 1980s, when in 1985, the Office of general Counsel indicated that, in addition to the substantial and widespread economic and social impact test that was imposed by regulation, 48 Fed.Reg 51403, Nov. 8, 1983, variances could be granted on any of the factors specified in 40 C.F.R. §131.10(g) for removal of a use. But in addition to these requirements, EPA imposed two additional operating assumptions:

> First, variances would not exceed 3 years, the time frame stipulated for the triennial review and the review of any water body segment that does not include the uses specified in Section 101(a)(2) of the CWA, the "fishable/swimmable uses". Second, variances would be granted to an individual discharger. This discharger-specific element evolved because the agency developed the variance mechanism to ensure that permits issued complied with the CWA.

Memorandum from Edwin L. Johnson, Director Office of Water Regulations and Standards to Water Division Directors, entitled "Variances in Water Quality Standards," U.S. EPA, March 15, 1985, available at http://water.epa.gov/scitech/swguidance/standards/upload/2008_08_04_standards_wqsvariance.pdf.

A variance does not replace a waterbody's designated use, but instead merely provides a temporary standard while still preserving the underlying use. It must be based on a use attainability demonstration and targets achievement of the highest attainable use and criteria (or best achievable water quality) during the period of the variance. As such, the variance is a revised water quality standard that must be supported on the basis of the factors specified in 40 CFR §131.10(g), it requires a full public review process, and EPA and approval before it can be used for Clean Water Act purposes. *Variance Compendium,* Oregon Department of Environmental Quality. January 24, 2011, Salem, Oregon. In addition to ensuring the highest level of water quality is attained, every 3 (not 5 as proposed in the rule) years, the state must consider whether there is any new information that may indicate that a 101(a) use is attainable, and if so, revise the WQS accordingly 40 C.F.R. §131.20(a).

EPA continues to substantially limit the duration and scope of variances, while the Proposed Rule broadens the scope of application and provides no timeframe for their expiration. In the public process, variances for durations of 40 years were discussed for some pollutants that would be applicable statewide or to entire watersheds. This timeframe was reportedly based on timeframes for municipal capital budget planning, with no regard for required compliance with the Clean Water Act through achievement of the highest water quality during the interim and preventing the permanent downgrade of the use.

The state's variance proposal and anticipated policy is perhaps the most egregious portion of the state's proposed rulemaking in that it provides a steep and swift off-ramp from the goals and requirements of the Clean Water Act and its implementing regulations. By definition variances are not protective of human health or, in the case of conventional pollutants, not the fishery, and variances pose a significant possibility for the diminishment of the tribe's treaty rights.

Accordingly, in compliance with the Clean Water Act, federal regulations, and to meet the State's obligations to protect tribal treaty rights, the Puyallup Tribe has no recommendations but for making no changes to the existing state policy.

Intake Credits

Current Washington State surface water quality standards rules (Chapter 173-201A WAC) does not include language on the use of intake credits as an implementation tool. The intake credit rule section in the Proposed Rule is new and will be used for the first time in the State of Washington, if approved by EPA. Federal regulations allow for the use of intake credits to be applied to technology-based effluent limitations 40 C.F.R. §122.45(g)). It is essential that the state's water quality standards rule provide a sufficient definition, and specify how and when these tools will be used.

An intake credit is a tool used to account for the level of a pollutant in the intake water of a facility when establishing a permit limit for the effluent of that facility. *See* 40 C.F.R §122.45(g). As typically used in federal permits and other states, intake credits have a limited applicability due to requirements that the intake pollutant must not be altered in such a way as to cause or contribute to an excursion of a water quality standard.

The use and application of intake credits should be narrowly construed to and only applied in circumstances that will not cause or contribute to violations of water quality standards or degrade tribal waters. To avoid potential violations of water quality standards, intake credits should be limited to the following circumstances:

- The facility does not add the intake pollutant of concern
- The facility does not alter the intake pollutant chemically or physically
- When intake of the pollutant of concern comes from the same surface body of water from the immediate vicinity of the discharge.
- When the intake credit is used to demonstrate *compliance with* effluent limitations, as opposed to avoiding the setting of effluent limitations through the Reasonable Potential Analysis review.

The Puyallup Tribe fundamentally has a problem with a facility "bringing in" pollutants via their process and delivering these pollutants into the Tribe's treaty and jurisdictional waters, namely toxics like arsenic. The facility then gets a "credit" under their permit that in effect allows the facility to violate usually-applicable water quality based limits if it has not added or modified the pollutant. These toxics are carcinogenic, or in the case of other toxics, persistent and often bioaccumulate. These pollutants would not have been otherwise discharged to receiving waters but for the facility's operations and it is blatantly unconscionable to us to receive a "credit" to discharge these pollutants under a water quality based effluent limit.

Waters under the Tribe's CWA jurisdiction and treaty waters do not have assimilative capacity for many of the pollutants and toxics for which intake credits may apply, such as arsenic. Instead of allowing a known carcinogen be discharged into tribal waters, that would not have been there but for the facility's importation from source ground and surface waters, we have successfully removed arsenic loadings from dischargers effluent by imposing low-limit monitoring programs, process evaluations, and product substitutions.

As a discretionary policy under the CWA, the Tribe intends to prevent the allowance of intake credits in the Puyallup River watershed, as such an allowance will provide for additional loads of toxics discharged that would not have been there otherwise but for the polluters actions specifically "importing" these wastes that are carcinogenic, bioaccumulative, persistent, or act as endocrine disruptors.

Without narrowly construing the definition, scope, and applicability of the proposed Intake Credit language in the Proposed Rule so that an intake pollutant will not "cause or contribute to an excursion of a water quality standard", we find Ecology's Proposed Rule to be arbitrary, capricious, contrary to law, and violates the Tribe's treaty rights.

Protection of Downstream Uses

Pursuant to sections 303 and 101(a) of the Clean Water Act, the federal regulation at 40 C.F.R. §131.10(b) requires that "[i]n designating uses of a water body and the appropriate criteria for those uses, the State shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters." This provision requires states and authorized tribes (hereinafter "states/tribes") to consider and ensure the attainment and maintenance of downstream water quality standards (WQS) during the establishment of designated uses and water quality criteria in upstream waters. *See Protection of Downstream Waters in Water Quality Standards: Frequently Asked Questions,* U.S. EPA, EPA-820-F-14-001, 2014, available at http://water.epa.gov/scitech/swguidance/standards/library/upload/downstream-faqs.pdf.

Designated uses and criteria that ensure attainment and maintenance of downstream WQS facilitate consistent and efficient implementation and coordination of water quality-related management actions (e.g., water quality monitoring and assessment, development of Total Maximum Daily Loads (TMDLs) and other watershed-based restoration and protection plans, and National Pollutant Discharge Elimination System (NPDES) permitting and Clean Water Act Section 401 certifications).

Although states have flexibility and discretion as to how this requirement is accomplished, the Tribe prefers this approach. Consistent upstream and downstream uses and criteria provide consistency across jurisdictional waters for the successful management of resources and reduce the likelihood of interjurisdictional disputes. Based on the Proposed Rule, the State of Washington's rules continue to become more and more disparate from Washington Tribe's water quality standards and neighboring states like Oregon. The state's proposed changes to implementing the proposed standards through the use of variances and compliance schedules broaden the chasm between neighboring states and Washington's Tribes. The requirement to protect downstream uses mandates adopting either narrative or numeric criteria to ensure the attainment and maintenance of downstream and preferably, an antidegradation policy and implementation plan that expressly prevents degradation of downstream waters and a plan for assurances.

Specifically, when designating or revising upstream uses specified in Clean Water Act section 101(a)(2), or subcategories of such upstream uses, provisions should include how the state's revised upstream uses (and associated criteria) will continue to demonstrate protection of existing or designated uses of downstream waters. The state has not provided the rationale as to *how* they will ensure downstream tribal and inter-state uses with neighboring states of Oregon and Idaho will be protected, particularly in light of the broadening of the off-ramps from the Clean Water Act provided by authorizing extensive undefined compliance schedules, variances and, intake credits. The Puyallup Tribe would like to obtain assurances from the State of Washington that the integrity of our downstream waters will be maintained and human health and our resources will be protected. Accordingly, we have requested assistance from EPA and cooperation from the State to restore downstream waters of the Tribe under the 303(d) process.

Absent any clear evidence as to how Washington intends to meet the Clean Water Act's obligations regarding downstream waters, the Proposed Rule is arbitrary, capricious, contrary to law, and a violation of the Tribe's Treaty Right.

CONCLUSION

Based upon the extensive discussion and reasons stated herein, the Proposed Rule is arbitrary, capricious and a violation of law. In addition, the Proposed Rule violates the Tribe's Treaty rights. Absent significant changes to address the issues stated herein, Ecology risks significant ongoing litigation, EPA disapproval and subsequent delay in implementing the water quality standards that will protect all citizens of the State of Washington, including tribal people.

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Coho Returns in the Puyallup Basin and South Puget Sound, prepared by Russ Ladley, Puyallup Tribal Fisheries Biologist (April 2016)

Coho returns to the Puyallup Basin and south Puget Sound were very poor in 2015 and projections for 2016 are even worse. The upcoming fishing season may hold unprecedented changes in harvest regulations. Its highly likely that all Puget Sound coho fishing will be suspended and even targeted Chinook opportunities will be closely watched to avoid unwanted interceptions of both wild and hatchery origin coho. Some Puget Sound river systems are forecast to not meet minimum escapement even without interception fisheries in place!

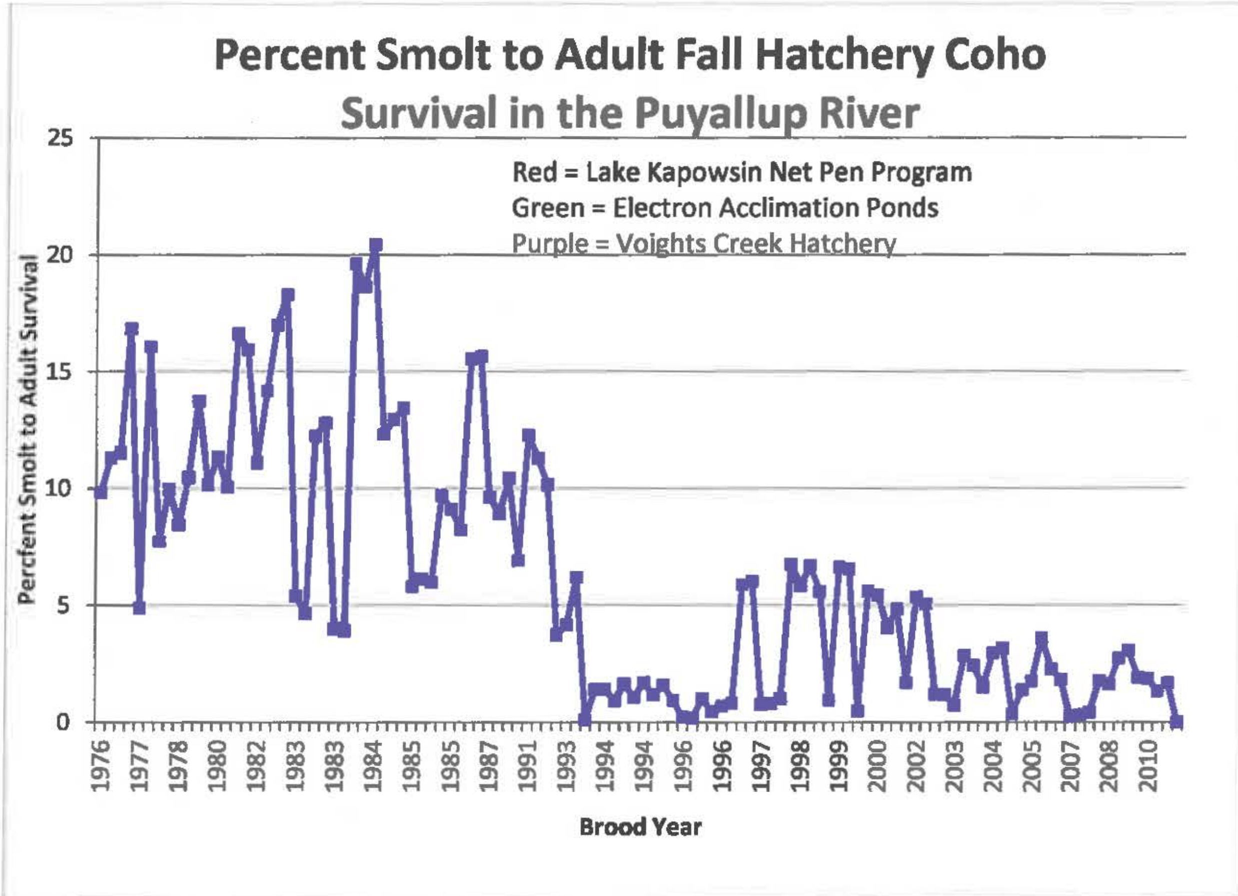
The specific causes of poor survival are unknown but habitat conditions , whether freshwater, marine or both are certainly the culprit. Coho survival rates for Puget Sound hatchery stocks in particular have plummeted from what they were in the 80's and 90's. Summer rearing flows are one of the key habitat variables affecting freshwater survival of coho and extreme summer water temperatures observed in the summer of 2015 will undoubtedly impact 2016 adult returns. The Voight Creek Hatchery lost 600,000 coho yearlings at the new Orting facility last June and July due to record warm water temperatures in Voight Creek which supplies up to 20-cfs flow for incubation and rearing.

The extreme El Nino event of 2015-16 will greatly affect marine survival rates of coho returning in both 2016 and 2017. Another coho forecasting tool is the Puget Sound Summer Low Flow Index (PSSLFI) that is a composite of eight Puget Sound stream gages and used for Sound wide forecasting models and utilizes the close correlation between summer low flows and freshwater survival.

	Escapement estimates			
	Buckley trap Counts	Nat spawners	**Total Nat Esc + Buckley**	Voight Creek Hatchery
1973				3,785
1974	1,081	5,271	**6,352**	20,542
1975	546	1,331	**1,877**	9,873
1976	833	5,769	**6,602**	19,883
1977	1,080	9,014	**10,094**	24,819
1978	487	2,562	**3,049**	10,663
1979	313	6,131	**6,444**	7,969
1980	335	6,134	**6,469**	24,236
1981	1,237	3,800	**5,037**	17,151
1982	525	1,818	**2,343**	9,228
1983	406	3,691	**4,097**	14,608
1984	402	3,197	**3,599**	15,983
1985	1,363	1,331	**2,694**	3,646
1986	617	1,101	**1,718**	13,816
1987	1,940	4,454	**6,394**	12,928
1988	3,211	969	**4,180**	5,117
1989	833	480	**1,313**	20,833
1990	5,804	770	**6,574**	15,241
1991	4,591	952	**5,543**	14,955
1992	1,264	636	**1,900**	52,465
1993	1,387	1,221	**2,608**	38,095
1994	6,513	2,897	**9,410**	53,149
1995	2,733	1,967	**4,700**	41,198
1996	962	5,694	**6,656**	50,649
1997	7,988	6,068	**14,056**	18,452
1998	1,789	3,627	**5,416**	7,597
1999	1,002	2,020	**3,022**	9,005
2000	21,345	2,899	**24,244**	39,394
2001	6,022	5,510	**11,532**	34,298
2002	6,370	1,609	**7,979**	43,099
2003	16,476	2,237	**18,713**	35,253
2004	14,341	4,657	**18,998**	15,004
2005	13,894	4,147	**18,041**	22,443
2006	8,366	3,467	**11,833**	2,023
2007	12,719	3,330	**16,049**	6,878
2008	7,482	2,350	**9,832**	2,769
2009	9,801	3,986	**13,787**	5,736
2010	4,556	758	**5,314**	2,329
2011	23,770	2,466	**26,236**	4,883
2012	23,795	3,712	**27,507**	3,540
2013	5,854	3,056	**8,910**	3,785
2014	9,493	505	**9,998**	4,406
2015	9,593	353	**9,946**	6,217

Puyallup River Coho Forecasts

YEAR	WILD	HATCHERY	TOTAL
2001	5,200	51,587	56,787
2002	6,880	58,233	65,113
2003	36,100	87,639	123,739
2004	13,900	54,932	68,832
2005	13,900	55,754	69,654
2006	5,400	56,420	61,820
2007	2,100	36,918	39,018
2008	3,300	33,561	36,861
2009	13,600	31,729	45,329
2010	3,200	7,897	11,097
2011	37,770	17,271	55,041
2012	8,600	23,165	31,765
2013	12,041	26,668	38,709
2014	23,600	14,712	38,312
2015	21,385	18,949	40,334
2016	1,576	7,606	9,182



Please note in the graph above, the 2012 survival rate is erroneously depicted. The data for 2012 brood year fish have not yet been collected as this cohort returned just last fall. The trend and its cause(s) are clearly the problem but an explanation for the observations remains a mystery. The x-axis brood years that appear twice e.g. 1994, denote two different CWT tag groups of fish released for those years. Puget Sound coho production from hatcheries used to average 10-12% but is presently around 3% or less over the last decade.

The link below focuses on marine oceanographic findings and coho survival that may also be of interest.

http://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/g-forecast.cfm

Commenter ID: 40

Commenter Name: Rusty Nelson

Commenter Association: Spokane Veterans for Peace

Comment received via online comment form

Comment:

This rule seems designed to benefit those who pollute the river, certainly not to benefit the river or those of us who love it. You can do a lot better.

WASHINGTON ENVIRONMENTAL COUNCIL

wecprotects.org
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April 22, 2015

Kelly Susewind
Special Assistant to the Director
Department of Ecology
300 Desmond Drive SE
Lacey, WA 98503

Dear Mr. Susewind,

Thank you for the opportunity to comment on the draft rule for Human Health Criteria and Implementation Tools for Surface Water Quality Standards. Washington Environmental Council (WEC) is a nonprofit organization that advocates for positive environmental change. A core area of our work is reducing water pollution that threatens the health of the public and our environment.

First, we want to acknowledge the hard work done by Department of Ecology (Ecology) staff over the many years to get to this point. Establishing water quality standards is one of the most complex, technical, and difficult issues our state faces. Washington urgently needs water quality standards that meet the requirements of the Clean Water Act and protect human health and the environment.

When Ecology submitted comments to EPA's draft rule in late 2015, Ecology expressed concern with aspects of the EPA rule because it did not accurately reflect the risks to the health of Washington residents from toxic and harmful water pollution. In fact, Ecology pointed out that EPA used fish consumption surveys and data that did not reflect the populations in Washington that are most at risk, which include tribes, Asian Pacific Islanders, and immigrant communities that rely on fish as an important component of their diet and for cultural reasons.[1]

WEC also believes that developing standards and utilizing credible data to protect individuals who are most impacted by pollution is essential to any final rule. We also believe that environmental justice perspectives must be infused into the process and application of implementation tools to avoid untenable human health impacts.

For these reasons, we submit the following comments on the draft rule:

1. Water Quality Standards and Human Health Criteria:

[1] *See* http://www.ecy.wa.gov/programs/wq/swqs/EPALetterWQCriteria12212015.pdf

[2] *See* https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OW-2015-0174-0001 " Once finalized, Washington will have considerable discretion to implement these revised federal human health criteria through various water quality control programs including the NPDES program,

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WEC supports the rule's inclusion of a 175 g/day and a one in one million (10-6) cancer risk rate for many chemicals subject to regulatory oversight. However, we are concerned about the draft rule's approach to not impose this stringent standard for some of the most important pollutants that impact human health today: mercury, arsenic, and polychlorinated biphenyls (PCBs). A number of tribes have significant expertise and data on what this regulatory approach means for their communities, and WEC supports the comments provided by experts such as the NW Indian Fisheries Commission on this issue.

WEC also recognizes that removing PCBs, mercury, and arsenic can by uniquely challenging. For example, despite an EPA ban on manufacturing PCBs in the late 1970s, the chemical continues to pollute more than a dozen Washington waterbodies, including the Spokane River, Duwamish River, Lake Whatcom, Wenatchee River, and Puget Sound. We are concerned that the current draft rule does not set the state on a course to reduce the number of PCB polluted waters as soon as possible. Although it is true that removing PCBs from entering our waters will require a wider range of strategies, one important step is to have strong limits in water quality standards and narrow and appropriate application of implementation tools on a case-by-case basis to provide flexibility only where meeting water quality standards is not feasible.

2. Implementation Tools

Effective implementation and enforcement of strong water quality standards is critical to adequately protect human health and the environment. The draft rule makes changes to existing implementation tools, namely variances, compliance schedules, and adds intake credits to the WAC.

In terms variances, WEC understands the changes in the draft rule are intended to provide more clarity and details when a variance may be considered, requirements for an applicant requesting a variance, the process for reviewing and deciding on a variance application, and an interim review process to determine if a variance should be terminated or continue. Adding these details to the rule may help permittees and the agency in understanding the regulatory framework for a variance, and requiring a variance to go through a public rulemaking process may help with transparency in decisionmaking. But these steps alone are not sufficient to protect public health. To better understand how the details in the draft rule will be applied in practice, it would be helpful to include language explicitly identifying when a variance may not be considered or pursued.

Similarly, understanding when compliance schedules do not apply would help in understanding the limitations to how this unique implementation tools should be used. The language and four part test for determining when a compliance schedule can be extended beyond ten years is also vague and broad. As referenced in the accompanying documents to the draft rule, the four-part test was the result of legislation. However, the WAC language should provide direction on the scope of these tools to avoid permittees or future Ecology decisionmakers from taking advantage

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of the rule by interpreting it too broadly to meet the foundational water quality objectives in the Clean Water Act.

WEC is concerned about how the intake credits in the draft rule will be applied and what safeguards exist for disproportionately impacted communities. WEC believes it is important to push dischargers to reduce pollution, especially in areas with toxic "hot spots" affecting surface waters where people live, recreate, swim, and fish. We are concerned that the intake credit provision in the rule may be used to allow areas of high pollution concentrations to be maintained and compliance obligations on dischargers to be unfairly weakened based on the "no net addition" standard in the rule. We recommend this provision be removed with a process for discussing if it is necessary given the other implementation tools available to the agency to provide flexibility.

Finally, we imagine that the implementation process will be significant for Ecology regardless of whether the state agency adopts a final water quality standard for surface water or if EPA moves forward and adopts their proposed rule. EPA has clearly stated that under their draft rule, the federal agency expects Ecology to retain and utilize existing authority and discretion to implement the adopted standards under the requirements of 40 CFR 131.14.[2] Therefore, WEC believes it is essential for Ecology to follow a transparent, robust, and inclusive process to develop standards for implementing the standards to maximize water quality and human health benefits and improvements over time. More research and public education is needed on how other states, like Oregon, are implementing their water quality standards and the lessons that can inform Washington moving forward.

Once again, thank you for the opportunity to provide comments on the draft rule. Please don't hesitate to contact Darcy Nonemacher (darcy@wecprotects.org) in our office with any questions. WEC is committed to working with Ecology, EPA, tribes, environmental and community organizations, businesses, and the public to move the state forward in reducing harmful pollution to our residents, aquatic species, and the environment.

Sincerely,

Darcy Nonemacher
Washington Environmental Council

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[2] *See* https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OW-2015-0174-0001 " Once finalized, Washington will have considerable discretion to implement these revised federal human health criteria through various water quality control programs including the NPDES program, which limits discharges to water except in compliance with a NPDES permit."

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Protecting, restoring, and sustaining Washington's environment.

Comments to Washington Department of Ecology
Proposed Revisions to Water Quality Standards for the State of Washington
Chapter 173-201A WAC
April 22, 2016

Please accept these comments regarding the Department of Ecology's (Ecology) second set of proposed revisions to the Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC [hereinafter Ecology's proposed WQS]. These comments reflect the views of the author. Although they raise concerns about the impacts of Washington's proposed WQS on American Indian tribes, they do not purport to represent the perspective of any tribe; those perspectives must be obtained directly from each tribe. Indeed, the author wishes to underscore the importance of consultation with the individual tribal nations affected, within the context of a government-to-government relationship, as committed to under the terms of the *Centennial Accord between the Federally Recognized Indian Tribes in Washington State and the State of Washington*.[1] Additionally, the author supports the comments submitted to Ecology's rulemaking docket by the Northwest Indian Fisheries Commission [hereinafter NWIFC Comments],[2] and hereby incorporates these comments by reference.

I. Introduction

Water quality standards (WQS) for Washington[3] impact the rights, resources, and health and well-being of numerous tribes in the region. In fact, when the waters that support fish are allowed to be contaminated, tribes' interests are profoundly affected and tribal people disproportionately among the

[1] WASHINGTON GOVERNOR'S OFFICE OF INDIAN AFFAIRS, CENTENNIAL ACCORD BETWEEN THE FEDERALLY RECOGNIZED INDIAN TRIBES IN WASHINGTON STATE AND THE STATE OF WASHINGTON (1989), *available at* http://www.goia.wa.gov/Government-to-Government/Data/CentennialAccord.htm.
[2] Northwest Indian Fisheries Commission, Comments on the State's Proposed 2016 Rule for Human Health Criteria and Implementation Tools in WA State Water Quality Standards (April, 2016)[hereinafter NWIFC Comments].
[3] In using this term throughout these comments, I mean to exclude waters within Indian Country, and support EPA's similar understanding when it clarifies that "[t]his proposed rule would apply to waters under the state of Washington's jurisdiction, and not to waters within Indian Country, unless otherwise specified in federal law. Some waters located within Indian Country already have CWA-effective human health criteria, while others do not. Several tribes are working with EPA to either revise their existing CWA-effective WQS, or obtain treatment in a similar manner as a state (TAS) status in order to adopt their own WQS in the near future." U.S. Environmental Protection Agency, Revision of Certain Water Quality Criteria Applicable to the State of Washington, 80 Fed. Reg. 55063, 55067 (Sept. 14, 2015).

most exposed. This context is significant, because it constrains rulemaking in important ways. Among other things, the adequacy of WQS for Washington must be considered in view of legal protections for tribes' fishing rights, including treaties and other instruments.

Under the Clean Water Act (CWA), water quality standards are health-based standards. The touchstone for agencies' efforts is human health. Fish are the primary route of human exposure to PCBs, mercury, dioxins, and a host of toxic chemicals that are harmful to human health. Health-based water quality standards are set to ensure that humans can safely consume fish, without also being exposed to contaminants in harmful amounts. Pursuant to U.S. Environmental Protection Agency (EPA) guidance, agencies enlist quantitative risk assessment methods to set standards for both threshold and non-threshold contaminants. For threshold contaminants, standards are set so that contaminants don't exceed levels that are safe for humans. For non-threshold contaminants, including carcinogens, exposure to any non-zero amount has the potential to cause cancer; standards are set so that contaminants don't exceed a risk level determined to be "acceptable." In either case, agencies then work with a risk assessment equation to "solve" for the concentration of each chemical that will be permitted in the waters that support fish. Agency risk assessors consider the toxicity of each contaminant together with human characteristics and practices that expose people to the contaminant in their environment: how much fish will people eat, over how long a period, at what bodyweight?

The fish consumption rate (FCR) is a key variable in this equation. The FCR currently assumed by the state of Washington is 6.5 grams/day – just one fish meal per month. This estimate of fish intake is drawn from a survey of the general population in the United States conducted in 1973-74. Thus the data on which Washington's current human health criteria are based are over *forty years old* – they were gathered back when the rivers were on fire; lakes and bays were treated as sewers; and tribal harvest was still under open attack. Importantly, this 6.5 grams/day rate functions as a *de facto* ceiling on safe consumption for so long as it serves as the premise for state WQS. Because Washington's waters are only required to be clean enough to support this rate of fish intake, anyone who eats or would eat more fish than this is left to do so at his or her peril.

A FCR of 6.5 grams/day grossly underestimates what people in the fishing tribes in fact consume today, let alone what tribal members would consume were consumption not "suppressed" (a term discussed further below). Recognizing this significant inadequacy, the tribes in the Pacific Northwest took the lead in efforts to document tribal people's fish intake rates.[4] Beginning in 1994 with a groundbreaking survey by the Columbia River Inter-Tribal Fish Commission (CRITFC), data were published quantifying contemporary fish intake by people in the four CRITFC member tribes.[5] In 1996, the Squaxin Island Tribe and the Tulalip Tribes published a similar survey of their members' fish consumption practices. Other tribes and groups soon followed suit. These surveys documented contemporary consumption rates

[4] *See, infra*, Part IV.A.1.

[5] CRITFC's four member tribes are the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation, and the Confederated Tribes and Bands of the Yakama Nation.

several orders of magnitude greater than the 6.5 grams/day currently assumed by Washington, particularly for those at the upper percentiles of the tribal populations.

It has now been over twenty-one years since the CRITFC study was published and the state of Washington has had quantified evidence of tribes' higher fish consumption rates. *A generation of Indian people has been born and come of age during this time.* They have grown up seeing signs along the waterways warning against consuming fish, encountering notices at tribal fisheries departments of toxic shellfish, and clicking on websites containing instructions for trimming the fat and discarding the skin so as to avoid the lipophilic toxics harbored there.[6] With ample local data in hand, Washington has nonetheless declined to revise its WQS throughout this time.

Yet the CWA envisions frequent updates to state water quality standards, directing states at least every three years to review and, as appropriate, revise their water quality standards.[7] Importantly, the CWA sets forth the touchstone for state efforts to this end: "[s]uch standards shall be such as to protect the public health or welfare, enhance the quality of water and serve the purposes of this chapter."[8] Among those purposes, the CWA sets forth a national goal of "water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water."[9] The EPA has interpreted this goal of "fishable" uses to "include, at a minimum, designated uses providing for the protection of aquatic communities and human health related to consumption of fish and shellfish."[10] The CWA gives EPA broad authority to oversee state efforts to this end, among other things, directing EPA promptly to issue WQS itself "in any case where the Administrator determines that a revised or new standard is necessary to meet the requirements of this chapter."[11] Indeed, Congress' impatience with the slow pace of states' work to control toxic contamination is well documented during the debate surrounding the 1987 amendments to the CWA; the resulting provisions for regular revisions to state WQS reflect this concern.[12] Flouting Congress' directive, Washington has simply refused to update its WQS.

[6] *See, e.g.,* Washington Dept. of Health, *Fish Consumption Advisories*, http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories.
[7] Federal Water Pollution Control Act (Clean Water Act), 33 U.S.C. § 1313(c)(1) (2012). As recognized, *supra* note 2, the CWA authorizes both states and tribes to administer WQS for waters under their respective jurisdictions. However, because these comments address a state's (Washington's) failure to update its WQS and EPA's proposal to issue human health criteria for that state, they will refer throughout to the duties of "states" under the CWA.
[8] 33 U.S.C. § 1313(c)(2).
[9] 33 U.S.C. § 1251(a)(2).
[10] 80 Fed. Reg. at 55064; 40 C.F.R. § 131.2, § 131.4 (unless a state or tribe demonstrates that this use is not attainable, by means of a "use attainability analysis" pursuant to 40 C.F.R. § 131.10(j)).
[11] 33 U.S.C. § 1313(c)(4).
[12] Congress' distaste for delay on the part of the states was made known during debate surrounding the 1987 amendments. *See, e.g.,* U.S. Environmental Protection Agency, Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance; Final Rule, 57 Fed. Reg. 60,848, 60.849 (Dec. 22, 1992) [hereinafter EPA, National Toxics Rule] ("The critical importance of controlling toxic pollutants has been recognized by Congress and is reflected, in part, by the addition of section 303(c)(2)(B) to the Act. Congressional impatience with the pace of State toxics control programs is well documented in the legislative history of the 1987 amendments.").

Washington's recalcitrance is deeply troubling in view of the impact on the fishing tribes. Fish and all of the lifeways associated with the fish are essential to tribal health and well-being, today as in the past.[13] This fact has also been recognized by U.S. courts, which have observed that, at treaty times, "fish was the great staple of [Indians'] diet and livelihood,"[14] and thus fishing rights "were not much less necessary to the existence of the Indians than the atmosphere they breathed."[15] Fish are vital to tribal people for the nutrients they provide, of course, but fish consumption is also imbued with social meaning. Every facet of managing, harvesting, distributing, and honoring the fish is woven into the fabric of tribal life. These practices and the knowledge they beget form a central part of the inheritance of each succeeding generation. Fish are important for each individual tribal member, and for the tribe as a whole – necessary for health and well-being broadly understood to include not only physiological, but also cultural and spiritual dimensions.[16]

After years of "process" that has involved multiple changes of course, "pivots," proposals and withdrawals, Ecology's abject failure to update its WQS prompted EPA to step in. Exercising its authority under the CWA, EPA proposed WQS for Washington on September 14, 2015 [hereinafter EPA's proposed WQS];[17] these standards await finalization. Ecology has now offered a second version of its proposed rule.

While Ecology's proposed WQS include an improved FCR and reinstate a more appropriate general cancer risk level, its proposal promptly undercuts these gains by several devices. Ecology selectively embraces new science and local data when to do so suits the end of rendering the standards less protective, but ignores it otherwise. Remarkably, Ecology proposes to make no progress for two of the contaminants of greatest concern – methylmercury and PCBs – and actually to *regress* (i.e., set standards that are more lenient) for two other of the contaminants of greatest concern – dioxins and arsenic. The fish consumption advisories that currently blanket the state's waters are due in large part to methylmercury and PCBs.

So, while the *apparent* fish consumption rate for Ecology's second proposed WQS is 175 grams/day at 1 in 1 million (1×10^{-6}) excess cancer risk (for carcinogens) and at safe thresholds (for non-carcinogens),

[13] The Swinomish Tribe, for example, explains: "We are the People of the Salmon and our way of life is sustained by our connection to the water and to the lands where we have fished, gathered and hunted since time immemorial." Swinomish Indian Tribal Community, "We are …," http://www.swinomish-nsn.gov/. As *Tsi'li'xw* Bill James, Lummi Nation Hereditary Chief, explains, "seafood is the lifeline of our people. Everything under the water, our people ate during different times of the year." LUMMI NATION SEAFOOD CONSUMPTION STUDY, LUMMI NATURAL RESOURCES DEPARTMENT, LUMMI NATION SEAFOOD CONSUMPTION STUDY 1 (2012) [hereinafter LUMMI NATION SEAFOOD CONSUMPTION STUDY]. *See also*, David Close, Northwest Indian Fisheries Commission News Release (Apr. 27, 2010) (speaking at the Coast Salish Gathering, David Close (Cayuse) explains "we made a promise – the food would take care of us and we would take care of the food").
[14] Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n, 443 U.S. 658, 665 n.6 (1979) (citations and internal quotation marks omitted).
[15] United States v. Winans, 198 U.S. 371, 381 (1905).
[16] *See, e.g.,* Jamie Donatuto et al., *Poisoning the Body to Nourish the Soul: Prioritizing Health Risks and Impacts in a Native American Community.* 13 HEALTH, RISK, AND SOCIETY 103 (2011).
[17] 80 Fed. Reg. 55063.

the *actual* fish consumption rate protected by Ecology's second proposed rule is much lower if – as is most often the case in the real world – one of these four toxic substances contaminates the relevant waters. Where PCB or methylmercury contamination is a concern, people will still only be able to eat fish at a rate of 6.5 grams/day (one fish meal per month) if they are not to exceed a 1 in 1 million excess cancer risk or not to exceed levels deemed safe, respectively. For both of these toxic substances, EPA's proposed WQS set forth standards that are markedly more protective than those proposed by Ecology. Where dioxins are a concern, people are placed in even worse straits: Ecology proposes to reclassify these toxic substances as non-carcinogens, thereby justifying much more lenient standards than would be required were they treated as carcinogens. Yet dioxins are recognized by the Agency for Toxic Substances & Disease Registry as among a handful of hazardous substances "known to be a human carcinogen,"[18] and EPA has long treated members of this chemical family as among the most potent carcinogens (as reflected, e.g., in its chemical slope factor (CSF) for 2,3,7,8 TCDD indicating orders of magnitude greater potency than other carcinogens). While EPA is in the process of revisiting the precise figure for this CSF, it has nonetheless recognized the ongoing need to recognize the considerably potency of this human carcinogen and EPA's proposed WQS for Washington reflect this recognition. Ecology, by contrast, has seized upon EPA's ongoing evaluation of the CSF as justification for ignoring dioxins cancer-causing effects altogether. Rather, by treating dioxins as a non-carcinogen, Ecology is able to propose standards that are *two orders of magnitude* less protective than EPA's proposed WQS – and, indeed, less protective than even the current, woefully underprotective Washington WQS. As for arsenic, Ecology similarly seeks to justify its more lenient standards; in this case, Ecology borrows a standard from an entirely different statute (the Safe Drinking Water Act), one that allows human health concerns to be "balanced" against competing considerations, such as feasibility and cost. Under the CWA, however, WQS are health-based standards.

Despite its efforts to fashion standards that do little or nothing (or worse) to enhance the quality of the state's waters or to ensure that fish are fit for human consumption, Ecology additionally proposes several additional mechanisms, termed "implementation tools," that enable delayed compliance with the standards – perhaps for years.

Part II of these comments discusses tribes' unique rights to harvest and consume fish – rights that are protected by treaties and other sources of law.[19] Part III evaluates the various aspects of Ecology's proposed rule in light of this legal landscape. Part IV then offers comments on the particular inputs to Ecology's derivation of human health criteria for Washington. Part V takes up what Ecology terms the "challenging chemicals," i.e., methylmercury, PCBs, dioxins, and arsenic. Finally, Part VI discusses Ecology's proposed "implementation tools."

[18] Agency for Toxics Substances & Disease Registry, Toxic Substances Portal, NTP: Known to Be a Human Carcinogen http://www.atsdr.cdc.gov/substances/toxorganlisting.asp?sysid=23 (including "chlorinated dibenzo-p-dioxins (CDDs)" among a roster of eighteen known human carcinogens).
[19] The discussion in Part II and elsewhere draws from Catherine A. O'Neill, *Fishable Waters*, 1 AMERICAN INDIAN L. J. 181 (2013), http://www.law.seattleu.edu/Documents/ailj/Spring%202013/O'Neill-Fishable%20Waters.pdf. [hereinafter O'Neill, *Fishable Waters*].

II. The Tribes' Unique Political and Legal Status and Rights to Fish

Tribes comprise distinct *peoples* with inherent rights. Tribes' status as self-governing, sovereign entities pre-dated contact with European settlers. This status, nonetheless, was affirmed by the nascent United States. Among other things, the U.S. viewed the Indian tribes as sovereigns, capable of entering into treaties.[20] Today, tribes are recognized to have a unique political and legal status – a status that sets them apart from every other population or group that might warrant particular consideration in decisions about environmental standards.[21] Tribes' rights and interests, moreover, are protected by a constellation of laws and commitments that are unique among groups affected by federal, state, and other decisions. These include protections secured by treaties, laws, and executive orders that speak to the rights of tribes and their members.

The starting place for an analysis of tribal fishing rights is a recognition that, prior to European contact, fishing, hunting, and gathering were vital to the lives of Indian people. Indians' aboriginal title to this land included the right to engage in these practices.[22] When tribes entered into treaties and agreements ceding lands to the United States, they often nonetheless reserved a suite of important rights, including their aboriginal fishing rights.

The Treaty of Point Elliott provides that "[t]he right of taking fish at usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the Territory...."[23] Although the precise language of the fishing clause varies somewhat in the different treaties with the tribes of the Pacific Northwest, U.S. courts have interpreted these provisions similarly to secure to the tribes a permanent, enforceable right to take fish throughout their fishing areas for ceremonial, subsistence and commercial purposes.[24] For its part, upon entering into treaties and agreements with the various tribes, the U.S. bound itself and its successors to protect the tribes' right to take fish in perpetuity. The treaties, moreover, have the status under the Constitution of "supreme law of the land."[25]

[20] Worcester v. Georgia, 31 U.S. (6 Pet.) 515 (1832).
[21] *See, e.g.,* United States v. Mazurie, 419 U.S. 544, 557 (1977) (rejecting lower court's characterization of tribe as mere association of U.S. citizens and finding, instead, that "Indian tribes are unique aggregations possessing attributes of sovereignty over both their members and their territory …"); *see also* Williams v. Lee, 358 U.S. 217 (1959); Morton v. Mancari 417 U.S. 535 (1974).
[22] FELIX COHEN, HANDBOOK OF FEDERAL INDIAN LAW 1154-56 (2012 ed.).
[23] Treaty with the Duwamish, Jan. 22, 1855, U.S.-Duwamish, art. V, 12 Stat. 927 (1859).
[24] *See, e.g.,* Confederated Tribes of the Umatilla Indian Reservation v. Alexander, 440 F. Supp. 553 (D. Or. 1977) (finding that a proposed dam on Catherine Creek would infringe rights guaranteed to the Umatilla tribe by the Treaty with the Walla Walla and stating "[f]urther, while the 1855 treaty spoke only of 'stations,', it is clear that the government and the Indians intended that all Northwest tribes should reserve the same fishing rights. 'It is designed to make the same provision for all the tribes and for each Indian of every tribe. The people of one tribe are as much the people of the Great Father as the people of another tribe; the red men are as much his children as the white men.'" (quoting Governor Stevens)).
[25] *Worcester*, 31 U.S. (6 Pet.) at 519 (1832) ("The constitution [declares] treaties already made, as well as those to be made, the supreme law of the land . . .").

Importantly, all of the rights not expressly relinquished by the tribes were retained. This is a crucial tenet of federal Indian law.[26] As affirmed by the U.S. Supreme Court, the treaties represent "not a grant of rights to the Indians, but a grant of rights *from* them – a reservation of those not granted."[27] Treaty-reserved fishing rights are akin to pre-existing servitudes that burden and "run with" off-reservation lands.[28] The Court has held, for example, that implicit within the treaties' specific reservation of the right to "take fish" are rights of access, including over state or privately owned land.[29] "This principle ensures that reserved treaty rights are not rendered a nullity by shifting patterns of property ownership and development."[30]

Additionally, under federal Indian law, unique canons guide courts' construction of the treaty language.[31] According to the canons, treaties should be construed liberally in favor of Indian tribes; they should be construed as the Indians would have understood them; and any ambiguities should be resolved in the tribes' favor.[32]

The historical record, from both sides, is very clear on the point that protections for the Pacific Northwest tribes' pre-existing fishing rights were crucial to obtaining tribes' assent to the treaties. U.S. courts have recognized this understanding on the part of the treaty negotiators:

> It is perfectly clear … that the Indians were vitally interested in protecting their right to take fish at usual and accustomed places, whether on or off the reservations, and that they were invited by the white negotiators to rely and did in fact rely heavily on the good faith of the United States to protect that right.[33]

Accordingly, for more than a century, the courts have regularly interpreted the fishing right to encompass not only the right to harvest but also the subsidiary rights necessary to render it of continued relevance for tribal fishers. Among the facets of the treaty guarantees affirmed by the courts are the points that: (1) "The treaty clauses regarding off-reservation fishing . . . secured to the Indians

[26] COHEN, *supra* note 22, at 1156-57.
[27] United States v. Winans, 198 U.S. 371, 381 (1905) (emphasis added).
[28] *Id.* (stating "[t]hey imposed a servitude upon every piece of land as though described therein").
[29] *Id.* (observing that "[n]o other conclusion would give effect to the treaty").
[30] COHEN, *supra* note 22, at 1174; *accord* Grand Traverse Bay of Ottawa & Chippewa Indians v. Dir., Michigan Dept. of Natural Resources, 141 F.3d 635, 641 (6th Cir. 1998) (finding that tribe's reserved fishing rights in Lake Michigan entitled the tribe to mooring access at two municipally owned marinas, given the necessity of using large boats for safety reasons and the fact that the marinas occupied the only harbors within reasonable distance of the reserved fishing locations).
[31] COHEN, *supra* note 22, at 113-19, 1156. ("The canons have quasi-constitutional status; they provide an interpretive methodology for protecting fundamental constitutive, structural values against all but explicit congressional derogation."); *id.* at 118-19.
[32] *See, e.g.,* Minnesota v. Mille Lacs Band of Chippewa Indians, 526 U.S. 172, 194, 196, 200 (1999).
[33] Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n, 443 U.S. 658, 667 (1979) (holding that the treaty fishing clause guarantees to the tribes not merely access to usual and accustomed fishing sites and an "equal opportunity" for Indians, along with non-Indians, to try to catch fish, but instead secures to the tribes a right to harvest a share of each run of anadromous fish that passes through tribal fishing areas).

rights, privileges and immunities distinct from those of other citizens."[34] (2) The rights secured to tribes by treaty are permanent, such that "[t]he passage of time and the changed conditions affecting the water courses and the fishery resources in the case area have not eroded and cannot erode the right secured by the treaties . . ."[35] (3) "[N]either the treaty Indians nor the state . . . may permit the subject matter of these treaties [i.e. the fisheries] to be destroyed."[36] (4) The treaty fishing rights encompass the right to fish in all areas traditionally available to the tribes, and "[agencies] ... do not have the ability to qualify or limit the Tribes' geographical treaty fishing right (or to allow this to occur ...) by eliminating a portion of an Indian fishing ground …," except as necessary to conserve a species.[37] (5) The treaty fishing rights encompass all available species of fish found in the treating tribes' fishing areas, "[b]ecause the 'right of taking fish' must be read as a reservation of the Indians' pre-existing rights, and because the right to take *any* species, without limit, pre-existed the Stevens Treaties."[38] These features of tribes' rights are important in part because they continue to inform tribes' aspirations for and entitlements to a future in which their exercise of their rights is robust, and tribal members' consumption and use of the resources on which they have historically depended is restored.

The U.S. courts' most recent affirmation of the treaty guarantees is of a piece with these previous cases. In what is known colloquially as the "Culverts" case,[39] the court addressed a threat to the tribes' treaty rights posed by environmental degradation. The Culverts case is an outgrowth of *United States v. Washington*, in which Judge Boldt divided the questions before the court into two "phases." In Phase II, the district court considered "whether the right of taking fish incorporates the right to have treaty fish protected from environmental degradation." [40] The court in 1980 held that "implicitly incorporated in the treaties' fishing clause is the right to have the fishery habitat protected from man-made despoliation….The most fundamental prerequisite to exercising the right to fish is the existence of fish to be taken."[41] On appeal, the district court's opinion was vacated on jurisprudential grounds.[42] The Ninth

[34] United States v. Washington, 384 F. Supp. 312, 401 (W.D. Wash. 1974).
[35] *Id.*
[36] United States v. Washington, 520 F.2d 676, 685 (9th Cir. 1975).
[37] *See, e.g.,* Muckleshoot v. Hall, 698 F. Supp. 1504, 1513-14 (W.D. Wash. 1988) (enjoining construction of a marina in Elliott Bay that would have eliminated a portion of the tribes' usual and accustomed fishing areas); *see also* United States v. Oregon, 718 F.2d 299, 305 (9th Cir. 1983) (holding that "the court must accord primacy to the geographical aspect of the treaty rights").
[38] United States v. Washington, 873 F. Supp. 1422, 1430 (W.D. Wash. 1994) (emphasis in original).
[39] Culverts Order, 2007 WL 2437166 (W.D. Wash.); Culverts Decision, No. 9213RSM, Subproceeding 01-1, slip op. (W.D. Wash. 2013).
[40] United States v. Washington, 506 F. Supp. 187, 190 (W.D. Wash. 1980) (Phase II) *vacated by* United States v. Washington, 759 F.2d 1353 (9th Cir. 1985).
[41] United States v. Washington, 506 F. Supp. at 203.
[42] The procedural history of Phase II is discussed at greater length by Judge Martinez in the Culverts Order. *See* Culverts Order, 2007 WL 2437166, at *4-*5. Notably, although the State had argued that the Ninth Circuit's vacatur ought to be understood broadly, as a rejection of the tribes' position, the court disagreed. "The [appellate] court's order did not contain broad and conclusive language necessary to reject the idea of a treaty-based duty in theory as well as in practice. … [its] ruling, then, cannot be read as rejecting the concept of a treaty-based duty to avoid specific actions which impair salmon runs. The court did not find fault with the district court's analysis on treaty-based obligations, but rather vacated the declaratory judgment as too broad, and lacking a factual basis at that time. The court's language, however, clearly presumes some obligation on the part of the State …" *Id*.

Circuit found its “general admonition” inappropriate as a matter of “judicial discretion” and stated that the duties under the treaties in this respect “will depend for their definition and articulation upon concrete facts which underlie a dispute in a particular case.”[43] So, in the Culverts subproceeding, filed in 2001, the tribes brought to the court’s attention such a set of concrete facts. Specifically, the tribes cited evidence that the state of Washington had improperly maintained culverts around the state, with the result that miles of salmon habitat were blocked, contributing to a decline in salmon numbers and thus an erosion of tribes’ ability to exercise their treaty-guaranteed right to take fish. Thus, the district court in the Culverts case considered the question “whether the Tribes’ treaty-based right of taking fish imposes upon the State a duty to refrain from diminishing fish runs by constructing or maintaining culverts that block fish passage.”[44]

In 2007, the district court ruled in favor of the tribes’ request for a declaratory judgment to this effect on cross-motions for summary judgment. In finding that the state indeed had the duty urged by the tribes, Judge Martinez considered carefully the intent of the parties to the treaties, in accordance with “well-established principles of treaty construction,” citing U.S. Supreme Court precedent for the instruction that “the treaty must therefore be construed, not according to the technical meaning of its words to learned lawyers, but in the sense in which they would naturally be understood by the Indians.”[45] Judge Martinez began his analysis by quoting the Court’s earlier work in the *U.S. v. Washington* line of decisions, but highlighted language underscoring that among the points of “taking” fish was, ultimately and obviously, eating fish.

> Governor Stevens and his associates were well aware of the “sense” in which the Indians were likely to view assurances regarding their fishing rights. During the negotiations, the vital importance of the fish to the Indians was repeatedly emphasized by both sides, and *the Governor’s promises that the treaties would protect that source of food and commerce were crucial in obtaining the Indians’ assent.* It is absolutely clear, as Governor Stevens himself said, that neither he nor the Indians intended that the latter “should be excluded from their ancient fisheries,” and it is accordingly inconceivable that either party deliberately agreed to authorize future settlers to crowd the Indians out of any meaningful use of their accustomed places to fish.[46]

Notably, Judge Martinez added the emphasis indicated to the Court’s language he quoted.

Judge Martinez then quoted at length from expert testimony that focused explicitly on the role of the fish as food, forever – “for subsistence and for trade” – noting “[t]he significance of [the] right [to take

[43] United States v. Washington, 759 F.2d at 1357.
[44] Culverts Order, 2007 WL 2437166, at *3.
[45] *Id*. at *6 (quoting State of Washington v. Washington State Commercial Passenger Fishing Vessel Association).
[46] *Id*. at *7 (quoting State of Washington v. Washington State Commercial Passenger Fishing Vessel Association, internal citation omitted, emphasis added by Judge Martinez).

fish] to the Tribes, its function as an incentive for the Indians to sign the treaties, and the Tribes' reliance on the unchanging nature of that right."[47] He recited from the declaration of historian Richard White:

> Stevens and the other negotiators anticipated that Indians would continue to fish the inexhaustible stocks in the future, just as they had in the past. Stevens specifically assured the Indians that they would have access to their normal food supplies now and in the future. At the Point Elliot Treaty, Stevens began by speaking of subsistence. "[A]s for food, you yourselves now, as in time past, can take care of yourselves." The question, however, was not whether they could now feed themselves, but rather whether in the future after the huge cessions that the treaties proposed the Indians would still be able to feed themselves. Stevens assured them that he intended that the treaty guarantee them that they could. *"I want that you shall not have simply food and drink now but that you may have them forever."*[48]

Judge Martinez noted the parties' likely understandings, given the reliability of the anadromous fishery resource in particular, the "abundance" of the fisheries in general, and their presumed "future 'inexhaustability.'"[49] These understandings, and Stevens' promises to the end that this would "forever" be the case, were what persuaded the tribes to sign the treaties. As Judge Martinez observed, "[i]t was not deemed necessary to write any protection for the resource into the treaty because nothing in any of the parties' experience gave them reason to believe that would be necessary." He quoted historian Joseph Taylor:

> During 1854-55, white settlement had not yet damaged Puget Sound fisheries. During those years, Indians continued to harvest fish for subsistence and trade as they had in the past. Given the slow pace of white settlement and its limited and localized environmental impact, Indians had no reason to believe during the period of treaty negotiations that white settlers would interfere, either directly through their own harvest or indirectly through their environmental impacts, with Indian fisheries in the future. During treaty negotiations, Indians, like whites, assumed their cherished fisheries would remain robust forever.[50]

Thus, Judge Martinez concluded:

> [T]he representatives of the Tribes were personally assured during the negotiations that they could safely give up vast quantities of land and yet be certain that their right to take fish was secure. These assurances would only be meaningful if they carried the implied promise that neither the negotiators nor their successors would take actions that would significantly degrade the resource.[51]

[47] *Id*. at *7-*8.
[48] *Id*. at *9 (quoting Declaration of historian Richard White, emphasis added by Judge Martinez).
[49] *Id*.
[50] *Id*. (quoting Declaration of historian Joseph E. Taylor, III).
[51] *Id.* at *10. .

Indeed, Judge Martinez observed, environmental degradation would not have been anticipated by the Indians not only because white settlement had not yet occasioned much by way of adverse environmental impacts, but also because the Indians regulated their own activities in order to prevent environmental harm and ensure the health of the fishery resource.[52] Thus, according to Judge Martinez, "[s]uch resource-degrading activities as the building of stream-blocking culverts could not have been anticipated by the Tribes, who themselves had cultural practices that mitigated negative impacts of their fishing on the salmon stocks."[53]

The significance of the Culverts order is widely recognized. While the state, in the wake of the Ninth Circuit's vacatur of the Phase II decision, may have harbored questions about the vibrancy of its treaty-based duty to avoid actions that impair the health of the salmon, the existence of this duty was explicitly confirmed by the Culverts order. This duty, as the court stated, exists "in theory as well as in practice." Although the parties attempted to settle upon a schedule for the state to fix its stream-blocking culverts in view of this duty, they were unsuccessful and a bench trial on the remedies was held in 2010. On March 29, 2013, Judge Martinez granted the tribes' request for a permanent injunction, and denied the state's request for reconsideration of the court's 2007 Culverts order.[54] Judge Martinez incorporated his earlier ruling in its entirety, reiterating that "[t]he Treaties were negotiated and signed by the parties on the understanding and expectation that the salmon runs were inexhaustible and that salmon would remain abundant forever."[55]

The tribes brought their claim to the court in the context of a discrete set of facts and Judge Martinez decided the question in this particularized context, carefully avoiding a broad, acontextual pronouncement.[56] Yet the court's rulings and reasoning in the Culverts case are instructive. Arguably,

[52] *Accord, e.g.,* RONALD L. TROSPER, RESILIENCE, RECIPROCITY AND ECOLOGICAL ECONOMICS: NORTHWEST COAST SUSTAINABILITY (2009); D. Bruce Johnsen, *Salmon, Science, and Reciprocity on the Northwest Coast*, 14 ECOLOGY AND SOCIETY 43 (2009). In the earliest times, when the balance of power still favored Native people, settlers too in some cases had to observe indigenous rules for consumption and resource management. As Joseph Taylor recounts in the context of the Columbia River Basin, "Clatsop and Chinooks delivered canoe loads of fish …but aboriginal rules still shaped the exchange. During ceremonial periods Indians continued to restrict consumption …Non-Indians grudgingly obeyed as long as Indians could force compliance, but repeated epidemics undermined aboriginal control." JOSEPH E. TAYLOR, III, MAKING SALMON: AN ENVIRONMENTAL HISTORY OF THE NORTHWEST FISHERIES CRISIS 60 (1999).
[53] Culverts Order, 2007 WL 2437166, at *10 (citing Declaration of Robert Thomas Boyd).
[54] Culverts Decision, No. 9213RSM, Subproceeding 01-1, slip op. at 32 (W.D. Wash. 2013).
[55] *Id.*
[56] Culverts Order, 2007 WL 2437166, at*10. Thus, Judge Martinez assured the State of Washington that "[t]his is not a broad 'environmental servitude' or the imposition of an affirmative duty to take all possible steps to protect fish runs as the State protests, but rather a narrow directive to refrain from impeding runs in one specific manner." *Id*. Similarly, in the Culverts Decision, Judge Martinez stated that "[t]he State's duty to maintain, repair or replace culverts which block passage of anadromous fish does not arise from a broad environmental servitude against which the Ninth Circuit Court of Appeals cautioned. Instead, it is a narrow and specific treaty-based duty that attaches when the State elects to block rather than bridge a salmon-bearing stream with a roadbed. The roadbed crossing must be fitted with a culvert that allows not only water to flow, but which insures the free passage of salmon of all ages and life stages both upstream and down. That passage is best facilitated by a stream simulation culvert rather than the less-effective hydraulic design or no-slope culvert." Culverts Decision, slip op. at 35. Note,

the Culverts decision can fairly be read to confirm the point that, as successors to the negotiators, federal and state governments[57] may be held to account for the actions they take, or permit others to take, that significantly degrade the treaty resource – given an appropriately concrete factual context. Given the court's concern with the *function* of the treaty resource, moreover – its role in securing food and a livelihood for the tribes – it is logical that governments may be held to account for actions that compromise the treaty resource whether by depletion or by contamination.

It should be noted that the tribes' fishing rights encompass geographical areas throughout the Pacific Northwest. In Washington, for example, tribes' adjudicated usual and accustomed or "U & A" areas have been determined to consist in virtually the entirety of the waters within the state's exterior boundaries.[58] As a consequence, environmental standards applicable in this area – whether set by federal, tribal, or state governments – can affect tribes' rights and interests.

Although the discussion above is focused on tribal fishing rights secured by treaties and the Constitution, it bears noting that tribal fishing rights affected by Washington's WQS may enjoy legal protections under executive order, statute, or other sources of law.

Additionally, when the rights and resources of tribes and their members are affected by state and federal agencies' decisions, there is a particular constellation of laws and commitments that comes into play. This constellation is unique to tribes – it would not be relevant were only other groups' interests affected, but it must be considered given that tribes' rights are at stake. Although it is beyond the scope of these comments to discuss these laws and commitments, it is worth noting them here. In addition to the treaties and agreements between the U.S. and the Pacific Northwest tribes discussed above, numerous legal commitments recognize the unique duties owed to tribes and their members. Chief among these is the federal trust responsibility, under which doctrine the federal government is held to the heightened standards of a trustee in its decisions affecting tribal resources and rights. Although courts' recent interpretations of this trust responsibility in the context of agencies' environmental decisions have tended toward a narrow rather than robust understanding, the EPA at least has indicated its appreciation of a duty that flows from tribes' unique legal status under the Constitution, treaties, laws, executive orders, and court decisions and from the historical relationship between the federal

too, that the state of Washington has since appealed Judge Martinez' decision to the Ninth Circuit, where it remains at present; the parties have submitted briefs, and oral argument has been heard, but the court has not yet rendered an opinion.

[57] *See, supra* note 25 and accompanying text (discussing the treaties' status under the U.S. Constitution as "supreme law of the land").

[58] This is not to suggest that tribes' rights are limited to the state's exterior boundaries; rather, it is to say that insofar as the state asserts environmental regulatory authority over "the waters of Washington," these waters are burdened by tribes' pre-existing rights. For state recognition of this point, *see, e.g.,* Washington State Governor's Office of Indian Affairs, "Map of Reservations and Ceded Lands," http://www.goia.wa.gov/tribal_gov/documents/Tribal_Cedres.pdf; *see also,* Washington State Department of Transportation, Model Comprehensive Tribal Consultation Process for National Environmental Policy Act, Appendix B (July 2008), http://www.wsdot.wa.gov/environment/tribal (summarizing adjudicated "usual and accustomed" areas for western Washington tribes).

government and tribal nations.[59] Relatedly, the federal government has committed to work with tribes on a government-to-government basis, in furtherance of tribal self-determination, pledging, among other things, to consult with tribal governments in a meaningful and timely fashion.[60]

Other obligations and commitments that are particular to tribes and their members stem from U.S. commitments under international law to protect the rights of indigenous peoples, including rights to traditional resources and to hunt, fish, and gather.[61] Additionally, if water quality standards for Washington permit tribes to be disproportionately impacted, they may run afoul of federal commitments to environmental justice. Disproportionate impacts can include impacts that are not only different in degree, but also different in kind – such as those implicated when tribes' rights, resources, and the multiple facets of the lifeways associated with harvesting and consuming fish are affected. EPA has indicated that it will take seriously its obligations to ensure environmental justice in discharging its various duties. Executive Order 12,898 commits agencies of the federal government to further environmental justice and specifically mentions to need to protect "subsistence consumption of fish and wildlife;"[62] Executive Order 13,175 also bears on federal agencies' environmental justice obligations to tribes.[63] Moreover, EPA has recently emphasized its particular commitment to ensuring environmental justice for tribes, their members, and indigenous people. EPA's July 2014 *Policy on Environmental Justice for Working with Tribes and Indigenous Peoples* commits in this context to addressing disproportionate risks to human health and the environment, and to encouraging states to implement environmental justice principles when states' programs, policies, and activities may affect tribes and their members.[64]

[59] *See* Memorandum from Lisa P. Jackson, Administrator, U.S. Environmental Protection Agency, to All EPA Employers (Jul. 22, 2009), http://www.epa.gov/tp/pdf/reaffirmation-memo-epa-indian-policy-7-22-09.pdf (reaffirming EPA's 1984 Indian policy and explicitly acknowledging its trust responsibility to the tribes); U.S. Environmental Protection Agency, Policy for the Administration of Environmental Programs on Indian Reservations (Nov. 8, 1984), http://www.epa.gov/tp/pdf/indian-policy-84.pdf; *see generally*, COHEN, *supra* note 22, at 430-32. For a more expansive understanding of the federal government's trust responsibility regarding the ecosystems that support salmon, *see* NORTHWEST INDIAN FISH COMMISSION, TREATY RIGHTS AT RISK (2011).

[60] *See* Executive Order 13,175, Consultation and Coordination with Indian Tribal Governments, 65 Fed. Reg. 67,249 (Nov. 6, 2000); President Barack Obama, Memorandum for the Heads of Executive Departments and Agencies, 74 Fed. Reg. 57,881 (Nov. 5, 2009); *see, generally*, Colette Routel & Jeffrey Holth, *Toward Genuine Tribal Consultation in the 21st Century*, 46 U. MICH. J. L. REFORM 417 (2013).

[61] UNITED STATES MISSION TO THE UNITED NATIONS, ANNOUNCEMENT OF U.S SUPPORT FOR THE UNITED NATIONS DECLARATION ON THE RIGHTS OF INDIGENOUS PEOPLES 6, 8 (2011), http://usun.state.gov/documents/organization/153239.pdf (acknowledging that the Declaration calls upon the U.S. to acknowledge the "interests of indigenous peoples in traditional lands, territories, and natural resources," and recognizing "that many indigenous peoples depend upon a healthy environment for subsistence fishing, hunting and gathering" and that various Declaration provisions address the consequent need for environmental protections); United Nations Declaration on the Rights of Indigenous Peoples, G.A. Res. 61/295, U.N. Doc. A/RES/61/295 (Sept. 13, 2007).

[62] Executive Order 12,898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (Feb. 11, 1994) (singling out the issue of "subsistence consumption of fish and wildlife" in section 4-4, the only subject matter issue receiving specific mention in the Executive Order).

[63] Executive Order 13,175, *supra* note 60.

[64] U.S. Environmental Protection Agency, Policy on Environmental Justice for Working with Tribes and Indigenous Peoples 1, 4 (July 24, 2014), http://www.epa.gov/oecaerth/environmentaljustice/resources/policy/indigenous/ej-indigenous-policy.pdf.

III. WQS for Washington Must Be Evaluated in View of the Above Legal Constraints

Water quality standards for Washington must be evaluated in view of the legal constraints elaborated above, in Part II. This point is underscored by EPA's proposed WQS, which are instructive in several respects.

A. EPA Has Recognized that WQS for Washington Must Comport with the Above Legal Constraints

As EPA has correctly recognized, the legal constraints elaborated above have implications both for EPA's necessity determination and for EPA's proposed WQS for Washington. Ultimately, neither Washington's recalcitrance in updating its WQS nor the human health criteria proposed by EPA for Washington may serve to undermine the rights secured to the tribes by treaties and other legal commitments.

In concluding that Washington's existing human health criteria are not protective of the applicable designated uses, which include fishing and shellfish harvesting, EPA has stated that:

> In determining whether WQS comply with the CWA and EPA's regulations, when setting criteria to support the most sensitive use in Washington, it is necessary to consider other applicable laws, including federal treaties. In Washington, many tribes hold reserved rights to take fish for subsistence, ceremonial, religious, and commercial purposes, including treaty reserved rights to fish at all usual and accustomed fishing grounds and stations in waters under state jurisdiction, which cover the majority of waters in the state. Such rights include not only a right to take those fish, but necessarily include an attendant right to not be exposed to unacceptable health risks by consuming those fish.[65]

EPA's rationale here echoed exactly that of the courts, which have long recognized that the tribes' continued ability to consume fish or to earn a livelihood by selling fish to others for their consumption was an essential point of the treaty guarantees.[66] As the U.S. Supreme Court observed in *Washington v. Washington State Commercial Passenger Fishing Vessel Association*, "the Indians were vitally interested in protecting their right to take fish at usual and accustomed places whether on or off the reservations, and they were invited by the white negotiators to rely and did in fact rely on the good faith of the United States to protect that right."[67] In a passage from that case underscored by Judge Martinez in the recent Culverts order, the Court found that "Governor [Stevens'] promises that the treaties would protect that source of food and commerce were crucial in obtaining the Indians' assent."[68] Thus, as courts have emphasized, important among the myriad facets of tribes' reserved fishing rights is the role

[65] 80 Fed. Reg. at 55066 (citation omitted).
[66] *See* discussion *supra* notes 31-38 and accompanying text.
[67] Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n, 443 U.S. 658, 667 (1979).
[68] Culverts Order, 2007 WL 2437166, at at *7 (quoting State of Washington v. Washington State Commercial Passenger Fishing Vessel Association, internal citation omitted, quoted text italicized by Judge Martinez)

of fish as food for human consumption.[69] Put another way: the tribes' right to take fish does not refer to catch-and-release practices.

Similarly, in deriving its human health criteria for Washington, EPA correctly stated that:

> A majority of waters under Washington's jurisdiction are covered by reserved rights, including tribal treaty-reserved rights. Many areas where reserved rights are exercised cannot be directly protected or regulated by the tribal governments and, therefore, the responsibility falls to the state and federal governments to ensure their protection. In order to effectuate and harmonize these reserved rights, including treaty rights, with the CWA, EPA determined that such rights appropriately must be considered when determining which criteria are necessary to adequately protect Washington's fish and shellfish harvesting designated uses.[70]

EPA's understanding, moreover, has received recent support from the Office of the Solicitor in the Department of Interior, which considered the relationship between tribal fishing rights and WQS in Maine and confirmed to EPA that tribal fishing rights "should be taken into account when evaluating the adequacy of [a state's] WQS."[71] Although the Solicitor's analysis involved the particular legal sources of Maine tribes' fishing rights, it drew on broadly applicable tenets of federal Indian law, including principles articulated by the courts in cases interpreting tribal fishing rights in Washington. As the Solicitor stated:

> In summary, fundamental, long-standing tenets of federal Indian law support the interpretation of tribal fishing rights to include the right to sufficient water quality to effectuate the fishing right. Case law supports the view that water quality cannot be impaired to the point that fish have trouble reproducing without violating a tribal fishing right; similarly water quality cannot be diminished to the point that consuming fish threatens human health without violating a tribal fishing right. A tribal right to fish depends on a subsidiary right to fish populations safe for human consumption. If third parties are free to directly and significantly pollute the waters and contaminate available fish, thereby making them inedible or edible only in small quantities, the right to fish is rendered meaningless. To satisfy a tribal fishing right to continue culturally important

[69] *Accord* Lac Courte Oreilles Band of Lake Superior Chippewa Indians v. Wisconsin, 653 F. Supp. 1420, 1426 (W.D. Wis. 1987)(By dint of the 1837 and 1842 treatie, the Chippewa were "guaranteed the right to make a moderate living off the land and from the waters in and abutting the ceded territory and throughout that territory by engaging in hunting, fishing, and gathering as they had in the past and by consuming the fruits of that hunting, fishing, and gathering or by trading the fruits of that activity for goods they could use and consume in realizing that moderate living").

[70] 80 Fed. Reg. at 55067 (citations and internal cross-references omitted).

[71] Letter from Hilary C. Tompkins, Office of the Solicitor, U.S. Department of the Interior, to Avi S. Garbow, Office of General Counsel, U.S. Environmental Protection Agency (Jan. 30, 2015).

fishing practices, fish cannot be too contaminated for consumption at sustenance levels.[72]

EPA's recognition that the adequacy of WQS under the CWA must be considered in light of the need "to effectuate" tribes' legally protected fishing rights, and that criteria designed to protect Washington's fish and shellfish designated harvesting uses must be "harmonize[d]" with "these reserved rights, including treaty rights," corrects a frequent misunderstanding among some states and commentators about the import of tribes' legally protected rights. Specifically, the states of Washington and Idaho have cited EPA guidance under the CWA as authority for a host of determinations that, together, would support WQS that would permit the waters to be contaminated to the point that the fish are "inedible or edible only in small quantities," thereby rendering meaningless the tribes' rights to fish.[73]

Yet EPA has acknowledged that its guidance must be considered as subsidiary to any applicable sources of law.[74] This would include tribes' legally protected fishing rights. States and others cannot simply

[72] *Id.*

[73] *See, e.g.*¸Washington Dept. of Ecology, Washington State Water Quality Standards: Human Health Criteria and Implementation Tools, Overview of Key Decisions in Rule Amendment (Jan., 2015), https://fortress.wa.gov/ecy/publications/SummaryPages/1410058.html (citing "EPA guidance" throughout as source of authority for its choice of variables for deriving its proposed human health criteria, which would have enlisted a FCR of 175 grams/day, a cancer risk level of 10^{-5}, a bodyweight of 80 kg, and a RSC of 1). Note that Washington has since withdrawn the proposed rule for which this document provided support. The analogue document supporting Washington's second proposed rule similarly cites "guidance" or the state's prerogative to make "risk management" decisions as the justification for WQS that ultimately undermine tribes' rights to harvest fish fit for human consumption. Washington Dept. of Ecology, Washington State Water Quality Standards: Human Health Criteria and Implementation Tools, Overview of Key Decisions in Rule Amendment (Jan., 2016), https://fortress.wa.gov/ecy/publications/documents/1610006.pdf [hereinafter Ecology, 2016 Key Decisions]. *See, also, e.g.* Idaho Dept. of Environmental Quality, Final Proposal, Water Quality Standards, Docket No. 58-0102-1201 (Dec. 8, 2015), http://www.deq.idaho.gov/media/60177653/58-0102-1201-final-proposal-1215.pdf (stating that "EPA guidance allows states to choose from a risk range of 10^{-4} to 10^{-6} for the incremental increase in cancer risk used in human health criteria calculations" in support of replacing Idaho's previous 10^{-6} value with a proposed 10^{-5} value; this risk level would be coupled with a FCR of 66.5 grams/day and a bodyweight of 80 kg). Moreover, whereas EPA Region X, in comments on IDEQ's proposal, reminded IDEQ of the need to effectuate tribes' fishing rights, IDEQ, in its reponse to public comments, disagreed. *Compare* Letter from Angela Chung, Manager, Water Quality Standards Unit, EPA Region X, to Don Essig, Idaho Dept. of Environmental Quality, att. at 6 (Nov. 6, 2015), http://www.deq.idaho.gov/media/60177521/58-0102-1201-epa-region-10-comment-1115.pdf [hereinafter EPA Region X, Comments on IDEQ Proposal] ("In Idaho, certain tribes hold reserved rights to take fish for subsistence purposes, including treaty-reserved rights to fish at all usual and accustomed fishing grounds and stations and in the unoccupied lands of the United States, which in combination appear to cover the majority of waters under state jurisdiction … Such rights appropriately must be considered when determining which criteria are necessary to adequately protect Idaho's waters used for consumption of fish") *with* Idaho Dept. of Environmental Quality, Public Comment Summary 20 (Dec. 7, 2015), http://www.deq.idaho.gov/media/60177654/58-0102-1201-public-comment-summary-1215.pdf ("[T]he underlying premise of EPA's argument that the treaties preserve a right to take and consume fish at a subsistence rate unsuppressed by fish availability or concerns about the safety of available fish is not supported by the treaty language itself or by relevant case law"). Idaho's WQS have since been adopted, but have not been approved by EPA.

[74] U.S. Environmental Protection Agency, Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health 1-2 (2000)[hereinafter EPA, AWQC Guidance], http://water.epa.gov/scitech/swguidance/standards/upload/2005_05_06_criteria_humanhealth_method_comple

assume that EPA's general guidance for water quality standard-setting has accounted for tribes' fishing rights, including rights secured by treaty and other legal agreements. Nor could EPA, in guidance, purport to authorize itself or states to take actions in contravention of the tribes' treaties and other agreements with the United States.[75] Additionally, EPA's *Ambient Water Quality Criteria Methodology* must be interpreted in light of data and developments since it was published, in 2000. Among other things, EPA's guidance pre-dated the U.S. district court's further explication of the scope of tribes' treaty-secured rights to fish in the Culverts litigation in 2007 and 2013, outlined above. As a consequence, statements in the guidance must also be understood as a product of their time.

EPA's proposed rule appropriately acknowledged the need "to effectuate reserved fishing rights, including the rights that federal treaties afford to tribes in Washington" and explicitly stated that "the EPA's 2000 Human Health Methodology did not consider how CWA decisions should account for applicable reserved fishing rights, including treaty-reserved rights."[76]

B. EPA Correctly Understands Tribes Exercising Their Fishing Rights to be the Relevant Target General Population; Other Highly-Exposed Groups Would Also be Protected

EPA understands tribes "exercising their reserved fishing rights in Washington" to be "the target general population" to be protected by Washington's WQS. As EPA correctly stated:

> Protecting Washington's fish and shellfish harvesting designated uses, which include consumption of such fish and shellfish, necessitates protecting the population exercising those uses. Where a population exercising such uses has a legal right to do so, the criteria protecting such uses must be consistent with such right. Thus, EPA proposes to consider the tribal population exercising their reserved fishing rights in Washington as the target general population for the purposes of deriving protective criteria that allow the tribes to harvest and consume fish consistent with their reserved rights.[77]

EPA's disapproval of Maine's proposed WQS corroborates the understanding that WQS affecting tribal fishing rights must "treat the tribal population exercising the sustenance fishing use as the target general population, not as a high-consuming subpopulation of the State," and must therefore use fish consumption data that appropriately reflect tribal consumers' fishing practices.[78]

te.pdf. (making a disclaimer at the outset of its guidance to this effect: "This Methodology does not substitute for the CWA or EPA's regulations; nor is it a regulation itself. Thus, the 2000 Human Health Methodology cannot impose legally-binding requirements on EPA, States, Tribes or the regulated community, and may not apply to a particular situation based upon the circumstances.")

[75] O'Neill, *Fishable Waters*, *supra* note 19, at 255-260.

[76] 80 Fed. Reg. at 55068.

[77] 80 Fed. Reg. at 55067.

[78] Letter from H. Curtis Spalding, Regional Administration, U.S. Envtl. Protection Agency, Region 1, to Patricia W. Aho, Commissioner, Me. Dep't of Envtl. Protection (Feb. 2, 2015); *Analysis Supporting EPA's February 2, 2015 Decision to Approve, Disapprove, and Make No Decision on, Various Maine Water Quality Standards, Including Those Applied to Waters of Indian Lands in Maine*, U.S. ENVTL. PROTECTION AGENCY,

Ecology's second proposed WQS enlist a FCR that reflects the "average" of what it terms "highly exposed populations" affected by Washington's WQS, which Ecology defines to "include, among other groups, the following: tribes, Asian Pacific Islanders (API), recreational and subsistence fishers, immigrant populations, etc."[79] Ecology's broad and open-ended definition of the target population for protection is a source of concern inasmuch as the average FCR for such a broadly defined set of populations will surely be lower than an FCR that is adequately protective of tribal people exercising fully their rights to fish. To the extent that Ecology seeks to ensure protection of other groups (e.g., API populations) who may also have legally protected rights that are implicated by Washington's WQS, it is worth noting than an approach that targets the tribal population exercising its fishing rights is likely *also* to be protective of these other groups (assuming currently available data about such groups' fish consumption rates).

C. EPA Has Appropriately Recognized the Issue of Suppression

EPA has appropriately recognized the issue of suppression and recommended that human health criteria be derived by "selecting a FCR that reflects consumption that is not suppressed by fish availability or concerns about the safety of available fish."[80] Importantly, EPA correctly observed that "[w]hile EPA encourages doing so in general, where tribal treaty or other reserved fishing rights apply, selecting a FCR that reflects unsuppressed fish consumption could be necessary in order to satisfy such rights."[81] Additionally, as EPA noted, "[d]eriving criteria using an unsuppressed FCR furthers the restoration goals of the CWA, and ensures protection of human health as pollutant levels decrease, fish habitats are restored, and fish availability increases."[82]

Contemporary fish consumption rates may reflect fish consumption at or close to its nadir – a point vividly illustrated by the Nez Perce Tribe's presentation on suppression during a recent Idaho

http://www.ecy.wa.gov/programs/wq/ruledev/wac173201A/comments/0060g.pdf [hereinafter EPA, Region 1, Maine Disapproval Letter](stating that "the data used to determine the fish consumption rate for tribal sustenance consumers must reasonably represent tribal consumers taking fish from tribal waters and fishing practices unsuppressed by concerns about the safety of the fish available to them to consume. . . . EPA concludes that the best available data that represent the unsuppressed sustenance fishing practices of tribal members fishing in tribal waters are contained in the Wabanaki Lifeways study, which looked at the historic sustenance practices of the Tribes in Maine"). Although a complete analysis of the similarities and differences in the legal bases for tribes' fishing rights affected by Maine's WQS and those affected by Washington's WQS is beyond the scope of these comments, the comparison is sufficiently apt to support an analogy between the unsuppressed consumption rates and fishing practices guaranteed to the Maine tribes through various statutory and other legal recognitions and the unsuppressed consumption rates and fishing practices guaranteed to the Washington tribes through various treaties and other legal recognitions. The issue of suppression is taken up in Part III.C of these comments.

[79] Ecology, 2016 Key Decisions, *supra* note 73 at 18.

[80] 80 Fed. Reg. at 55065 (citing U.S. Environmental Protection Agency, Human Health Ambient Water Quality Criteria and Fish Consumption Rates Frequently Asked Questions (Jan. 18, 2013), http://water.epa.gov/scitech/swguidance/standards/criteria/health/methodology/upload/hhfaqs.pdf).

[81] 80 Fed. Reg. at 55066.

[82] 80 Fed. Reg. at 55065-66.

Department of Environmental Quality (IDEQ) public meeting.[83] A FCR selected from the 90th or even the 99th percentile of contemporary tribal consumption surveys will likely be considerably lower than historical fish intake levels – and considerably lower than fish intake consonant with a more robust fish resource and full exercise of tribal fishing rights.

Ecology, by contrast, fails to acknowledge the relevance of suppression to its derivation of the human health criteria set forth in its second proposed WQS. The implications of suppression are elaborated here:

1. Historical Fish Consumption Practices and Rates

The tribes of the Pacific Northwest are fishing peoples. Historically, fish were vital to tribal life – a central feature of the seasonal rounds by which food was procured for ceremonial, subsistence, and commercial purposes. This fact is self-evident to tribal people. As noted above, it has also been recognized by U.S. courts, which have observed that, at treaty times, "fish was the great staple of [Indians'] diet and livelihood,"[84] and thus fishing rights "were not much less necessary to the existence of the Indians than the atmosphere they breathed."[85]

There are ample data documenting the role of fish as a dietary mainstay for Indian people prior to European contact and at the time of the treaties. There were differences, of course, in the species relied upon and the quantities consumed, from group to group and from year to year. Nonetheless, there is no doubt that fish comprised a staple source of calories, protein, and other nutrients for tribal people throughout the Pacific Northwest. These data, moreover, drawn from multiple lines of scientific evidence, have supported quantified estimates of historical consumption rates. For example, Professor Deward Walker has estimated pre-dam fish consumption rates for the Columbia River tribes (Umatilla, Yakama, and Nez Perce), based on a review of the ethnohistorical and scientific literature. Walker has quantified total fish consumption for these peoples at 1000 grams/day.[86] Earlier estimates, for example, by Gordon Hewes, produced figures of similar magnitude. Hewes estimated salmon consumption rates for the Cayuse at 365 pounds/year (453.6 grams/day) and for the Umatilla and Walla Walla at 500 pounds/year (621.4 grams/day).[87] Hewes' estimates for the Puget Sound tribes were similar. For example, he estimated salmon consumption rates for the Lummi and Nooksack tribes at 600 pounds/year (745.6 grams/day), for the Clallam at 365 pounds/year (453.6 grams/day) and for the

[83] Nez Perce Tribe, The Nez Perce Tribe and its Fisheries: "Our Fate and the Fate of the Fish are Linked," Powerpoint Presentation (Oct. 10, 2014), http://www.deq.idaho.gov/media/1118105/58-0102-1201-nez-perce-tribe-fisheries-presentation-100214.pdf.

[84] Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n, 443 U.S. 658, 665 n.6 (1979) (citations and internal quotation marks omitted).

[85] United States v. Winans, 198 U.S. 371, 381 (1905).

[86] A. SCHOLTZ, ET AL., COMPILATION OF INFORMATION ON SALMON AND STEELHEAD TOTAL RUN SIZE, CATCH, AND HYDROPOWER-RELATED LOSSES IN THE UPPER COLUMBIA RIVER BASIN, ABOVE GRAND COULEE DAM, Fisheries Technical Report No. 2, Upper Columbia United Tribes Fisheries Center, Eastern Washington University (1985).

[87] Gordon W. Hewes, *Indian Fisheries Productivity in Pre-Contact Times in the Pacific Salmon Area*, 7 NORTHWEST ANTHROPOLOGICAL RESEARCH NOTES 133, 136 (1973).

Puyallup, Nisqually, and various other tribes at 350 pounds/year (435 grams/day).[88] These and other data have been enlisted in peer-reviewed methodologies for quantitative exposure estimates for various Pacific Northwest tribes. For example, Barbara Harper, et al. concluded that "[h]istorically, the Spokane Tribe consumed roughly 1,000 to 1,500 grams of salmon and other fish per day."[89]

The substantial degree to which fish were relied upon by the tribes at treaty time was emphasized in evidence before the court in *U.S. v. Washington.* Among the findings of fact in that case, Judge Boldt cited the following figure: "Salmon, however, both fresh and cured, was a staple in the food supply of these Indians. It was annually consumed by these Indians in the neighborhood of 500 pounds per capita [i.e., 621.4 grams/day]."[90] Note that the figure cited by Judge Boldt records consumption of salmon only; total fish consumption would have been even greater.[91]

2. "Suppression" Identified as an Issue by NEJAC

In contrast to estimates of historical fish consumption rates, recent surveys of tribal populations produce estimates of contemporary fish consumption rates. It is important to recognize that these snapshots of contemporary practices are likely distorted due to suppression.

Beginning in 2000, the National Environmental Justice Advisory Council (NEJAC) responded to EPA's request that it document and recommend ways to address the disproportionate impacts of contaminated and depleted fish, wildlife and aquatic resources.[92] Tribal representatives in particular emphasized that degraded ecosystems adversely impacted important tribal resources and undermined tribal members' consumption and use of those resources. They pointed out that surveys of tribal members' contemporary fish intake would reflect consumption rates and patterns that had been greatly altered from historical practices – practices to which tribes had rights, secured in many instances by treaties and other legal protections. The NEJAC recognized, too, that surveys of other groups' contemporary fish intake would also to some extent reflect consumption rates that had been diminished

[88] *Id.*
[89] Harper, et al., *The Spokane Tribe's Multipathway Subsistence Exposure Scenario and Screening Level RME*, 22 Risk Analysis 513, 518 (2002)[hereinafter, Harper, et al., *Spokane Tribe's Exposure Scenario*]. Harper, et al. improved upon the earlier estimates, among other things by accounting for the greater caloric requirements of an active, subsistence way of life. Thus, for example, while Hewes' estimates assumed a 2000 kcal/day energy requirement, Harper, et al. used a 2500 kcal/day figure, "based on a moderately active outdoor lifestyle and renowned athletic prowess" of Spokane tribal members. *Id.* at 517. For updated studies supporting similar heritage rate figures, *see* Barbara L. Harper & Deward E. Walker, Jr., *Comparison of Contemporary and Heritage Fish Consumption Rates in the Columbia River Basin*, 43 HUM. ECOLOGY 225 (2015); Barbara L. Harper & Deward E. Walker, Jr., *Columbia Basin Heritage Fish Consumption Rates*, 43 HUM. ECOLOGY 237 (2015).
[90] United States v. Washington, 384 F. Supp. 312, 380 (W.D. Wash. 1974) (discussing Yakama consumption).
[91] In a related vein, we note with approval that EPA's proposed rule, at footnote 18, cites many of the sources included in this and the preceding paragraph of these comments; however, we urge attention to whether the data in each case refer to intake of salmon only or to total fish intake. EPA's characterization in footnote 18 of the figure cited by Judge Boldt in *U.S. v. Washington*, for example, may suggest that it refers to total fish intake ("a heritage FCR of 621 g/day") rather than salmon intake only. 80 Fed. Reg. at 55066, n.18.
[92] NATIONAL ENVIRONMENTAL JUSTICE ADVISORY COUNCIL, FISH CONSUMPTION AND ENVIRONMENTAL JUSTICE 1 (2002) [hereinafter NEJAC FISH CONSUMPTION REPORT].

in the face of contamination and depletion– particularly given the recent proliferation of fish consumption advisories nationwide. The NEJAC report, issued in 2002, thus brought attention to the issue of "suppression effects" – enlisting a term coined by one of its members, Professor Patrick West, to describe the impact of fish consumption advisories on rates purporting to reflect fish intake in Michigan.[93]

> A 'suppression effect' occurs when a fish consumption rate (FCR) for a given population, group, or tribe reflects a current level of consumption that is artificially diminished from an appropriate baseline level of consumption for that population, group, or tribe. The more robust baseline level of consumption is suppressed, inasmuch as it does not get captured by the FCR.[94]

Importantly, the NEJAC report highlighted the potential feedback loop set in motion when contemporary survey data, biased downward due to suppression, were used to set environmental standards.

> [W]hen environmental agencies set or approve water quality standards that rely on a picture of exposure that takes people to be eating smaller quantities of fish, agencies will permit relatively greater quantities of pollutants to remain in or be discharged to the waters and sediments. That is to say, agencies will set less protective standards. The downward spiral thus begins, as these aquatic environments and the fish they support will be permitted to become increasingly contaminated, and some individuals in turn might be expected to respond by reducing their fish consumption even further. Or some individuals in turn might find that there are fewer fish to be caught (and those that remain to be increasingly contaminated) or there are fewer places open for shellfish harvesting. In either case, studies would reflect even lower FCRs, and agencies would then set new standards assuming that little or no human exposure to contaminants occurs via fish consumption, and permit even greater quantities of pollutants in aquatic ecosystems.[95]

Rather, it was urged, environmentally just standards would require the use of an "appropriate baseline" for the relevant affected group.[96] In the case of the Yakama and other fishing tribes in the Pacific Northwest, for example, the NEJAC report quoted workgroup member Moses Squeochs, then-Environmental Program Director for the Yakama Nation, who pointed to the more robust level of fish consumption supported by the environment as of 1855, the date of the treaty between the bands of the Yakama and the U.S.[97]

[93] *Id.* at 43 (observing that "suppression effects" were recognized and named in an early survey of Michigan sport anglers and served as a basis for adjusting the observed FCR upward).
[94] *Id.* at 43-45.
[95] *Id.* at 49.
[96] *Id.* at 44.
[97] *Id.* at 44 & n.116.

3. Suppression Broadly Recognized

The NEJAC's observation that surveys depicting contemporary practices will provide a snapshot distorted by suppression was soon echoed in the legal, science, and risk policy literature.[98] Researchers elaborated that suppression in this context may be a consequence of several factors, and that the forces of suppression may have affected different groups in different ways. For the fishing tribes in the Pacific Northwest, these pressures have operated since at least the 1800s and include depletion and contamination of the fish or other resources; denied or diminished access to fishing and harvesting places; years of prosecution and gear confiscation by public officials; and intimidation by private individuals.[99] For example, as researchers have documented:

> Tribal people are still harassed while participating in the harvest of traditional foods via verbal, physical, and legal threats by private citizens and public law enforcement authorities, and their gear is still being vandalized, stolen, or seized.[100]

And while earlier public policies seeking to thwart tribal fishing have been disavowed, the legacy of this era remains. Some fishing families have never recovered from having their fishermen imprisoned and their gear confiscated, leaving them to look to other employment to make ends meet – a necessity that has reverberated throughout the tribes, affecting others who would have depended on these families for fish.[101]

For other groups, these forces have shaped behavior more recently, as contamination became evident in the late 1960s and fish consumption advisories became more prevalent beginning in the 1970s and

[98] *See, e.g.*, Catherine A. O'Neill, *Risk Avoidance, Cultural Discrimination, and Environmental Justice for Indigenous Peoples*, 30 Ecology. L. Q. 1, 50-51 (2003)[hereinafter O'Neill, *Risk Avoidance, Cultural Discrimination*]; Jamie Donatuto & Barbara L. Harper, *Issues in Evaluating Fish Consumption Rates for Native American Tribes*, 28 RISK ANALYSIS 1497, 1500 (2008). The term continues to gain recognition, and understanding of its implications continues to grow. *See, e.g.*, FRASER SHILLING ET AL., CALIFORNIA TRIBES FISH-USE: FINAL REPORT (July 2014) (documenting FCRs at the 95th percentile between 30 grams/day (Chumash) and 240 grams/day (Pit River) but adding the caveat that "[t]he rate of fish use (frequency and consumption rate) was suppressed for many tribes, compared to traditional rates.")

[99] Tribal leaders have long observed the myriad causes of suppression operating to diminish tribal fishing and fish consumption. These are usefully summarized in Donatuto & Harper, *supra* note 94 at 1500-01; *see also* WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW IN INDIAN COUNTRY 25 (2005) ("In the latter half of the nineteenth century, the fishing grounds were quickly enclosed. . . . In hundreds of confrontations, the Indians met owners who hadn't heard of the fishing 'servitude,' or who didn't believe in it; who knew for sure that access was not here but over there; who would let the gates down, but only for a small and reasonable fee; who would insist the fishery was a private one; . . . the Indians would be introduced to fences and road closures and padlocks and abutments and signs and guard dogs and firearms that were among the pleasures of all fee-simple property owners. . . . Litigation would begin in 1884, and in a fundamental sense, it would never end. Treaty fishing lawsuits continue today into the 21st century.").

[100] Donatuto & Harper, *supra* note 98 at 1501.

[101] *See, e.g.,* Salmon Defense, *Back to the River* (DVD, 2014)(providing personal accounts of tribal fishers, leaders, and others involved in the struggle for tribal treaty rights from the pre-Boldt era to the present).

1980s. For example, consumption surveys of women of childbearing age may reflect a current level of consumption that is diminished from levels that women in this group *would* consume, but for the existence of fish consumption advisories due to mercury contamination.[102]

Of course, not everyone is able to change his or her fish consumption practices in order to avoid contact with contaminants or to compensate for restricted resource uses.[103] Yet, recent studies have shown that even some tribal people for whom fish are traditionally important have reduced their fish intake in the face of a contaminated fish resource and consequent fish consumption advisories.[104] Moreover, such advisories can have spillover effects, as their reach often extends to family members and others beyond the "target" audience. For example, fish consumption advisories for methylmercury are aimed at children and women of childbearing age, given methylmercury's impact on neurodevelopment; however, studies have found that men and older women have reduced their fish intake in response to these advisories as well.[105]

Increasingly, federal, tribal, and state environmental agencies have acknowledged the issues posed by suppression. In 2013, EPA updated earlier guidance to recommend that suppression be accounted for when agencies set water quality standards – a position recognized in EPA's proposed rule.[106] The Spokane Tribe has adopted – and EPA has approved – water quality standards founded on

[102] *See, e.g.*, Emily Oken et al., *Decline in Fish Consumption Among Pregnant Women After a National Mercury Advisory*, 102 OBSTETRICS & GYNECOLOGY 346 (2003) (finding that pregnant women with access to obstetric care decreased their fish consumption in response to publication of federal advisory warning of mercury contamination in certain species of fish); *but cf.* Jay P. Shimshack, et al., *Mercury Advisories: Information, Education, and Fish Consumption*, 53 J. ENVTL. ECON. & MGMT. 158, 177 (2007) (finding that, among "educated" families with young or nursing children, purchase of canned fish decreased by 50% in response to consumption advisories due to mercury, but finding no change in fish consumption among "less educated" families).

[103] *See* O'Neill, *Risk Avoidance, Cultural Discrimination, supra* note 98; Catherine A. O'Neill, *No Mud Pies: Risk Avoidance as Risk Regulation*, 31 VT. L. REV. 273 (2007).

[104] Elizabeth Hoover, *Cultural and Health Implications of Fish Advisories in a Native American Community*, 2 ECOLOGICAL PROCESSES 1 (2013) (finding that 75% of respondents in Akwesasne community reported decreasing or ceasing entirely their fish intake in the face of contamination and fish consumption advisories); *see also* Donatuto & Harper, *supra* note 94 at 1501 (finding that "[k]nowledge of contamination in areas traditionally harvested—learned through anecdotal, first-hand or visual data, and fish advisories—have influenced some native people to eat less subsistence seafood," but noting that "[d]espite these obstacles, many tribal people continue to rely on subsistence foods with seafood being a primary source, although they may not always mirror levels of historic consumption. Furthermore, some tribal people continue to harvest and eat fish and shellfish in areas where fish advisories have been issued. In many cases, people continue to eat fish they know are contaminated because upholding the traditional ways is paramount to cultural survival").

[105] Hoover, *supra* note 100 (finding that men were among those limiting their intake, despite the fact that the advisories were aimed at women); Shimshack, et al., *supra* note 98 (finding that entire families were impacted by consumption advisories due to mercury, given that those in "educated" families with young or nursing children decreased their purchase of canned fish decreased by 50%, despite the target audience being children and women of childbearing age).

[106] U.S. Environmental Protection Agency, Human Health Ambient Water Quality Criteria and Fish Consumption Rates Frequently Asked Questions (Jan. 18, 2013), http://water.epa.gov/scitech/swguidance/standards/criteria/health/methodology/upload/hhfaqs.pdf.

unsuppressed, "heritage" rates.[107] EPA has also supported research into methods documenting heritage exposure scenarios for Wabanaki traditional lifeways.[108] Importantly, EPA has cited suppression among the reasons for disapproving water quality standards adopted by the state of Maine and applicable to "Indian lands,"[109] and for weighing in against the Idaho Department of Environmental Quality's proposed use of an average value from contemporary surveys of the Nez Perce tribe for water quality standards in Idaho.[110]

4. Past and Future

As noted above, fish and all of the lifeways associated with the fish are essential to tribal health and well-being, today as in the past. Fish consumption is thus an embedded practice. Fish are vital to tribal people for the nutrients they provide, of course, but fish consumption is also imbued with social meaning. Every facet of managing, harvesting, distributing, and honoring the fish is woven into the fabric of tribal life. These practices and the knowledge they beget form a central part of the inheritance of each succeeding generation. For this reason, the salmon have been described as a "cultural keystone species" for the Indian peoples of the Pacific Northwest.[111] Fish are important for each individual tribal member, and for the tribe as a whole – necessary for health and well-being broadly understood to include not only physiological, but also cultural and spiritual dimensions.[112] As depicted in artwork by Swinomish carver and painter Kevin Paul that graced a recent study, fish are "food for the body, food for the soul."[113]

For the tribes, the past informs the future. Historical, original, or "heritage" rates have ongoing relevance for the fishing tribes. This is so given that the treaty guarantees are in perpetuity, given that

[107] Spokane Tribe of Indians Res. 2010-173, *Surface Water Quality Standards*, at 13 (Feb. 25, 2010) ("aquatic organism consumption rate" of 865 g/day); Letter from Daniel D. Opalski, Director, Office of Water and Watersheds, U.S. Environmental Protection Agency, Region X, to Rudy Peone, Chairman, Spokane Tribe of Indians (Dec. 19, 2013).
[108] Barbara Harper & Darren Ranco, *Wabanaki Traditional Cultural Lifeways Exposure Scenario*, U.S. ENVTL. PROTECTION AGENCY (July 9, 2009), http://www.epa.gov/region1/govt/tribes/pdfs/DITCA.pdf (prepared for EPA by the authors, in collaboration with the five federally recognized tribal nations in what is now Maine).
[109] EPA, Region 1, Maine Disapproval Letter, *supra* note 75.
[110] EPA Region X, Comments on IDEQ Proposal, *supra* note 70.
[111] Ann Garibaldi & Nancy Turner, *Cultural Keystone Species: Implications for Ecological Conservation and Restoration* 9 ECOLOGY AND SOCIETY 1 (2004); *accord* Donatuto & Harper, *supra* note 94, at 1500 (explaining that, for the tribes of the Pacific Northwest, "fish represent a cultural keystone species—species that have significant meaning and identity in tribal values and practices and as such are used in family and place names, educational stories, and ceremonies. Impacts to cultural keystone species degrade overall cultural morale. Therefore, degradation of traditional foods, for example, via contamination, directly impacts the physical health of those consuming the food and is regarded, equally, as an attack on beliefs and values through the 'acknowledged relationship of the people with the land, air, water, and all forms of life found within the natural system.'") (quoting SUQUAMISH TRIBE, FISH CONSUMPTION SURVEY OF THE SUQUAMISH INDIAN TRIBE OF THE PORT MADISON INDIAN RESERVATION, PUGET SOUND REGION (2000)).
[112] *See, e.g.,* Donatuto et al., *supra* note 98.
[113] *See* Donatuto & Harper, *supra* note 98, at fig 1., "Swinomish Seafood Spiral"); magnet with artwork and text distributed by Swinomish Indian Tribal Community (on file with Catherine O'Neill).

the tribes in fact seek to resume fish consumption practices and rates consonant with the treaty guarantees, and given that the tribes envision a future in which ecosystems that support the fish are restored. Indeed, whereas the "appropriate baseline level of consumption" referred to by the NEJAC may be subject to debate for other groups, there is a clear touchstone for the fishing tribes: only tribes have legally protected rights to a certain historical, original, or heritage baseline level of consumption. Thus, for example, the Umatilla Tribe looked to "original consumption rates along the Columbia River and its major tributaries" in developing a fish consumption rate for environmental regulatory purposes "because that is the rate that the Treaty of 1855 is designed to protect and which is upheld by case law. It also reflects tribal fish restoration goals and healthy lifestyle goals."[114] Relatedly, recent surveys of Swinomish tribal members showed that they sought to reinvigorate more robust fish consumption practices and to increase their fish intake.[115]

In sum, EPA's recognition of the need to address suppression is to be commended; this recognition accords with the recommendation to this end by the NEJAC over a decade ago. Of particular note is EPA's acknowledgement that "where tribal treaty or other reserved fishing rights apply" it will be "necessary" to account for suppression, including by selecting a FCR that reflects unsuppressed fish consumption. EPA also correctly understands suppression's myriad causes, including depletion and contamination of the fish resource. Finally, EPA's appropriately emphasized that using an unsuppressed FCR to derive WQS "furthers the restoration goals of the CWA, and ensures protection of human health as pollutant levels decrease, fish habitats are restored, and fish availability increases." This emphasis is important, given that the CWA sets forth as its goal nothing less than "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters"[116] – a goal shared by the fishing tribes, as documented above.

Ecology's unwillingness to acknowledge or account for suppression, by contrast, is unsupportable.

IV. Ecology's Derivation of Human Health Criteria for Washington

Ecology's derivation of human health criteria for Washington is supportable in some of its particulars. However, when Ecology's second proposed WQS are considered as a whole – as they must be – they fail to incorporate the best available science and fail to satisfy the relevant law. The issues raised by the various inputs selected by Ecology are summarized below. The NWIFC Comments elaborate further the scientific and legal issues with Ecology's choice of variables.

[114] STUART G. HARRIS & BARBARA L. HARPER, CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION, EXPOSURE SCENARIO FOR CTUIR TRADITIONAL SUBSISTENCE LIFEWAYS app. 3 (2004).
[115] JAMIE DONATUTO, WHEN SEAFOOD FEEDS THE SPIRIT YET POISONS THE BODY: DEVELOPING HEALTH INDICATORS FOR RISK ASSESSMENT IN A NATIVE AMERICAN FISHING COMMUNITY, 85-89 (Ph.D. dissertation, University of British Columbia 2008) (summarizing survey of Swinomish Indian Tribal Community members, finding multiple causes of suppressed consumption, and finding that 73% of respondents stated that they would like to eat more fish than they do now). *Accord* Donatuto & Harper, *supra* note 94, at 150 (using the term "heritage" rates and describing the relevance of past consumption practices for future consumption practices for the fishing tribes).
[116] 33 U.S.C. § 1251(a).

A. Fish Consumption Rate

Ecology's proposed human health criteria enlist a FCR of 175 grams/day. Ecology characterizes this FCR as one that reflects the "average" of what it terms "highly exposed populations" affected by Washington's WQS, which Ecology defines to "include, among other groups, the following: tribes, Asian Pacific Islanders (API), recreational and subsistence fishers, immigrant populations, etc."[117] As noted above, this focus on the average of such a vaguely defined target population is problematic. While EPA's proposed WQS enlist the same FCR, they do so based on a different rationale, focusing on the 95th percentile consumption rate of the relevant target general population, i.e., tribes "exercising their reserved fishing rights in Washington," based on the Columbia River Inter-Tribal Fish Commission (CRITFC) survey (see Table 1, below). As EPA explained:

> [T]his FCR accounts for local data (consistent with EPA's methodology), reflects input received during consultation with tribes, and appropriately addresses protection of Oregon's downstream WQS, per EPA's regulations at 40 CFR 131.10(b).[118]

EPA correctly recognizes the need to target protection at the 95th percentile of the tribal population (rather than aiming to protect only some lesser portion of the tribal population). EPA also appropriately recognizes the need, under the CWA, to protect downstream states' and tribes' WQS.

Ecology also characterizes its proposed 175 grams/day as an "endorsed value" and claims that "[g]roups endorsing the use of this numeric value, at different times in the process, include EPA and several tribes."[119] Ecology's misportrays the various tribes' and NWIFC's positions, however. Ecology is referred to the NWIFC Comments for a more accurate and nuanced statement. Among other things, the FCR does not stand alone; rather, it must be considered in concert with the other variables selected and approaches chosen. As noted above, the proposed 175 grams/day FCR is an *apparent* value; fish consumption at this rate is not *actually* supported for waters and fish contaminated with methylmercury, PCBs, dioxins, or arsenic. Additionally, the 175 grams/day fish intake rate is undermined by several other assumptions enlisted by Ecology (as discussed below), rendering consumption at this rate perilous under real-world conditions.

1. Surveys of Contemporary Fish Intake in Tribal Populations

As EPA observed, the 175 grams/day figure "approximates the 95th percentile consumption rate of surveyed tribal members from the CRITFC study."[120] Surveys of fish consumption in tribal populations (including the CRITFC survey) are properly viewed alongside other surveys used to document contemporary fish consumption in other populations and relied upon by government agencies in the environmental regulatory context. These studies of tribal fish consumption have been conducted under

[117] Ecology, 2016 Key Decisions, *supra* note 73 at 18.
[118] 80 Fed. Reg. at 55067.
[119] Ecology, 2015 Key Decisions, *supra* note 73 at 18.
[120] 80 Fed. Reg. at 55067.

governmental or inter-governmental auspices, and subjected to internal and external peer review. These studies have consistently been found to be technically defensible by federal and state governments.[121]

In fact, to the extent that contemporary surveys of tribal populations have erred on the side of following conventions developed for general population surveys, they may underestimate even contemporary tribal consumption rates.[122] Thus, for example, the study of the Squaxin Island Tribe and the Tulalip Tribes and the study of the CRITFC member tribes both hewed to the statistical convention that "outliers" – in this case, representing high-end fish consumption rates – are treated as likely the result of error (for example, in recording a respondent's fish consumption rate) rather than a true value. As such, it is a frequent practice for such outlier data points to be omitted from the dataset that then forms the basis of population values (e.g., the mean, or the 90th percentile) or to be "recoded" to coincide with a number closer to the bulk of the population, such as a number equal to three standard deviations from the mean.[123] But, as has been recognized, some tribal members – particularly those from traditional and fishing families – in fact consume very large quantities of fish, even in contemporary times. Tribal researchers at Umatilla, for example, identified a subset of interviewees (35 of 75) who are "traditional fishers" and who confirmed eating fish "two to three times a day in various forms."[124] The average consumption rate for this group was found to be 540 grams/day. Notably, the relatively high fish consumption rates indicated by this subset of tribal members reflect *actual* contemporary consumption, not – as assumed for so-called outliers – error. When outliers are treated automatically as errors, according to statistical convention, the effect is to depress the various percentile values and,

[121] As part of the rulemaking process for updating Oregon's water quality standards, a cadre of independent experts, the Human Health Focus Group (HHFG), was convened to assess the scientific defensibility and applicability of the available fish consumption studies, including the tribal studies then available, namely, the CRITFC, Squaxin Island/Tulalip Tribes, and the Suquamish surveys. *See* Human Health Focus Group, *Oregon Fish and Shellfish Consumption Rate Project*, Or. Dep't of Envtl. Quality, http://www.deq.state.or.us/wq/standards/humanhealthrule.htm#fish; OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY, HUMAN HEALTH FOCUS GROUP REPORT, OREGON FISH CONSUMPTION RATE PROJECT (June, 2008) [hereinafter ODEQ, HHFG REPORT]. After an extensive, year-long review, the HHFG found each of these studies to be scientifically defensible, deeming them both "reliable" and "relevant." ODEQ, HHFG REPORT at 7, 39-40. In rulemaking processes supporting water quality standards for Washington and Idaho, these same surveys' scientific defensibility has been reviewed and re-reviewed: incredibly, Idaho's review of the Tulalip and Squaxin Island study was the *sixth* it had undergone as part of federal or state agency processes. Idaho, too, concluded that these surveys warranted high marks for quality and scientific defensibility. *See Quality of Survey Criteria Rating Matrix*, Idaho Dep't of Envtl. Quality (Nov. 26, 2012), http://www.deq.idaho.gov/media/924655-58-0102-1201-quality-of-survey-criteria-rating-matrix.pdf (assessing the quality and scientific defensibility of 19 fish consumption surveys from around the Pacific Northwest and finding that six of these, including the three tribal studies judged scientifically defensible by Oregon's HHFG and the more recent Lummi Nation study, warranted "a score of 10 or better.")

[122] *See, e.g.*, Donatuto & Harper, *supra* note 98.

[123] *But cf.* U.S. ENVIRONMENTAL PROTECTION AGENCY, GUIDELINES FOR EXPOSURE ASSESSMENT 65 (1992), http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=15263 (stating, in contrast to this frequent practice, that "[o]utliers should not be eliminated from data analysis procedures unless it can be shown that an error has occurred in the sample collection or analysis phases of the study. Very often outliers provide much information to the study evaluators.").

[124] Stuart G. Harris & Barbara L. Harper, *A Native American Exposure Scenario*, 17 RISK ANALYSIS 789 (1997).

importantly, to fail to reflect the consumption practices of those tribal members whose practices today are most consonant with practices guaranteed to the tribes by treaty and to which tribes, in an exercise of cultural self-determination, seek to return. A host of other conventions, detailed by tribal researchers, similarly operate so that, together, these surveys likely underestimate even contemporary tribal fish consumption rates.[125]

Additionally, depending on the time period that is covered by a survey, the recorded rates may undercount contemporary intake if the period is one of relatively low harvest. This has been shown to be the case, for example, for the years in the early 1990s canvassed by the CRITFC survey, during which the tribal harvest was significantly reduced from more recent years, coinciding with severe reductions in fish availability in the Columbia River Basin, for example, an 80% reduction for summer Chinook and a 94% reduction for fall Chinook.[126] With this concern in mind, the Lummi Nation opted in its recent survey to document consumption practices and rates for the year 1985, a period in contemporary time in which the harvest was more robust than at present, although still suppressed relative to the time of the treaties.[127]

While contemporary rates are not representative of treaty-guaranteed practices, surveys of contemporary tribal consumption document rates of fish intake that are nonetheless markedly greater than for the general population. According to the national survey on which the EPA bases its current default recommendations, the 50th percentile rate is 5.0 grams/day; the 90th percentile rate is 22.0 grams/day; and the 99th percentile rate is 61.1 grams/day.[128] As Table 1 shows, contemporary tribal intake is greater at every point of comparison.[129]

[125] *See, e.g.,* Donatuto & Harper, *supra* note 98.
[126] Letter from Babtist Paul Lumley, Executive Director, CRITFC, to Ted Sturdevant, Director, Washington State Department of Ecology 3 (Mar. 19, 2012) (pointing to "the fact that more than 61% of the survey respondents reported that their fish consumption was suppressed by poor fish harvests during the early 1990's" and observing that "[f]ish counts at Lower Granite Dam, reported by the US Army Corps of Engineers (USACE) confirm that spring and summer Chinook availability in the Columbia Basin at the time of the CRITFC survey (1991-1992) was close to 80% lower … and fall Chinook was 94% lower than [in 2002]. Fish availability is similar today compared to 2002 and continues to improve for fall Chinook").
[127] LUMMI NATION SEAFOOD CONSUMPTION STUDY, *supra* note 13 at 1.
[128] U.S. ENVIRONMENTAL PROTECTION AGENCY, ESTIMATED FISH CONSUMPTION RATES FOR THE U.S. POPULATION AND SELECTED SUBPOPULATIONS (NHANES 2003-10), FINAL REPORT , Tbl. 9a (April, 2014), http://www.epa.gov/sites/production/files/2015-01/documents/fish-consumption-rates-2014.pdf. Note that these figures do not represent total fish intake, but rather "usual" intake of "freshwater" and "estuarine" species only, for adults aged 21 and over, according to the 2003-2010 NHANES data. *Id.*
[129] Table 1 reflects the summary statistics reported by four recent surveys of contemporary tribal fish consumption. *See*, COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION, A FISH CONSUMPTION SURVEY OF THE UMATILLA, NEZ PERCE, YAKAMA, AND WARM SPRINGS TRIBES OF THE COLUMBIA RIVER BASIN (1994) [hereinafter CRITFC, FISH CONSUMPTION SURVEY]; TOY, ET AL, A FISH CONSUMPTION SURVEY OF THE TULALIP AND SQUAXIN ISLAND TRIBES OF THE PUGET SOUND REGION (1996) [hereinafter Tulalip and Squaxin Island Fish Consumption Survey]; SUQUAMISH TRIBE, FISH CONSUMPTION SURVEY OF THE SUQUAMISH TRIBE OF THE PORT MADISON INDIAN RESERVATIONS, PUGET SOUND REGION (2000) [hereinafter Suquamish Tribe, Fish Consumption Survey]; and LUMMI NATION SEAFOOD CONSUMPTION STUDY, *supra* note 13. These statistics in some cases represent conversions from data originally expressed in grams of fish intake/kilogram of bodyweight/day; such conversions necessarily involve a number of judgments and assumptions. As such, this Table enlists the statistics as they have been reported in a number of recent governmental publications, namely, by the Lummi

Table 1

Surveyed Population	Fish Consumption at Descriptive Percentiles (grams/day)					
	Mean	50th	90th	95th	99th	Maximum
CRITFC Tribes	63	40	113	176	389	972
Squaxin Island Tribe	73	43	193	247	--	--
Tulalip Tribe	72	45	186	244	312	--
Suquamish Tribe	214	132	489	796	--	1453
Lummi Nation	383	314	800	918	--	--

2. All Fish

Ecology's proposed human health criteria appropriately enlist an FCR that does not exclude anadromous species, such as salmon, from comprising the rate. This is an appropriate decision in view of the best available science and the relevant law. EPA's proposed WQS similarly supported this synthesis of the science and the law. As EPA explained:

> Although EPA's national default FCR only includes consumption of fish from inland and nearshore waters, 175 g/day in this case includes anadromous fish, which is appropriate given that anadromous species reside in Washington's nearshore waters, especially Puget Sound, and accumulate pollutants discharged to these waters. A FCR of 175 g/day, therefore, accounts for local fish consumption data.[130]

With respect to the science, data show that salmon are contaminated at levels that pose a threat to human health and several fish consumption advisories for Washington waters include salmon among the species for which intake should be curtailed or avoided altogether. However, given salmon's anadromous habit, and given that a portion of many salmon life histories is spent outside of the waters over which Washington asserts regulatory jurisdiction, (i.e., in the Pacific ocean beyond the three-mile coastal zone), it has been argued that salmon ought to be excluded from the tally of fish intake, because their contaminant body burden comes from "elsewhere." However, as elaborated below, the data for Puget Sound reveal a south-north gradient such that South Sound salmon, which must run a greater

Nation, the Oregon Department of Environmental Quality, and the Washington State Department of Ecology. LUMMI NATION SEAFOOD CONSUMPTION STUDY *supra* note 13, at 57; ODEQ, HHFG REPORT, *supra* note 121, at 28; and WASHINGTON DEPARTMENT OF ECOLOGY, FISH CONSUMPTION RATES TECHNICAL SUPPORT DOCUMENT 6 (Sept. 2011), https://fortress.wa.gov/ecy/publications/summarypages/1109050.html. The exceptions are the maximum values, which were not reported in these publications, but the Suquamish value is available at SUQUAMISH TRIBE, FISH CONSUMPTION SURVEY, at 11, 25, 71 (Catherine O'Neill's calculations, based on maximum individual rate, in g/kg/day; mean bodyweights for men and women, and percentage of male and female respondents); the CRTIFC value is available at CRTIFC, FISH CONSUMPTION SURVEY, at 29.

[130] 80 Fed. Reg. at 55067-78 (citation omitted).

gauntlet of contaminated environments in their outward and homeward migrations than their Georgia Strait and Pacific coastal counterparts, have significantly greater concentrations of bioaccumulative toxicants in their tissue. Other data from around the region show the presence of contaminants in the salmon at various life stages, including in outmigrating juveniles still in freshwater environments.[131] Moreover, there is considerable variability, even within species, in salmon's behavior. Chinook salmon originating in the rivers of the Puget Sound watershed, for example, typically migrate out to the Pacific and forage along the coastal continental shelf; however, a substantial portion of these salmon display "resident" behavior, remaining in the Puget Sound during the marine phase of their lives. Further, "the waters of Washington" include the Puget Sound, portions of the Straits of Juan de Fuca and the Columbia River, and Pacific coastal waters to a distance of three miles, and contaminants released or re-suspended at one location may be transported to another. It is likely, therefore, that some salmon get all of their contaminants from sources for which Washington has regulatory responsibility, and some salmon get only some of their contaminants from sources for which Washington has regulatory responsibility.

Recent studies by Sandra O'Neill and Jim West[132] and by Donna Cullon, et al.[133] have recognized that anthropogenic influences had contributed to contamination of the Puget Sound watershed and set out to determine the source of contaminants in Pacific salmon, as between their freshwater and saltwater environments. The O'Neill & West study looked at PCBs in Chinook salmon; the Cullon, et al., study looked at a host of persistent organic pollutants (POPs), including PCBs, dioxins and furans, and DDT. Both studies sampled out-migrating juveniles and returning adult salmon at several locations. The O'Neill & West study sampled five "in-river" (i.e., freshwater or estuarine) locations ranging from the Deschutes River in the south to the Nooksack River in the north, as well as two marine locations in the south and central Puget Sound. The Cullon, et al., study sampled two in-river locations, the Deschutes and the Duwamish.

O'Neill & West found, first, that the average PCB concentration in returning adult Puget Sound Chinook was 3 to 5 times greater than average concentrations reported in adult Chinook at six other West Coast locations outside Puget Sound. O'Neill & West concluded that "the elevated PCB levels observed for Puget Sound Chinook salmon relative to coastal populations were probably associated with differences in PCB contamination in the environments they inhabit or with differences in diet." O'Neill & West also

[131] *See, e.g.,* Lyndal L. Johnson, et al, *Contaminant Exposure in Outmigrant Juvenile Salmon from Pacific Northwest Estuaries of the United States*, 124 ENVIRONMENTAL MONITORING & ASSESSMENT 124 (2007); Catherine A. Sloan, et al., *Polybrominated Diphenyl Ethers In Outmigrant Juvenile Chinook Salmon From The Lower Columbia River And Estuary And Puget Sound, WA*, 58 ARCHIVES OF ENVIRONMENTAL CONTAMINATION & TOXICOLOGY 403 (2010); Gladys K. Yanagida, et al., *Polycyclic Aromatic Hyrdocarbons and Risk to Threatened and Endangered Chinook Salmon in the Lower Columbia River Estuary*, 62 ARCHIVES OF ENVIRONMENTAL CONTAMINATION & TOXICOLOGY 282 (2012).
[132] Sandra M. O'Neill & James E. West, *Marine Distribution, Life History Traits, and the Accumulation of Polychlorinated Biphenyls in Chinook Salmon from Puget Sound, Washington*, 138 TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY 616 (2009).
[133] Donna L. Cullon, et al., *Persistent Organic Pollutants in Chinook Salmon (Oncorhynchus tshawytscha): Implications for Resident Killer Whales of British Columbia and Adjacent Waters*, 28 ENVIRONMENTAL TOXICOLOGY & CHEMISTRY 148 (2009).

concluded that, although salmon uptake some PCBs from freshwater environments, the elevated concentrations of PCBs found in adult Chinook "were accumulated during residence in marine habitats rather than riverine habitats in the region." They reported that "adult Chinook salmon that had migrated as subyearlings from the Duwamish River, the most highly PCB-contaminated river draining into Puget Sound, accumulated the vast majority (>96%) of PCBs during their marine life history phase, whereas there was little PCB contribution from freshwater." Although Cullon, et al., sampled a small number of fish at fewer locations, their conclusions were similar.[134] Both O'Neill & West's discussion and their study design make clear that their findings respecting salmon's "marine life history phase" include the marine waters of Puget Sound, the Strait of Juan de Fuca, and other marine waters over which Washington asserts regulatory responsibility, in which returning adult salmon will have spent considerable time.

It should also be noted that, in many cases, the contaminants that are the subject of human health criteria are also contaminants of concern for the health of the salmon resource itself. Studies show that PCBs, PAHs, and other contaminants that are harmful to human health are also detrimental to the growth and reproductive success of the salmon.[135] One particularly troubling example has been documented by recent research into pre-spawn mortality among adult coho returning to urban streams, which the weight of the evidence suggests is attributable to toxic contaminants in urban stormwater runoff.[136] With adult mortality rates ranging from 60-100%, and inspection of the female carcasses showing 90% egg retention, the long-term impact on salmon reproduction is of grave concern. To take another example, juvenile Chinook salmon from the South Puget Sound have been shown to harbor PCBs in concentrations from 2,500 to 10,000 ng/g lipid, well above the 2,400 ng/g lipid threshold for adverse effects such as depressed growth.[137] Although EPA's proposed WQS address adverse impacts to

[134] *Id.* at 154 ("By comparing body burdens of POPs in returning adult Chinook to out-migrating smolts and juveniles, we estimate that 97 to 99% of the body burden of PCBs, PCDDs, PCDFs, DDT, and HCH in all stocks originated during their time at sea … Our estimation that the majority of POPs in Chinook salmon can be ascribed to their growth stage in coastal and marine waters is consistent with other studies. A study of Chinook from Washington ascribed 99% of PCBs in returning Duwamish River adults to the waters of Puget Sound and the Pacific Ocean.").

[135] See, e.g., Lyndal L. Johnson, et al., *The Effects of Polycyclic Aromatic Hydrocarbons in Fish in Puget Sound, Washington*, in The Toxicology of Fishes 877 (R.T. DiGiulio & D.E. Hinton, eds., 2008)(concluding "that even short-term exposures to PAHs may be associated with reduced growth and altered immune function in anadromous fish species that utilize contaminated estuaries in Puget Sound"); Eugene Foster, et al., *Toxic Conaminants in the Urban Aquatic Environment*, in Wild Salmonids in the Urbanizing Pacific Northwest 123 (J. Allen Yeakley, et al., eds., 2014)(discussing exposures and adverse impacts of PCBs, PAHs, dioxins and furans, heavy metals, PBDEs, chlorinated and other pesticides, and other toxic chemicals)

[136] See, e.g., Nathanial L. Scholz, et al., *Recurrent Die-Offs of Adult Coho Salmon Returning to Spawn in Puget Sound Lowland Urban Streams*, 6 PLoS One e28013 1, 7 (2011)(observing that "spawner mortality syndrome appears to be specific to coho in urban drainages. We observed no symptoms and less than 1% pre-spawn mortality among wild coho returning to spawn in the non-urban reference stream").

[137] James E. West, "Persistent Bioaccumulative and Toxic Contaminants in South Puget Sound's Pelagic Food Web," Presentation at the Fourth Annual South Sound Science Symposium, Squaxin Island (Oct. 30 2012) (citing James P. Meador, et al., *Use of Tissue and Sediment-Based Threshold Concentrations of Polychlorinated Biphenyls (PCBs) to Protect Juvenile Salmonids Listed Under the US Endangered Species Act*, 12 AQUATIC CONSERVATION: MARINE AND FRESHWATER ECOSYSTEMS 493 (2002) for source of threshold level of 2,400 ng/g lipid).

human health, the fact that many of the chemicals that are responsible for contamination of this fish resource also contribute to depletion of the fish resource is relevant to the bigger picture of tribes' legally protected fishing rights.

With respect to the law, the treaties reserved a means for ensuring tribes' survival and well-being in a changing world; they presumed resilience, not stasis. To this end, courts have held that tribal members are not restricted in their harvest to a particular mix of species, whether a mix taken in the past or in contemporary times. Rather, the right to take fish secured by the treaties is a right "without any species limitation."[138] As the court in the "Rafeedie" decision (a subproceeding of *U.S. v. Washington*) explained, "[at treaty] time,... the Tribes had the absolute right to harvest any species they desired, consistent with their aboriginal title.... The fact that some species were not taken before treaty time - either because they were inaccessible or the Indians chose not to take them - does not mean that their *right* to take such fish was limited."[139] Subsequent courts have continued to reject attempts to cabin tribes' fishing rights by excluding certain species argued not to have been harvested historically.[140] Tribes' rights cannot be thus pinned down: these rights encompass all species of fish. So, while a survey of contemporary tribal fish consumption practices may document a particular proportion of species consumed (e.g., out of a hypothetical 100 g/day of locally-harvested fish, 60 g/day salmon and 40 g/day other finfish and shellfish), tribal members are not in any sense bound to consume this mix of species in the future. Rather, to use the terminology of EPA Region X, tribal members are free to undertake "resource switching."[141] Yet industry has called for eliminating salmon from the FCR, in amounts calculated from contemporary consumption patterns.[142] This approach is at odds with tribes' rights to determine the mix of species that will comprise their dietary intake from their "usual and accustomed" areas in the future. Put another way, tribes' rights should be protected to the full extent of their total fish intake, at heritage rates.

Ecology's determination that it is not justified in excluding anadromous species from its calculation of the FCR is supportable on scientific and legal grounds. Ecology ought not alter this determination in the final rule.

[138] United States v. Washington, 873 F. Supp. 1422, 1430 (W.D. Wash. 1994).
[139] *Id*. (emphasis in original).
[140] *See, e.g.,* Midwater Trawlers Co-operative v. Department of Commerce, 282 F.3d 710 (9th Cir. 2002) (rejecting challenge to allocation of Pacific whiting fish to coastal tribes on grounds that they had not fished for whiting at the time of the treaties, stating "the term "fish" as used in the Stevens Treaties encompassed all species of fish, without exclusion and without requiring specific proof").
[141] U.S. ENVIRONMENTAL PROTECTION AGENCY REGION X, FRAMEWORK FOR SELECTING AND USING TRIBAL FISH AND SHELLFISH CONSUMPTION RATES FOR RISK-BASED DECISION MAKING AT CERCLA AND RCRA CLEANUP SITES FOR PUGET SOUND AND THE STRAIT OF GEORGIA 9 (Aug., 2007).
[142] *See, e.g.*, The Boeing Company, *Comments on Proposed Rule Making – Surface Water Quality Standars for the State of Washington*, 8-9 and Attachment 1 "Exclusion of Salmon Consumption from Fish Consumption Rate." (Mar. 23, 2015), http://www.ecy.wa.gov/programs/wq/ruledev/wac173201A/comments/0038b.pdf.

B. Cancer Risk Level

Ecology's proposed human health criteria enlist a cancer risk level of 10^{-6}. To its credit, Ecology corrects the flawed approach of its first proposed rule, and embraces once again the cancer risk level that has long been in force in Washington. EPA, too, in its proposed WQS for Washington recognized the appropriateness of retaining a cancer risk level of 10^{-6}. As EPA explained:

> Based on Washington's longstanding use of a cancer risk level of 10^{-6}, along with EPA's consideration of tribal reserved rights, EPA guidance, and downstream protection, EPA proposes to derive human health criteria for carcinogens in Washington using a 10^{-6} cancer risk level.[143]

Ecology's use of 10^{-6} for the cancer risk level is appropriate and ought to be retained in the final rule.

1. "Acceptable" Risk

Washington has long embraced the judgment that its WQS ensure that those affected are subjected to an excess cancer risk level "less than or equal to" 10^{-6}. Indeed, Washington has been emphatic in this embrace, expressing concern for aggregate risks and real-world impacts, should EPA have opted for a less protective cancer risk level when it issued the National Toxics Rule (NTR), through which it promulgated human health criteria for Washington back in 1992. As EPA recounted:

> To derive final human health criteria for each state in the NTR, EPA selected a cancer risk level based on each state's policy or practice regarding what risk level should be used when regulating carcinogens in surface waters. In its official comments on EPA's proposed NTR, Washington asked EPA to promulgate human health criteria using a cancer risk level of 10^{-6}, stating, ''The State of Washington supports adoption of a risk level of one in one million for carcinogens. If EPA decides to promulgate a risk level below one in one million, the rule should specifically address the issue of multiple contaminants so as to better control overall site risks.'' (57 FR 60848, December 22, 1992). Accordingly, in the NTR, EPA used a cancer risk level of 10^{-6} (one in one million) to derive human health criteria for Washington. Subsequently, Washington adopted and EPA approved a provision in the state's WQS that reads: ''Risk-based criteria for carcinogenic substances shall be selected such that the upper-bound excess cancer risk is less than or equal to one in a million'' (WAC 173–201A–240(6)). This provision has been in effect in Washington's WQS since 1993.[144]

[143] 80 Fed. Reg. at 55068.
[144] *Id.*

As a general matter, a risk's acceptability can turn on a host of factors respecting the nature of the risk (including, e.g., its familiarity, controllability, etc.); whether the risk is sought out or undertaken voluntarily; what is at stake/the seriousness of the harm (including, e.g., death, irreversible neurological impairment, cancer); whether the risk is equitably distributed (including, e.g., whether those who bear the risk also benefit from the risk-producing activity); whether subpopulations of particular concern will bear the risk (including, e.g., children); and whether the risk attends the exercise of practices that are important or to which people have rights.[145]

Yet, public debate about risk is often couched in the abstract, in terms of "statistical lives," i.e., nameless, faceless probabilities. As Professor Douglas MacLean observes, "[r]isk analysts have tended to focus only on the magnitude of the risk, however distributed. … If exactly one person will die each year, the $1(10^{-6})$ magnitude indicates our ignorance in advance about who it will be."[146] This theoretical ignorance allows the discussion about risk to proceed on the premise that everyone is equally likely to be among the unfortunate.

This requisite – that everyone is equally likely to have to bear the risk – is thought to be satisfied in one of two ways. First, everyone can be expected to experience roughly the same level of risk if their circumstances of exposure are roughly the same – that is, the physical, geographical, and other parameters that determine each individual's exposure don't vary that much from person to person. Alternatively, everyone can be thought to experience roughly the same *chance* of experiencing a relatively high or relatively low level of cancer risk if we don't know, in advance, on whom the greater risk will fall – it is a greater chance being taken by all of us, like a lottery.[147] But, as elaborated below, neither of these conditions holds true when we are talking about fish consumption.

As to the first, individuals' circumstances of exposure are emphatically *not* "roughly the same" where the exposure pathway involves fish consumption. In fact, fish intake is highly variable, with differences in people's contemporary intake spanning as many as three orders of magnitude. Some people eat no fish at all; others eat 1453 grams/day.[148] The 90th percentile intake rate for the general population is the source of the EPA's national default of 22 grams/day.[149] By contrast, the 90th percentile intake rate documented by recent surveys of the Suquamish and Lummi is 489 grams/day and 800 grams/day, respectively.[150] Note that these are contemporary, suppressed fish consumption rates (FCRs); if unsuppressed historical or "heritage" rates were considered the variability would be even more marked.

[145] See, e.g., Molly J. Walker Wilson, *Cultural Understandings of Risk and the Tyranny of the Experts*, 90 OREGON L. REV. 113 (2011); see generally, VALUES AT RISK (Douglas MacLean, ed., 1986).
[146] Douglas MacLean, *Social Values and the Distribution of Risk*, in VALUES AT RISK 75, 78-79 (Douglas MacLean, ed., 1986).
[147] See discussions in Catherine A. O'Neill, *Variable Justice: Environmental Standards, Contaminated Fish, and "Acceptable" Risk to Native Peoples*, 19 Stan. Envtl. L. J. 3, 73-75 (2000); and O'Neill, *Fishable Waters*, *supra* note 19, at 255-260.
[148] *See* O'Neill, *Fishable Waters*, *supra* note 19, at Table 1 (The 1453 grams/day figure is the value for intake by the maximum consumer surveyed in the Suquamish tribal study).
[149] *See, supra* note 128 and accompanying text.
[150] O'Neill, *Fishable Waters*, *supra* note 19, at Table 1.

As to the second, we cannot pretend that everyone's chances of being subjected to a greater level of risk are roughly the same. In the Pacific Northwest, we know *who* it is that depends on fish, *who* it is that is the most exposed. We know, then, *who* will be left to bear the risk if the level deemed "acceptable" for a state such as Washington is permitted to shift to a less protective level: it will be tribal people. This is problematic as an ethical matter, and it changes the terms of the policy debate. We cannot pretend to be debating the appropriate risk level in the abstract, i.e., in terms of statistical lives.

Previously, the state of Washington had deemed "acceptable" a risk level of 10^{-6}. This is the risk level that Washington found tolerable *when it assumed that everyone was more or less equally likely to be on the receiving end of the risk of cancer* – when it employed the national general population default rate for fish intake in its calculations. Now, however, studies are available that demonstrate both that fish intake is highly variable and that tribal people are among the very highest consumers. Any shift away from Washington's longstanding embrace of a 10^{-6} risk level would have an undeniable implication: namely, that Washington believes it to be "okay" for risk-producers to transfer the costs of their processes to identifiable people – tribal people – in the form of increased cancer risk.

2. Consideration of Tribes' Legally Protected Rights

Moreover, as EPA correctly recognized, it is simply not free to choose a cancer risk level for Washington that, together with the other relevant inputs to the human health criteria, has the effect of impairing tribes' legally protected fishing rights. Neither is Ecology free to do so. Courts have repeatedly recognized that if the waters are permitted to be significantly degraded, tribes' legally protected fishing rights can be eviscerated as surely as if tribal members had been hauled from their boats or barricaded from their fishing places.

As EPA acknowledged:

> In order to effectuate reserved fishing rights, including the rights that federal treaties afford to tribes in Washington, EPA proposes to derive criteria that will protect the tribe's reserved fishing rights in Washington, treating the tribal population exercising those rights as the target general population. EPA's selection of a 10^{-6} cancer risk level for the tribal target general population is consistent with EPA's 2000 Human Health Methodology, which states that when promulgating water quality criteria for states and tribes, EPA intends to use the 10^{-6} level, which reflects an appropriate risk for the general population. EPA's 2000 Human Health Methodology did not consider how CWA decisions should account for applicable reserved fishing rights, including treaty-reserved rights. [B]ecause a FCR of 175 g/day very likely does not reflect unsuppressed consumption, using a cancer risk level of 10^{-6} ensures protection of tribal members' unsuppressed consumption. Independently, the treaties themselves could require higher levels of protection. The treaties themselves could be interpreted to require a certain level of risk; *e.g., a de minimis* level of risk that would most reasonably approximate conditions at the time the treaties were signed and the fishing rights were

> reserved. … In this case, EPA considers 10^{-6} to be sufficiently protective, and the tribes have supported this during consultation.[151]

EPA's rationale correctly recognized that the tribes' treaty-protected rights presumed fish that are fit for human consumption – not fish that harbor unhealthful levels of carcinogenic and other contaminants. As elaborated at greater length in Part II, above, Judge Martinez' analysis in the Culverts case of the tribes' reservation of their right to take fish emphasized the role of the fish as food, forever – "for subsistence and for trade" – noting "[t]he significance of [the] right [to take fish] to the Tribes, its function as an incentive for the Indians to sign the treaties, and the Tribes' reliance on the unchanging nature of that right."[152] Judge Martinez found that the parties' understandings of the reliability and abundance of fish resource, together with Stevens' promises to the end that this would "forever" be the case, were what persuaded the tribes to sign the treaties. As Judge Martinez observed, "[i]t was not deemed necessary to write any protection for the resource into the treaty because nothing in any of the parties' experience gave them reason to believe that would be necessary." He then quoted historian Joseph Taylor:

> During 1854-55, white settlement had not yet damaged Puget Sound fisheries. During those years, Indians continued to harvest fish for subsistence and trade as they had in the past. Given the slow pace of white settlement and its limited and localized environmental impact, Indians had no reason to believe during the period of treaty negotiations that white settlers would interfere, either directly through their own harvest or indirectly through their environmental impacts, with Indian fisheries in the future. During treaty negotiations, Indians, like whites, assumed their cherished fisheries would remain robust forever.[153]

Thus, Judge Martinez concluded:

> [T]he representatives of the Tribes were personally assured during the negotiations that they could safely give up vast quantities of land and yet be certain that their right to take fish was secure. These assurances would only be meaningful if they carried the implied promise that neither the negotiators nor their successors would take actions that would significantly degrade the resource.[154]

Thus, courts' interpretations of the treaties support EPA's recognition that the proper touchstone is the "level of risk that would most reasonably approximate conditions at the time the treaties were signed and the fishing rights were reserved." I support this recognition by EPA[155] and urge it upon Ecology.

[151] 80 Fed. Reg. at 55068 (citations and internal cross-references omitted).
[152] Culverts Order, 2007 WL 2437166 at *7-*8.
[153] *Id*. (quoting Declaration of historian Joseph E. Taylor, III).
[154] *Id.* at *10. .
[155] I support this recognition with one caveat. EPA characterizes the "level of risk that would most reasonably approximate conditions at the time the treaties were signed and the fishing rights were reserved" as a "*de*

As EPA further acknowledged, while "[i]ndependently, the treaties themselves could require higher levels of protection" than that afforded by the proposed human health criteria, a 10^{-6} is appropriate in this context because it has been supported by tribes in consultation.

3. Actual Risk

Additionally, EPA has indicated that, in determining the adequacy of states' WQS, it will consider the *actual* risk that results to those affected when all of a state's selected parameters are considered, and has stated that its scrutiny will increase as a state's target risk level becomes less protective or less conservative, e.g., if it moves from 10^{-6} to 10^{-5}.[156] EPA has emphasized that it will require "substantial support in the record," including an analysis of how the state's selected inputs to its risk assessment equation, when taken together, reasonably estimate the risk actually posed.[157] This concern for the risks actually faced by those exposed counsels attention to estimates of cumulative impacts experienced by tribal members consuming at contemporary rates. Studies of cancer risks from the multiple chemicals present in the Columbia River Basin suggest reason for disquiet.[158] When one considers particular species or sites, the risk levels are sobering. For example, at a site between the John Day and McNary dams, a person consuming fish at contemporary levels documented in the CRITFC survey (389 grams/day) has an excess cancer risk between 1 in 100 and 1 in 1000 for all four species surveyed (i.e., steelhead, fall Chinook, largescale sucker, and white sturgeon). This concern also counsels attention to the actual risks that would be experienced by those consuming at historical or "heritage" rates, as tribal members have a right and an intention to do. Ultimately, this concern lends further support to Ecology's selection of a 10^{-6} level in proposing human health criteria for Washington.

minimis" level. If this characterization is meant to acknowledge that, at treaty time, the fish resource would have been virtually free of carcinogenic and other contaminants, it may be supportable. However, EPA then goes on to state that it equates "de mininis" in this context with a level of contaminants that results in 10^{-6} cancer risk, and to suggest, moreover, that this has "often" been EPA policy. 80 Fed. Reg. at 55068 ("In policy development regarding management of cancer risks, EPA often uses 10^{-6} as a *de minimis* risk level"). I do not agree that this statement is accurate. For water quality standards, for example, EPA historically took pains to point out that for non-threshold contaminants, such as carcinogens, only a zero-risk level would render the fish free from contaminants in amounts harmful to human health. A complete discussion of this issue, however, is beyond the scope of these comments.

[156] EPA, National Toxics Rule, *supra* note 6, 57 Fed. Reg. at 60848-01 ("In submitting criteria for the protection of human health, States were not limited to a 1 in 1 million risk level (10^{-6})… If a State selects a criterion that represents an upper bound risk level less protective than 1 in 100,000 (i.e., 10^{-5}), however, the State needed to have substantial support in the record for this level…. [Among other things,] the record must include an analysis showing that the risk level selected, when combined with other risk assessment variables, is a balanced and reasonable estimate of actual risk posed, based on the best and most representative information available. The importance of the estimated actual risk increases as the degree of conservatism in the selected risk level diminishes. EPA carefully evaluated all assumptions used by a State if the State chose to alter any one of the standard EPA assumption values.").

[157] *Id.*

[158] EPA and CRITFC, Columbia River Basin Contaminant Survey, app. N, 2-3 and fig. 6-26. (2002), http://yosemite.epa.gov/r10/oea.nsf/0/C3A9164ED269353788256C09005D36B7?OpenDocument. This estimate of risk is for whole body samples and assumes a 70-year exposure duration.

Importantly, Ecology's second proposed rule explicitly or implicitly adopts a much less protective cancer risk level for three of the carcinogens of greatest concern, as outlined above (PCBs, dioxins and arsenic), even assuming a fish consumption rate of 175 grams/day (that is, a contemporary, rather than "heritage" rate). In short, when it matters, Ecology has rejected the 10^{-6} risk level, leaving tribal people to bear far greater actual risk. Additionally, Ecology has been selective in choosing the inputs to its risk assessment equation – adopting more recent values in EPA guidance where they render the standards less protective, but ignoring the latest values where they would require the standards to be more protective. However, as EPA's statements about the net effect of states' choices suggest, Ecology does not have unlimited flexibility to select the least conservative or least protective values for most or all of the relevant variables, e.g., human bodyweight, relative source contribution, bioconcentration factor, and human lifespan, such that any progress toward fishable waters is undermined, and people's actual risk is far greater than a level deemed "acceptable."

C. Relative Source Contribution

Ecology's second proposed WQS eschew EPA guidance and instead enlist a relative source contribution (RSC) of 1. By contrast, EPA's proposed human health criteria enlist its recently updated chemical-specific values for relative source contributions for noncarcinogens and nonlinear carcinogens, which range from 0.2 (20 percent) to 0.8 (80 percent), and use an RSC of 0.2 for the remaining pollutants for which national values were not updated. As EPA explained:

> EPA recommends using a RSC for non-carcinogens and nonlinear carcinogens to account for sources of exposure other than drinking water and consumption of inland and nearshore fish and shellfish.[159]

I support EPA's approach to the RSC, and agree with the rationale cited by EPA in support of its choice.

The RSC accounts for the fact that people are exposed to contaminants through other pathways in addition to consumption of fish. Because non-carcinogens and non-linear carcinogens are threshold contaminants (i.e., there is a threshold above which exposure is not safe), the RSC is intended to recognize that, were people to obtain the entirety of their contaminant "budget" from fish and/or surface water intake, exposures via other pathways (e.g., dietary intake of non-fish items; inhalation; dermal absorption) would lead to an exceedance of the relevant health-protective threshold. By selecting an RSC of 1, Ecology attempts to avert its gaze from people's exposures in the real world and to ignore the threshold nature of the contaminants to which a more protective RSC would apply. Ecology effectively leaves it to other sources and/or to those people who are exposed to deal with the fact that Ecology permits the sources of contaminants in water and fish to exhaust the contaminant budget.

[159] 80 Fed. Reg. at 55068.

EPA recommends its default of 0.2 to allow room in the "budget" for other sources of exposure where there is uncertainty about other sources of exposure, but states that if other sources of exposure are well known and characterized, an RSC of up to 0.8 may be adopted. As Ecology recognizes, the difference between a criterion calculated assuming an RSC of 1.0 and 0.2 is significant, with the former producing a criterion that is less stringent by 80%. Although Ecology does not suggest that the other potential sources of exposure for Washingtonians are well characterized, it nonetheless proposes to exceed even EPA's high-end recommendation of an RSC of 0.8. It again attempts to portray its decision as a "risk management" call that is left to the states "to carefully weigh," in this instance based on a questionable understanding of the scope of the CWA and states' role in determining that scope.

The use of an RSC to account for an individual's total exposure to contaminants in the environment is particularly important for tribal populations, given that tribal people are disproportionately exposed to contaminants through multiple pathways, some of which are unique and unaccounted for in health and environmental agencies' conventional exposure assumptions.[160] A more protective RSC can help ensure that tribal people's practice of their traditional lifeways and exercise of their legally protected fishing, hunting, gathering and other rights aren't undermined by contamination.

D. Bodyweight

Ecology's proposed human health criteria use a bodyweight of 80 kg. Ecology cites EPA's 2015 national ambient water quality criteria, which enlist an updated average adult bodyweight of 80 kg (176 pounds) in place of the bodyweight of 70 kg (154 pounds) previously assumed nationally and in Washington. Ecology also suggests that this national figure is consistent with local tribal data relevant to Washington. Ecology's choice is unsupportable when considered, as it must be, in context; Ecology should retain the former 70 kg bodyweight.

Because the bodyweight variable resides in the denominator of the relevant risk assessment equations, an increase in its value means a decrease in the protectiveness of the resulting WQS. Ecology's proposed change to 80 kg would render Washington's WQS about 10-15% less protective than were it to retain a 70 kg value. Such a change would mean that the fish will be that much less safe to eat – or, to put a finer point on it: tribal people seeking to put a healthy, uncontaminated meal of fish on their table will be able to do so less often.

Tribes know well the connection between tribal members' health and their ability to obtain and consume traditional foods. For the fishing peoples throughout the Pacific Northwest, salmon and other fish and shellfish are at the center of a traditional diet. As documented by a recent study of one of the fishing tribes, "[t]he loss of traditional food sources is now recognized as being directly responsible for a host of diet-related illnesses among Native Americans, including diabetes, obesity, heart disease,

[160] *See, generally*, NATIONAL TRIBAL TOXICS COUNCIL, UNDERSTANDING TRIBAL EXPOSURES TO TOXICS (June 2015).

tuberculosis, hypertension, kidney troubles, and strokes."[161] These illnesses are currently a matter of grave concern throughout Indian Country. American Indians and Alaska Natives now suffer extraordinary rates of diabetes – two to three times that of all other racial/ethnic populations combined.[162] Some 1,300 patients with diabetes require the services of the Yakama Indian Health Clinic; the incidence of diabetes in the Yakama Nation is 14.8% – double that in the state of Washington. The relatively higher bodyweights recorded in contemporary surveys of tribal people in the Pacific Northwest coincide with the depletion and contamination of the fish resource. This increase is also a direct legacy of the days in which tribal fishers were harassed and their fish frightened away by public officials; tribal nets were slashed; and tribal boats and gear were destroyed or confiscated. With tribal fishers in jail, there was no fish to put on their family's table. Without gear – and no fish to sell to buy new gear – some fishers were forced to turn to other work.[163] Together, these forces have worked to deprive tribal people of their salmon and other traditional foods and have fueled a public health crisis.

The solution is not to take one element of that crisis – increased bodyweight – as a "given," and therefore a basis for environmental agencies to permit more contaminants in fish. Rather, the solution is to see the bigger picture: human health-based standards ought not be set in a manner that undermines human health. They shouldn't permit *greater* contamination of the very foods that are recommended as healthful ways to combat diabetes, obesity, and other diet-related conditions.[164] The historical context that is relevant where, as here, WQS affect tribes' rights, resources, and health and well-being, provides support for deriving criteria in a manner that departs from EPA's updated national assumptions.

The perversity of Ecology's approach is underscored by the fact that the National Indian Health Board[165] and the Centers for Disease Control and Prevention (CDC)[166] are hard at work in the opposite direction. They have devoted funds and devised programs that seek to enable, not thwart, tribal efforts to access and consume traditional foods as a means to decrease the incidence and impact of diabetes, obesity, and other conditions. For example, the CDC has partnered with seventeen tribes to launch traditional foods programs, which seek to encourage *increased* intake of these tribes' first foods in order to restore tribal health and well-being.

[161] Kari Marie Norgaard, *The Effects of Altered Diet on the Health of the Karuk People* (2005), http://ejcw.org/documents/Kari%20Norgaard%20Karuk%20Altered%20Diet%20Nov2005.pdf.
[162] Centers for Disease Control and Prevention, MMWR, *Health Disparities Experienced by American Indians and Alaska Natives* (Aug. 1, 2003), http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5230a1.htm.
[163] *See, e.g.,* Salmon Defense, *supra* note 97 (providing personal accounts of tribal fishers, leaders, and others involved in the struggle for tribal treaty rights from the pre-Boldt era to the present).
[164] *See* Catherine A. O'Neill, "Washington State's Weakened Water Quality Standards Will Keep Fish Off the Table, Undermine Tribal Health," Center for Progressive Reform Blog (March 4, 2014), http://www.progressivereform.org/CPRBlog.cfm?idBlog=8D9DD724-B323-B46A-857B382825C93F62.
[165] National Indian Health Board, Special Diabetes Program in Indian Country, http://www.nihb.org/sdpi/index.php.
[166] Centers for Disease Control and Prevention, Traditional Foods Project, http://www.cdc.gov/diabetes/projects/ndwp/traditional-foods.htm.

Ecology should be mindful of the historical context and retain the 70 kg body weight as a value that is supportive of tribal members' future health, including tribes' ability to combat the scourge of diabetes and other diet-related illnesses in their communities.

E. Drinking Water Intake

Ecology's proposed human health criteria use a drinking water intake (DWI) value of 2.4 liters/day. To its credit, Ecology improves upon its flawed first proposed WQS, which selected a DWI value of only 2 liters/day, citing an outdated version of EPA's Exposure Factors Handbook. Ecology's second proposed WQS enlist an updated DWI figure drawn from EPA's 2011 Exposure Factors Handbook. However, the 2011 Exposure Factors Handbook arguably supports updated values even greater than this.[167] Moreover, researchers have documented tribal drinking water intake needs at rates greater than the general U.S. population's needs, e.g., at 4 liters/day for a SpokaneTribal exposure scenario.[168]

F. Bioconcentration Factors Versus Bioaccumulation Factors

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Ecology proposes to eschew use of a bioaccumulation factor (BAF) in place of a bioconcentration factor (BCF), despite the fact that the former represents the best available science. Moreover, because a BAF accounts for all sources that contribute to the uptake of contaminants by fish (which are in turn consumed by humans), including water, food, and sediment, whereas a BCF only accounts for accumulation directly from the water, the former is also most appropriate for local conditions in Washington, where, among other things, the sediments harbor significant bioaccumulative toxics. Ecology's failure to move to the use of BAFs is likely to impact tribes in particular, given the importance of many upper trophic level fish to tribal people, as emphasized by the NWIFC Comments.

Ecology declines to enlist BAFs, despite the fact that EPA's AWQC Guidance has since 2000 recognized their greater accuracy in accounting comprehensively for the uptake of contaminants encountered by fish in the aquatic environment, and despite the fact that EPA itself published national default BAFs for 94 contaminants in early 2014, and incorporated these BAFs into EPA's proposed WQS for Washington in 2015. Ecology cites no plausible rationale for declining to make use of this newer science, instead, it claims that it needs more time and that EPA's embrace of this more scientifically defensible approach to accounting for actual contaminant concentrations in fish seems "rushed."

G. Life Expectancy

Ecology proposes to retain a 70-year exposure duration among its "implicit" inputs to its risk assessment equation, based on an average 70-year life expectancy supported by earlier editions of EPA's Exposure

[167] U.S. Environmental Protection Agency, *Exposure Factors Handbook 2011 Edition (Final)*, http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252 at 3-3 (documenting 95th % per capita value for all ages at 2.7 liters/day and 95% consumers-only value for all ages at 2.8 liters/day).

[168] Harper, et al., *Spokane Tribe's Exposure Scenario*, *supra* note 89; *accord*, National Tribal Toxics Council, *supra* note 160, at 10 (providing tribal subsistence exposure factors, including drinking water intake at "4+ liters per day").

Factors Handbook. However, the 2011 Exposure Factors Handbook indicates that the updated average life expectancy nationwide, based on the most recent science then available, is 78 years.[169] Moreover, local data published by the Washington Department of Health in 2013 document life expectancy for Washingtonians at 80.3 years, with recent trends "show[ing] that Washingtonians are living longer" than in previous times.[170] Interestingly, were Ecology as keen to base its exposure duration on the "newer science and local data" for life expectancy, this change would almost exactly cancel out the change Ecology proposes to the bodyweight variable.

V. The "Challenging Chemicals"

Ecology exempts four contaminants from the general parameters for deriving human health criteria discussed above, in Part VI: methylmercury, PCBs, dioxins, and arsenic. Dubbing these the "challenging chemicals," Ecology tackles them by postponing action (methylmercury) or by seeking out creative devices to justify standards that protect fish intake at only the status quo – 6.5 grams/day (one meal per month) – rate (PCBs) or at less than this rate (dioxins and arsenic), if one were to hold the cancer risk level constant. The flaws in Ecology's different devices for these contaminants are outlined above, in Part I, and elaborated at greater length in the NWIFC Comments. Ecology's rationale in each case does not hold up, in view of the science or the law.

Moreover, for each of these contaminants, there is a scientifically defensible and legally supportable basis for deriving a much more protective standard – one that would actually make progress toward attaining "fishable waters" and honoring tribes' rights to take fish. Each of these contaminants has serious adverse health effects (please see the NWIFC Comments for a catalogue of these impacts); together, they are the reason for the vast majority of the fish consumption advisories that apply to Washington waters and warn people away from consuming fish in quantities that would otherwise be healthful. Where Ecology should be redoubling its efforts to clean the waters and enable advisories to be lifted, Ecology instead has bent its energies toward justifying the contaminated status quo or worse. Rather, Ecology should adopt the current human health criteria in EPA's proposed WQS for Washington, except insofar as these do not incorporate an appropriate value for bodyweight and/or FCR (see, e.g., EPA guidance on deriving a methylmercury criterion), in which case Ecology should work with and consult the affected tribes in order to identify appropriate substitute values for these inputs.

VI. Implementation Tools

Ecology has had data evidencing tribes' and other Washingtonians' higher fish consumption rates for more than two decades now, beginning with the publication of the CRITFC survey back in 1994. Ecology

[169] EPA, Exposure Factors Handbook 18-1 (2011) *available at* http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf.

[170] Washington Dept. of Health, Mortality and Life Expectancy 1, 5 (Aug. 26, 2013), available at http://www.doh.wa.gov/Portals/1/Documents/5500/GHS-MLE2013.pdf (reporting the 80.3 years figure and adding that "[t]rends in life expectancy show that Washingtonians are living longer: the average life expectancy for those born in 2011 is 80 years, about five years longer than for those born in 1980").

has watched as fish consumption advisories have proliferated for Washington waters. Ecology has long been aware of the dangers of methyl mercury, PCBs, and other contaminants for which the primary route of human exposure is fish intake. Ecology has seen the NEJAC's admonitions regarding the environmental justice impacts of contaminated fish. Ecology, along with the other successors to the treaties, marked the 40th anniversary of the Boldt decision affirming tribes' treaty-secured rights to take fish just last year. After years of inaction, missed deadlines, and reversals of course, Ecology's proposed WQS make little or no progress – or worse – toward cleaning our waters and ensuring that our fish are fit for human consumption.   Remarkably, then, Ecology's proposed WQS also include a suite of what it calls "Implementation Tools" – i.e., mechanisms by which compliance with Washington's WQS can be delayed for some additional number of years.   The rationale for these tools offered by Ecology is the need for "more time" for the sources of contamination to be addressed – as if the contaminated state of Washington's waters and fish had been only recently discovered to be a concern. As I have argued elsewhere, the delay to date has been unconscionable; to augment the mechanisms by which sources might add to the time before which they must comply with WQS compounds this error.[171] Ecology is referred to the NWIFC Comments for a more detailed discussion of the particular problems with its various proposed implementation tools.

Conclusion

I thank Ecology for the opportunity to comment on its second proposed WQS for Washington and urge Ecology to work with the affected tribes on a government-to-government basis in order to ensure that the final rule advances protection of tribes' rights, resources, and health and well-being.

Respectfully submitted,

Catherine A. O'Neill
Professor of Law
Seattle University School of Law

[171] The implementation tools proposed by Ecology are also questionable on a variety of legal and policy bases, as elaborated in comments to the rulemaking docket by the Waterkeepers and NWIFC, which are incorporated herein by reference.

Commenter ID: 43

Commenter Name: Robert Oeinck

Commenter Association: Citizen

Comment received via online comment form

Comment:

Sure relax the time frames for compliance, let Inland paper ride, ignore Kaiser PCB's , arsenic isn't an issue. Flint officials are getting jail time for mismanagement, that should apply to all public servants who deny the public clean viable water resources, and place them at risk. It has been 100 years of pollution get a grip and end this madness.

Ms. Becca Conklin
Department of Ecology
PO Box 47600
Olympia, WA 98503-7600

Dear Ms. Conklin,

On behalf of our members, the Washington Public Ports Association (WPPA) respectfully offers the following comments on Ecology's proposed Water Quality Standards.

Port districts are created by the state to protect and preserve the public interest in access to commerce and to promote job growth through economic opportunity. Driven by this mission, ports have a long and distinguished record of advancing the economic interests of the State of Washington. Likewise, their role as stewards of land and water resources combines with the direct, elected accountability of our commissioners to demand that ports fully comply with environmental protection regulations. In this context, it is not surprising that ports have spent huge sums to acquire lands contaminated with toxic chemicals by other parties to ensure they are restored to health and productive use. Port districts are partners in environmental stewardship with the State of Washington for the long run.

WPPA commented on the previous water quality standards proposal and continues to prefer it. We have closely monitored the development of the proposed standards. We thanked the Governor for recognizing that inserting a 1×10^{-6} excess cancer risk rate into a complex formula will not produce the real life public health benefits hoped for by its advocates. We were encouraged by decisions to recognize the practical challenges posed by the ubiquitous contaminants arsenic, polychlorinated biphenyls (PCBs) and mercury and provisions to address them accordingly. Our members welcomed the leadership provided by Governor Inslee as evidenced in the previous rule-making proposal.

Furthermore, Ports worked to pass the Governor's proposed source control legislation because we believe that it is both more efficient and cost effective than further "end of pipe" regulations. We were disappointed by the failure of the legislation in 2015, but continue to be committed to practical solutions.

However, the new water quality standards raise a number of difficult questions. These questions include:

- As detection methods are inevitably improved, how will permittees be expected to achieve compliance under the proposal?
- What "reasonably available" technology will result in compliance?
- How can Ecology propose to use waivers and variances to achieve compliance when the processes to secure these tools are wholly untested and inherently contentious?
- How will increased demand for administrative action on the Water Quality Program be addressed without damaging its ability function?

We are dismayed to have not yet heard credible answers to these fundamental questions.

Because the consequences of the proposed rule are so uncertain, WPPA expects a proposal of this far-reaching nature to provide a concrete, realistic framework for how they will be addressed. We are deeply concerned that the proposed rule does not clearly establish such a framework.

For these reasons ask you to revert to previously proposed rule language for water quality standards.

Respectfully,

Gerry O'Keefe
Senior Director, Environmental Affairs

April 21, 2016

Ms. Becca Conklin
WA Dept. of Ecology
VIA Electronic Submittal

Re: Comments on Proposed WAC 173-201A Human Health Based Water Quality Standards

Dear: Ms. Conklin

The Washington Association of Sewer and Water Districts (WASWD) appreciates the opportunity to comment on Ecology's latest proposal for Water Quality Standards (WQS) revisions based on human health criteria.

WASWD supports the State taking the lead in development of these updates of WQS and values the greater local knowledge that Ecology staff can bring to bear in making the many decisions this process requires. Our members expect to continue to work in partnership with Ecology staff going forward, to protect human health and water quality, using the most reasonable approaches available.

WASWD supports the inclusion of implementation tools, including the addition of Intake Credits and the modest revisions to the existing language for Compliance Schedules and Variances, as essential to achieving compliance with the new limits. These tools need to be practical and widely available in order to provide a reasonable framework for compliance.

We support the use of the Drinking Water Standard for Arsenic, Copper, and Asbestos as reasonable to address these substances commonly found in our environment. Arsenic, in particular, is present in bedrock throughout the state.

Unfortunately, Ecology's economic analysis assumes the impact on permit holders will be quite small, perhaps based on the expectation that we already know about the occurrence of the contaminants with revised standards, at the levels of concern. In many cases this is not true, such that the cost just to determine if a new limit will potentially need to be addressed is almost certain to be much greater than the average cost of compliance developed by the economic analysis. This rule will affect communities on a site-specific basis and therefore have the potential for wide variation in the economic impact.

The Implementation Plan is also lacking in detail about how the new standards will be rolled-out in new permits, given the lack of data and the difficulty of obtaining data at some of these new very low levels. While all of the key parts of the plan are included, some additional detail in this critical area is needed.

We look forward to working together toward the best possible implementation of new WQS.

Sincerely,

Clair Olivers, WASWD Regulatory Liaison
425-212-8816

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
WATER AND WATERSHEDS

April 22, 2016

Ms. Becca A. Conklin
Washington Department of Ecology
Water Quality Program
P.O. Box 47600
Olympia, Washington 98504-7600

Re: EPA's Comments on Proposed Revisions to Washington's Human Health Criteria and New and Revised Implementation Provisions (Proposal Dated February 1, 2016)

Dear Ms. Conklin:

I am writing to submit the U.S. Environmental Protection Agency's comments on the Washington Department of Ecology's proposed human health criteria and new and revised implementation provisions issued on February 1, 2016. If adopted, this proposed rulemaking would revise the following sections of Washington's water quality standards:

- Human Health Criteria and Other Narrative Revisions (WAC 173-201A-240)
- Variances (WAC 173-201A-420)
- Intake Credits (WAC 173-201A-460)
- Compliance Schedules (WAC 173-201A-510(4))
- Implementation Clarification for Combined Sewer Overflows (CSO) Treatment Plants (WAC 173-201A-510(6))

The EPA fully supports Ecology's efforts to adopt human health criteria, and we appreciate the leadership that Ecology and the Governor's Office have shown thus far in developing Washington's human health criteria for toxics. Over the last several years, Ecology undertook an extensive public process to discuss options for rule development. The EPA appreciates that Ecology has gone through a second rule proposal that addresses some of the concerns the EPA raised about Ecology's first proposal dated January 12, 2015. As stated previously, the EPA supports Ecology's effort to use regional and local fish consumption data by proposing to adopt human health criteria based on a fish consumption rate of 175 grams per day. The best available data includes evidence of fish consumption rates well above 6.5 grams per day among high fish consumers in Washington, including tribal members with treaty-protected fishing rights.

The EPA is very supportive and pleased to see that Ecology's 2016 proposed rule retains the state's long-standing cancer risk level of 10^{-6}. Using this cancer risk level to derive the human health criteria for carcinogens sets an appropriate level of protection for all Washington citizens, including tribal members with treaty-protected fishing rights. In addition, using this cancer risk level should contribute to criteria that provide for the attainment and maintenance of the WQS of downstream waters, consistent with the EPA's regulations at 40 CFR 131.10(b).

As noted in previous comments, the EPA continues to have concerns that Ecology is not using the best available science for all the inputs to derive its human health criteria, in a manner that is consistent with the EPA's 2015 CWA section 304(a) recommendations or is based on a scientifically defensible alternative approach. Specifically, Ecology has chosen to use older bioconcentration factors (BCFs) instead of bioaccumulation factors (BAFs), and is not using relative source contributions (RSCs) that account for other contaminant sources in deriving the proposed human health criteria and has not demonstrated the scientific defensibility of these approaches. Although the EPA's updated human health 304(a) recommendations were in draft form at the time of our previous comments on Ecology's 2015 proposal, the EPA finalized those recommendations in June 2015. For more information on the EPA's position on using BAFs and RSCs when calculating human health criteria, please see the EPA's proposed federal rulemaking to update the National Toxics Rule (NTR) for Washington dated September 14, 2015 and our enclosed comments.

It is important to note that the EPA carefully considers the scientific defensibility and protectiveness of both the inputs used to derive criteria and the resulting criteria values, but it is ultimately on the criteria values that the EPA takes approval or disapproval action under CWA Section 303(c). The EPA has compared the criteria values from Ecology's proposal with the EPA's federal proposal, and notes that there may be instances where the state's proposed criteria are as or more stringent despite using BCFs (instead of BAFs) and RSC inputs that are not consistent with the EPA's 304(a) recommendations. The EPA will conduct a similar analysis in its review of any final criteria that Ecology adopts and submits to the EPA.

In addition, the EPA continues to note concerns about the approaches Ecology has used to derive criteria for two specific pollutants – PCBs and arsenic – as well as the lack of a methylmercury criterion in Ecology's proposal. Our enclosed comments provide more information on these pollutants.

Finally, as previously stated in our comments on Ecology's 2015 proposal, the EPA appreciates Ecology's efforts to consider implementation of these criteria by proposing new and revised implementation tools, which are relatively unchanged from the 2015 proposal. The EPA recognizes the importance of implementation tools in making progress toward improved water quality while accounting for the time needed for adaptive management, and remains committed to providing technical assistance to Ecology during implementation.

Enclosed are the EPA's detailed comments for your consideration. We have appreciated our work together throughout this process and remain available to provide technical assistance. If you have any questions concerning our comments or desire the EPA's assistance, please contact me at (206) 553-1855 or Angela Chung at (206) 553-6511.

Sincerely,

Daniel D. Opalski, Director
Office of Water and Watersheds

Enclosure

Enclosure

U.S. Environmental Protection Agency, Region 10
Comments on Washington Department of Ecology's Proposed Human Health Criteria and Implementation Tools Rule

April 22, 2016

Public Notice of Proposal Dated February 1, 2016

The Washington Department of Ecology (Ecology) provided draft surface water quality standards (WQS) revisions found at Chapter 173-201A WAC to the public for review and comment on February 1, 2016.[1] With these WQS revisions, Ecology is proposing to adopt human health criteria and revise or establish new implementation tools. This proposed rule has been revised from the state's previous proposed rule, which was public noticed on January 12, 2015. The EPA reviewed this second version of the state's proposed rule and associated documents and provides the following comments for Ecology's consideration. The comments are organized in the same manner as the EPA's comments on Ecology's 2015 proposed rule:

1. Human Health Criteria and Other Narrative Revisions (WAC 173-201A-240)
    - A. Fish Consumption Rate (FCR)
    - B. Cancer risk level
    - C. Relative Source Contribution (RSC)
    - D. Body Weight
    - E. Drinking Water Intake
    - F. Reference Dose (RfD) and Cancer Slope Factor (CSF)
    - G. Bioconcentration Factor (BCF)
    - H. Polychlorinated Biphenyls (PCBs)
    - I. Arsenic
    - J. Methylmercury
    - K. Pollutant Scope
    - L. Downstream Waters and Other Narrative Revisions

2. Implementation tools and definitions
    - A. Variances (WAC 173-201A-420)
    - B. Intake Credits (WAC 173-201A-460)
    - C. Compliance Schedules (WAC 173-201A-510(4))
    - D. Implementation Clarification for Combined Sewer Overflows (CSO) Treatment Plants (WAC 173-201A-510(6))

Please note that the EPA's positions described in the comments below, regarding the state's proposed WQS, are preliminary in nature and do not constitute an approval or disapproval by the EPA under the Clean Water Act (CWA) Section 303(c). Approval and/or disapproval decisions

[1] Department of Ecology. 2016. *Proposed Human Health Criteria and Implementation Tools Rule proposal – public review.* http://www.ecy.wa.gov/programs/wq/ruledev/wac173201A/1203docs.html.

will be made by the EPA following adoption of the new and revised standards by the state of Washington and submittal of revisions to the EPA. In addition, the EPA's comments do not constitute, and are not intended to be, an Administrator determination under CWA Section 303(c)(4)(B).

1. Human Health Criteria and Other Narrative Revisions (WAC 173-201A-240)

The state of Washington proposed human health criteria and revisions to certain implementation tools (e.g., variances and compliance schedules) in January 2015. However, in July 2015, Governor Inslee directed Ecology to reconsider its proposed human health criteria and implementation tool revisions given the 2015 Legislature's failure to pass proposed legislation and funding for stronger controls on toxics.

In June 2015, the EPA finalized updates to the Agency's national 304(a) recommendations for the protection of human health for 94 chemical pollutants.[2] These updated recommendations reflect the latest scientific information and EPA policies, including updated body weight, drinking water consumption rate, FCR, bioaccumulation factors (BAFs), health toxicity values, and RSCs. The EPA accepted written scientific views from the public from May to August 2014 on the draft updated human health criteria and published responses to those comments. The EPA water quality criteria serve as recommendations to states and tribes authorized to establish water quality standards under the CWA.

In September 2015, the EPA published a proposed rule to revise the current federal CWA human health water quality criteria applicable to Washington waters to ensure that the criteria are set at levels that will protect fish consumers in Washington from exposure to toxic pollutants. The EPA initially established Washington's existing human health criteria for toxic pollutants in the 1992 national toxics rule (NTR).[3] The EPA's proposed rule updates the FCR based on more recent regional and local fish consumption data, and updates the toxicity and exposure information, consistent with the EPA's 2015 updated 304(a) recommended human health criteria. The public comment period on the EPA's proposed rule ended on December 28, 2015. For more information, visit: http://www2.epa.gov/wqs-tech/water-quality-standards-regulations-washington.

In October 2015, Governor Inslee directed Ecology to revise the state's 2015 proposal. Ecology's 2016 proposal incorporates new science and includes several risk management decisions that affect the final criteria values. In particular, Ecology's 2016 proposed rule uses the current cancer risk level in Washington's WQS: one-in-one-million (10^{-6}).

Ecology's 2016 proposal includes human health criteria for 98 different toxic pollutants, which represents all CWA 307(a) priority toxic pollutants, except for methylmercury, for which the EPA has developed 304(a) recommendations for the protection of human health. Ecology added

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[2] Federal Register. Vol. 80, No. 124. June 29, 2015. *Final Updated Ambient Water Quality Criteria for the Protection of Human Health.* https://www.gpo.gov/fdsys/pkg/FR-2015-06-29/html/2015-15912.htm.
[3] EPA. 1992. *Toxics Criteria for Those States Not Complying with Clean Water Act*, section 303(c)(2)(B). 40 CFR Part 131.36. http://water.epa.gov/lawsregs/rulesregs/ntr/. Amended in 1999 for PCBs. http://water.epa.gov/lawsregs/rulesregs/ntrfact.cfm.

these proposed criteria values to Table 240 in the state's WQS, which also contains aquatic life criteria. In most cases, Ecology calculated criteria for each pollutant using the EPA's recommended 304(a) human health criteria equations for carcinogens and non-carcinogens with state-selected inputs. However, in the case of human health criteria for arsenic, copper, and asbestos, Ecology derived those values differently using Safe Drinking Water Act Maximum Contaminant Levels and Maximum Contaminant Level Goals.

In addition, Ecology's 2016 proposal includes new and revised implementation tools in the state's WQS. Ecology has revised its compliance schedule and variance provisions as well as added language regarding intake credits and implementation clarification for combined sewer overflow treatment plants (CSOs). With the exception of the provision regarding CSOs, these new and revised implementation tools are similar to the state's 2015 proposal.

Below are the EPA's comments on the individual input parameters that Ecology used to derive its proposed human health criteria along with comments on Ecology's proposed narrative revisions to WAC 173-201A-240. The EPA's comments will assist the state in developing final water quality criteria that protect applicable designated uses and are based on sound scientific rationale consistent with 40 CFR 131.11(a), and protect downstream WQS consistent with 40 CFR 131.10(b).

A. Fish Consumption Rate (FCR)

In Ecology's 2016 proposed rule, the state derived human health criteria using a FCR of 175 grams per day (g/day). Ecology stated that this value is representative of state-specific information and was determined through a process that included consideration of EPA guidance and precedent, and input from multiple stakeholder organizations. Specifically, Ecology stated that this value is representative of FCRs for highly exposed populations that consume both fish and shellfish from Puget Sound waters and is considered an "endorsed" value.[4]

Washington's proposal to use 175 g/day to calculate its revised human health criteria is consistent with the 95th percentile of *A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin* (Columbia River Inter-Tribal Fish Commission (CRITFC), 1994), and is the same FCR that the EPA used in its September 2015 federal proposal and that the state of Oregon used to derive its human health criteria, which the EPA approved in 2011.[5] In selecting a FCR, Ecology considered data from local fish consumption surveys.[6]

The EPA remains encouraged that Ecology is choosing to protect high fish consumers in Washington by deriving the state's human health criteria using local and regional fish

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[4] Department of Ecology. January 2016. *Washington State Water Quality Standards: Human Health Criteria and Implementation Tools. Overview of Key Decisions in Rule Amendment.* Publication no. 16-10-006. Page 18. https://fortress.wa.gov/ecy/publications/documents/1610006.pdf.

[5] EPA. October 2011. *Technical Support Document for Action on the State of Oregon's New and Revised Human Health Water Quality Criteria for Toxics and Associated Implementation Provisions Submitted July 12 and 21, 2011.* http://www.epa.gov/region10/pdf/water/or-tsd-hhwqs-2011.pdf.

[6] Department of Ecology. *Fish Consumption Rates Technical Support Document.* Final issued in January 2013. Draft issued in October 2011. http://www.ecy.wa.gov/programs/tcp/regs/fish/2012/FCR-doc.html.

consumption data. The EPA is also very supportive of the state's decision to include anadromous fish in the FCR used to derive the criteria, which is appropriate given the species that reside in Washington's nearshore and coastal waters, especially Puget Sound. Ecology's approach is consistent with the EPA's recommendation to use scientifically sound regional and local fish consumption data. The EPA acknowledges, however, that the tribes within the state have generally viewed 175 g/day as a compromise minimum value for current criteria-setting purposes, so long as it is coupled with a cancer risk level of 10^{-6}. Based on the EPA's review of existing data in Washington, in conjunction with consultation with the tribes, the EPA supports Washington's decision to derive the human health criteria using a FCR of 175 g/day and retaining a cancer risk level of 10^{-6} (see section B).

B. Cancer Risk Level

The EPA used a cancer risk level of 10^{-6} (1 in 1,000,000) to derive Washington's human health criteria for carcinogens in the 1992 NTR and the 2015 proposed federal rule to update the NTR for Washington. In the 1992 NTR, the EPA selected this cancer risk level with input from Washington, which adopted around the same time a WQS provision that states: "*Risk-based criteria for carcinogenic substances shall be selected such that the upper-bound excess cancer risk is less than or equal to one in a million*" (WAC 173-201A-240(6)), that the EPA approved in 1993. In Ecology's 2016 proposed rule, the state derived human health criteria for carcinogens using a cancer risk level of 10^{-6} (with the exception of PCBs and arsenic). The risk level is identified in the newly formatted toxics criteria table at WAC 173-201A-240.

The EPA's 2000 Human Health Methodology[7] states that use of a cancer risk level of 10^{-6} or 10^{-5} in the derivation of human health criteria may be an acceptable level of risk for the target general population.[8] However, the 2000 Human Health Methodology did not consider how CWA decisions should account for applicable treaty-reserved fishing rights in determining the appropriate level of protection. The EPA is very supportive of the state's decision to derive the human health criteria using a FCR of 175 g/day and retain a cancer risk level of 10^{-6}.

Finally, many of Washington's rivers are in the Columbia River basin, upstream of Oregon's portion of the Columbia River. Oregon's criteria are based on a FCR of 175 g/day and a cancer risk level of 10^{-6}. Ecology's proposal to derive human health criteria for Washington using a cancer risk level of 10^{-6} along with a FCR of 175 g/day helps ensure that Washington's criteria will provide for the attainment and maintenance of Oregon's downstream WQS consistent with 40 CFR 131.10(b) (see also Section L).

C. Relative Source Contribution (RSC)

The RSC is a factor applied in development of criteria for non-carcinogens and nonlinear carcinogens, to account for sources of exposure other than drinking water and freshwater and

[7] EPA. 2000. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health*. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA-822-B-00-004. http://www.epa.gov/waterscience/criteria/humanhealth/method/complete.pdf.

[8] The Methodology also notes that states and authorized Tribes can always choose a more stringent risk level, such as 10^{-7}. Page 1-12.

estuarine fish consumption (e.g., marine fish, non-fish food consumption, dermal exposure). In Ecology's proposed rule, the state derived human health criteria using a RSC value of 1.0. Ecology stated that this is an appropriate risk management decision due to the limited ability of the CWA to control exposure to pollutant sources outside of its jurisdiction. The EPA recommends a ceiling of 0.8 for the RSC to ensure protection of individuals whose exposure could be greater than indicated by current data and to account for unknown sources of exposure. In the EPA's 2015 updated 304(a) recommendations and September 2015 federal proposed rule for Washington, the EPA applied a pollutant-specific RSC value for all of the updated non-carcinogens and nonlinear carcinogens.[9]

The EPA commends Ecology for incorporating anadromous fish, which spend significant portions of their lives in marine waters, in the proposed FCR. This is particularly appropriate since data show adult salmon in Washington can accumulate a substantial fraction of their contaminant body burden during their residence time in Puget Sound (O'Neill and West, 2009) and near coastal marine waters (O'Neill 2006) that are under the jurisdiction of the CWA.[10, 11] The EPA's human health criteria FAQs clarify that, where a state's FCR includes freshwater, estuarine, and all marine fish consumption, states can adjust the RSC upward to reflect a greater proportion of the reference dose being attributed to marine exposures.[12]

However, even when accounting for anadromous fish in the FCR, Ecology has not adequately justified using a RSC value of 1.0 to derive human health criteria for all non-carcinogens and nonlinear carcinogens, nor has it adequately explained why it is appropriate to disregard all other routes of exposure, including air, soil, other marine fish and shellfish, non-fish food, etc. Therefore, the EPA continues to strongly recommend that Ecology choose an appropriate RSC in the recommended range of 0.2 to 0.8 using the Exposure Decision Tree approach as described in the EPA's 2000 Human Health Methodology and consistent with the EPA's 2015 304(a) recommendations and September 2015 federal proposed rule to calculate human health criteria that are protective of the designated use and based on sound science.

D. Body Weight

In Ecology's proposed rule, the state derived human health criteria using a body weight assumption of 80 kg based on tribal survey data relevant to Washington and the EPA's 2011

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[9] EPA. 2015. *Updated National Recommended Water Quality Criteria – Human Health.* http://www.epa.gov/wqc/human-health-water-quality-criteria.

[10] O'Neill, S.M., and J.E. West. 2009. Marine distribution, life history traits, and the accumulation of polychlorinated biphenyls in Chinook salmon from Puget Sound, Washington. Transactions of the American Fisheries Society 138: 616-632.

[11] O'Neill, S.M., G.M. Ylitalo, J.E. West, J. Bolton, C.A. Sloan, and M.M. Krahn. 2006. Regional patterns of persistent organic pollutants in five Pacific salmon species (*Oncorhynchus spp*) and their contributions to contaminant levels in northern and southern resident killer whales (*Orcinus orca*). 2006 Southern Resident Killer Whale Symposium, NOAA Fisheries Service Northwest Regional Office April 3-5, 2006. Seattle, WA. Extended Abstract. 5pp.

[12] EPA. January 2013. *Human Health Ambient Water Quality Criteria and Fish Consumption Rates: Frequently Asked Questions.* http://water.epa.gov/scitech/swguidance/standards/criteria/health/methodology/upload/hhfaqs.pdf.

Exposure Factors Handbook.[13] The EPA is supportive of Ecology assuming a body weight of 80 kg to derive human health criteria.

A body weight of 80 kg is the EPA's current default body weight assumption in its updated 2015 304(a) recommendations, which is the national mean based on a current survey of the U.S. population and described in the EPA's 2011 Exposure Factors Handbook.[14] Consistent with the EPA's guidance, Ecology is using local and regional specific data in deriving this value.

E. Drinking Water Intake

In Ecology's 2016 proposed rule, the state derived human health criteria using a drinking water intake rate of 2.4 L/day. In the absence of reliable local or regional data, the EPA recommends that the state refer to the most current available national data on drinking water intake rates. The EPA is supportive of Ecology assuming a drinking water intake rate of 2.4 L/day to derive human health criteria. This is consistent with the EPA's 2015 updated 304(a) recommendations where the EPA used a drinking water intake rate of 2.4 L/day, which represents the *per capita* estimate of combined direct and indirect *community water* ingestion at the 90th percentile for adults ages 21 and older.[15]

F. Reference Dose (RfD) and Cancer Slope Factor (CSF)

The EPA used updated toxicity values for non-carcinogenic effects (reference doses or RfDs) and carcinogenic effects (cancer slope factors or CSFs) to recalculate its 304(a) recommended human health criteria for certain pollutants various times since 1992. The EPA's Integrated Risk Information System[16] (IRIS) is the primary recommended source for RfD and CSF information; however, in some cases, more current peer-reviewed and publically-available toxicological data are available from other EPA program offices (e.g., Office of Pesticide Programs, Office of Water, Office of Land and Emergency Management), other national and international programs, and state programs. The EPA conducted a systematic search of nine peer-reviewed, publicly available sources to obtain the most current RfDs and CSFs to derive the 2015 304(a) recommendations. For substances that are both carcinogenic non-carcinogenic, the EPA takes an integrated approach and recommends the criteria be based on the more sensitive endpoint, presuming a cancer risk level of 10^{-6}.

The EPA supports Ecology using the most current RfDs and CSFs that the EPA used in its 2015 304(a) recommendations to derive criteria that reflect the latest scientific information on human health toxicity.

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[13] EPA. 2011. EPA Exposure Factors Handbook. 2011 edition (EPA 600/R-090/052F). http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252.
[14] Id.
[15] Id.
[16] EPA. *Integrated Risk Information System (IRIS)*. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C. www.epa.gov/iris.

Ecology has used this approach with two exceptions – arsenic and 2,3,7,8-TCDD – for which the state is proposing not to use the CSFs consistent with the EPA's 304(a) recommendations. Arsenic is discussed in further detail in the comments below.

Regarding 2,3,7,8-TCDD, Ecology made the decision to use the most recent IRIS non-cancer reference dose, which was finalized in 2012, for the human health criteria calculation. Ecology states that this is warranted given the uncertainty surrounding the assessment of carcinogenicity and the length of time this toxicity factor has been under review. Ecology needs to provide a rationale for how the resulting criteria for 2,3,7,8-TCDD are scientifically defensible and protective of human health in the state (see also Sections C and G).

G. Bioconcentration Factor (BCF)

In Ecology's 2015 and 2016 proposed rules, the state derived human health criteria using BCFs. Ecology's stated rationale is that bioaccumulation factors (BAFs) account for uptake from sources other than water (e.g., sediment, other food sources), and therefore, are overprotective because some of those sources could contain pollutants that come from areas and waters outside of Washington's CWA jurisdiction (e.g., mercury from air deposition). Pollutants from sources other than the water column can accumulate in fish that people consume, particularly if the pollutants have chemical properties that cause them to accumulate in fish dietary items. To account for bioaccumulation, the EPA's 2000 Human Health Methodology recommends use of BAFs that account for uptake of a contaminant from all sources by fish and shellfish, rather than BCFs that only account for uptake from the water column. The EPA's current 2015 304(a) recommendations replace BCFs with BAFs, where data are available. The EPA's national recommended BAFs are based on peer-reviewed, publicly available data and were developed consistent with the EPA's 2000 Human Health Methodology and its supporting documents. The EPA published supplemental information on development of the national recommended BAFs in January 2016.[17]

BAFs account for biomagnification in the food chain, which is an essential pathway that Ecology is missing by using BCFs. Therefore, the EPA continues to strongly recommend that Ecology adopt final criteria that reflect the latest scientific information on BAFs, as described in the EPA's 2000 Human Health Methodology, the EPA's 2015 304(a) recommendations, and the EPA's September 2015 proposed federal rule for Washington, to calculate human health criteria that are protective of the designated use and based on sound science.

H. Polychlorinated Biphenyls (PCBs)

For PCBs, Ecology has proposed human health criteria that are the same as those currently in effect under the NTR (as revised in 1999): 0.00017 µg/L for both the criteria for water & organisms and organisms only. In developing the proposed criteria, Ecology used a chemical-

[17] EPA. January 2016. *Development of National Bioaccumulation Factors: Supplemental Information for EPA's 2015 Human Health Criteria Update.* Office of Water, Washington, D.C. EPA 822-R-16-001. http://www.epa.gov/sites/production/files/2016-01/documents/national-bioaccumulation-factors-supplemental-information.pdf

specific cancer risk level of 4 x 10^{-5} or 0.00004, which exclusively applies to PCBs. Ecology states that it chose this cancer risk level for consistency with the level of risk that the Washington Department of Health uses to develop fish advisories for PCBs.[18] When Ecology used the 4 x 10^{-5} cancer risk level along with its other proposed inputs to calculate PCB criteria, the resulting criteria of 0.00029 µg/L were less stringent than the currently effective 1999 NTR values. However, the state proposed to adopt criteria equivalent to the 1999 NTR criteria for PCBs. Ecology's rationale for this decision is that PCBs are a chemical of concern in Washington and, therefore, Ecology made a chemical-specific decision not to increase the criteria concentrations above current criteria levels.[19]

The EPA does not support Ecology using a chemical-specific cancer risk level for PCBs. Instead, the EPA continues to strongly recommend the state calculate human health criteria for all carcinogenic pollutants, including PCBs, using a 10^{-6} cancer risk level, in order to result in criteria that are protective of the designated uses, including the tribal subsistence fishing use as informed by treaty-reserved fishing rights, and based on sound science.

The EPA recognizes that PCBs provide unique challenges due to the fact that they are pervasive, widespread, and long-lasting. However, this does not warrant setting the human health criteria at less stringent levels. The EPA is available to work with Ecology to further discuss PCBs and how they can be addressed through the state's implementation tools.

I. Arsenic

For arsenic, Ecology proposed to adopt a criterion of 10 µg/L, which is the Maximum Contaminant Level (MCL) for arsenic under the Safe Drinking Water Act. Ecology also proposed requirements relating to arsenic pollution minimization. Arsenic is the only pollutant for which Ecology proposed human health criteria less stringent than the values currently in effect under the NTR (0.018 µg/L for water & organism and 0.14 µg/L for organisms only). Ecology has not provided an adequate rationale to explain how 10 µg/L is scientifically defensible for ambient waters, and protective of the state's designated uses.

The EPA recognizes that developing human health criteria for arsenic may be challenging, particularly because naturally occurring levels in Washington could exceed the EPA's recommended criteria. Additionally, the EPA notes that the Agency's IRIS program is currently reassessing the toxicity of arsenic, and is targeting the end of 2017 for completion of that effort. The results of the IRIS reassessment will be helpful for states and the EPA to develop updated human health water quality criteria for arsenic in the future. The EPA is available to work with Ecology to explore other options for deriving protective arsenic criteria, including the consideration of any relevant information released as part of the EPA's arsenic reassessment.

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[18] Department of Ecology. January 2016. *Washington State Water Quality Standards: Human Health Criteria and Implementation Tools. Overview of Key Decisions in Rule Amendment.* Publication no. 16-10-006. Page 54. https://fortress.wa.gov/ecy/publications/documents/1610006.pdf.

[19] Department of Ecology. January 2016. *Washington State Water Quality Standards: Human Health Criteria and Implementation Tools. Overview of Key Decisions in Rule Amendment.* Publication no. 16-10-006. Page 53. https://fortress.wa.gov/ecy/publications/documents/1610006.pdf.

J. Methylmercury

Ecology decided to defer the adoption of human health criteria for methylmercury to allow time to develop a comprehensive implementation plan in a future state rulemaking. Therefore, the state proposes to leave the NTR human health criteria for total mercury in effect for Washington. Ecology has not provided sufficient rationale for why the state is not considering the latest scientific information and not proposing adoption of methylmercury criteria, beyond the difficulties anticipated in implementation.

In 2001, the EPA updated its 304(a) recommended methylmercury criterion for protection of human health after considering the latest science and data regarding health effects from intake of mercury and the primary routes of exposure. The 2001 methylmercury criterion is expressed as a fish tissue concentration and replaced the EPA's previous recommended water column concentration for total mercury.[20] Regarding implementation of a fish tissue criterion for methylmercury, the EPA published guidance in 2010 to assist states and tribes.[21] The EPA recognizes that there are unique challenges with implementing fish tissue criteria as opposed to water column criteria. The EPA recommends that Ecology consider the information available in the EPA's methylmercury criterion implementation guidance and is available to offer assistance in determining how best to implement a methylmercury fish tissue criterion in Washington.

The EPA continues to recommend that Ecology adopt methylmercury criteria consistent with the EPA's 2001 304(a) recommendations that are protective of the designated use and based on sound science.

K. Pollutant Scope

Ecology proposed human health criteria for all CWA Section 307(a) priority toxic pollutants, with the exception of methylmercury. The number of distinct pollutants in Ecology's proposal outnumbers the pollutants in the NTR because Ecology included additional priority pollutants for which the EPA developed 304(a) recommended criteria since last revising the NTR. The EPA also has 304(a) recommendations for several non-priority pollutants, but Ecology did not propose to adopt criteria for any non-priority pollutants.

The EPA recommends Ecology consider adopting human health criteria for the non-priority pollutants for which the EPA developed 304(a) recommendations. Although the state's existing narrative criterion for toxic pollutants at WAC 173-201A-240(1) provides coverage for these pollutants, the EPA recommends that states use numeric criteria instead of narrative criteria when available, consistent with 40 CFR 131.11(b). In the event Ecology has data or information suggesting that any of these pollutants do not warrant concern in Washington's waters, the EPA understands that Ecology could choose not to adopt human health criteria for those select non-

[20] EPA. January 2001. *Water Quality Criterion for the Protection of Human Health: Methylmercury.* U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 823-R-01-001. http://water.epa.gov/scitech/swguidance/standards/criteria/health/upload/2009_01_15_criteria_methylmercury_mercury-criterion.pdf.

[21] EPA. April 2010. *Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion.* U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 823-R-10-001. http://water.epa.gov/scitech/swguidance/standards/criteria/health/upload/mercury2010.pdf.

priority pollutants but believes Ecology should explain the rationale for not choosing to adopt such criteria.

L. Downstream Waters and Other Narrative Revisions

Ecology made several revisions to the provisions at WAC 173-201A-240, which provide background and organize the toxic substances section of Washington's WQS.

The EPA has no comments on Ecology's revisions to WAC 173-201A-240(3), (4), (5), and (5)(a). These revisions help clarify and organize the proposed rule.

The EPA has specific comments on WAC 173-201A-240(5)(b). In general, the EPA supports Ecology's revisions to this provision, which explain the purpose of the criteria, criteria derivation, and the format of Table 240. However, the EPA would like to address the proposed language regarding protection of downstream waters in further detail.

Ecology proposed to add the following language:

"All waters shall maintain a level of water quality when entering downstream waters that provides for the attainment and maintenance of the water quality standards of those downstream waters, including the waters of another state."

This is consistent with the EPA's regulation at 40 CFR 131.10(b). In addition, the EPA's 2014 guidance on Protection of Downstream Waters states that:

"Adoption of narrative criteria or numeric criteria (or both) that are protective of downstream waters are viable options under 40 CFR 131.10(b). States/tribes have discretion in choosing their preferred approach. The EPA expects that many states/tribes will consider using a combination of narrative and numeric criteria depending on their circumstances."[22]

The EPA's guidance also suggests that states and tribes can consider a more tailored and specific narrative criterion and/or a numeric criterion in certain situations, such as when more stringent numeric criteria are in place downstream and/or environmental justice issues are relevant.

Most of Washington's rivers are in the Columbia River basin and are, therefore, upstream of Oregon's portion of the Columbia River. In addition, the Columbia River constitutes most of the Washington–Oregon border. The EPA recommends that Ecology adopt numeric human health criteria (either in addition to or instead of narrative criteria), consistent with our comments in this letter, that ensure the attainment and maintenance of Oregon's downstream WQS, or to provide additional rationale detailing how the use of a narrative downstream protection criterion alone will protect Oregon's more stringent WQS. For waters flowing into Oregon, criteria that are equally stringent as or more stringent than Oregon's human health criteria would better ensure the attainment and maintenance of Oregon's downstream WQS consistent with 40 CFR

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[22] EPA. June 2014. *Protection of Downstream Waters in Water Quality Standards: Frequently Asked Questions.* http://water.epa.gov/scitech/swguidance/standards/library/upload/downstream-faqs.pdf.

131.10(b). This aligns with the EPA's previous statements regarding a desire for regional consistency in human health criteria among Region 10 states.

In addition, Ecology has moved language previously contained at WAC 173-201A-240(6), which pertains to protection from carcinogens at a one-in-one-million cancer risk level, to this section. Consistent with the comments above on the cancer risk level, the EPA is supportive of this language. The remainder of the rule language regarding duration of exposure, metals, and the obligation of dischargers to use all known, available and reasonable methods of prevention, control and treatment (AKART) help clarify and organize the proposed rule.

<u>2. Implementation Tools and Definitions</u>

Ecology proposed to revise procedures/authorizing provisions for two of the state's existing implementation tools (variances and compliance schedules) and added a new tool for intake credits. Ecology has also added an implementation clarification for combined sewer overflows (CSO) from treatment plants. In addition, the state proposed to adopt a definition for each of these implementation tools at WAC 173-201A-020.

As explained in further detail below, the EPA does not consider the intake credit rule (Section B) and provision regarding CSOs (Section D) to be WQS under CWA Section 303(c); rather they are NPDES permitting implementation provisions. Consistent with 40 Part 123.62 and Section VII.B. of the NPDES MOA between the EPA and Ecology, Ecology must notify the Regional Administrator and shall transmit to the EPA regulatory revisions that affect the NPDES permitting program. The EPA will determine whether the proposed change(s) triggers a revision to the state's approved program.

Below are the EPA's comments on each of the implementation tools Ecology proposed to revise and adopt, to assist the state in ensuring the final implementation tools are approvable under CWA Section 303(c), if applicable.

A. Variances (WAC 173-201A-420)

Ecology proposed to add a new definition at WAC 173-201A-020 to define variances and substantially revise the state's variance procedures at WAC 173-201A-420. The revised procedures establish minimum qualifications for granting variances for individual dischargers, stretches of waters, and multiple dischargers.

Ecology is still required to submit each individual variance to the EPA for review and action before it is effective for purposes of the CWA because the variances themselves are new or revised WQS. Accordingly, each variance submitted for the EPA's review must include the Attorney General's certification and be consistent with the CWA and the EPA's implementing regulations, including all applicable public participation requirements. Thus, the EPA's review of Ecology's variance procedures at WAC 173-201A-420 need not evaluate each hypothetical variance the state could issue under this regulation and consider whether such a variance would be consistent with the CWA and the EPA's implementing regulation. If the EPA does approve

Ecology's variance procedures, the EPA's approval would not be an automatic approval of any future variance the state wishes to grant.

In August 2015, the EPA finalized water quality standards regulatory revisions that included specific federal requirements for variances at 40 CFR 131.14.[23] Keeping in mind those revisions, below are the EPA's comments on Ecology's revisions to its variance provision and definition of variance:

1. Ecology proposed to remove its current five-year term limit on variances. Instead, Ecology expects the timeframe of a variance not to exceed the term of the permit, except under certain circumstances. If a variance term is issued for more than five years, Ecology proposed that the Department will complete mandatory five-year reviews. In general, the EPA supports this revision to the timeframe for variances as we recognize that there may be reasonable durations other than the term of a permit. The EPA will review each individual variance submittal and supporting information from Ecology and consider the justification for the term of the variance when making CWA approval/disapproval decisions.

2. Consistent with the regulations at 131.14, we recommend specifying that the variance will expire if Ecology does not submit the results of their five-year reevaluation to the EPA within 30 days.

3. In 5(a), the provision appears to indicate that a variance will be adopted for as long as it takes to meet the underlying designated use. To reiterate, a variance should be for the time necessary to meet the highest attainable condition where there is some level of certainty. The reason Ecology would use a variance and not a compliance schedule is because there is uncertainty surrounding meeting the underlying standard. If there is not uncertainty, then a compliance schedule is likely more appropriate.

4. The EPA is supportive of Ecology's proposed language regarding public process (noting that a variance is a new or revised WQS and, therefore, must meet the 131.20(b) requirements), pollutant minimization plans, and conditions in which variances would be considered for renewal (as long as reasonable progress toward meeting the underlying WQS is being made), shortened, or terminated.

5. Ecology also proposed consideration of variances for individual dischargers, multiple dischargers, and waterbodies. The EPA anticipates working closely with the state, especially for multiple discharger variances or waterbody variances, to ensure that each variance meets all applicable federal requirements. The EPA suggests that Ecology review the EPA's FAQs on multiple discharger variances.[24]

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[23] EPA. August 21, 2015. *Water Quality Standards Regulatory Revisions; Final Rule (40 CFR Part 131).* Federal Register Vol. 80, No. 162. 51019-51050. https://www.gpo.gov/fdsys/pkg/FR-2015-08-21/html/2015-19821.htm.
[24] EPA. March 2013. *Discharger-specific Variances on a Broader Scale: Developing Credible Rationales for Variances that Apply to Multiple Dischargers. Frequently Asked Questions.* http://water.epa.gov/scitech/swguidance/standards/upload/Discharger-specific-Variances-on-a-Broader-Scale-Developing-Credible-Rationales-for-Variances-that-Apply-to-Multiple-Dischargers-Frequently-Asked-Questions.pdf.

6. Once Ecology submits its final variance procedures, the EPA will review the specified sections of Ecology's variance procedures as a "general policy" under 40 CFR 131.13 and will base its review on whether the procedure is consistent with the CWA and federal regulations.

B. Intake Credits (WAC 173-201A-460)

Ecology proposed to add a new provision at WAC 173-201A-460 and an associated definition at WAC 173-201A-020 that addresses situations where a pollutant that a facility discharges also exists in the facility's intake water. The proposed new language addresses National Pollutant Discharge Elimination System (NPDES) permit requirements for point sources that do not increase the mass of a background pollutant above their intake water levels. This language is patterned after the language from the EPA's Great Lakes Initiative (GLI) as promulgated at 40 CFR 132, Appendix F, Procedure 5.D and 5.E.

The EPA does not consider this new implementation tool to be a WQS under CWA Section 303(c); rather it is an NPDES permitting implementation provision. The EPA provided comments on the 2015 proposed provision, and it appears Ecology has addressed our previous comments.

1. Ecology's proposed language at WAC 173-201A-460(2)(a) parallels, in part, the GLI language. Specifically, the rule provides that water quality-based effluent limits (WQBELs) may be established "so there is no net addition of the pollutant in the discharge compared to the intake water" if certain specified conditions are met. This provision is similar to the GLI's "No Net Addition" (NNA), and the conditions are essentially parallel to those included in the GLI provision. This revision from the previous version is consistent with the EPA's earlier comments.

2. In general, the restrictions on the use of the intake credit provision seem to be as protective as the GLI. Ecology appears to have addressed the EPA's primary comments from the previous draft version of this provision proposed in 2015 when it comes to separating out the two types of intake credit provisions in the GLI (Reasonable Potential and NNA provisions).

C. Compliance Schedules (WAC 173-201A-510(4))

Ecology proposed to add a new definition at WAC 173-201A-020 to define compliance schedules and revise the compliance schedule authorizing provision at WAC 173-201A-510(4). This revised provision removes the specific time limit for compliance schedules and describes circumstances when a compliance schedule can go beyond the term of a permit and ensures that compliance is achieved as soon as possible. The Washington legislature directed Ecology to extend the maximum length of compliance schedules to more than ten years when appropriate (RCW 90.48.605). Ecology also added language to describe the interaction with TMDLs.

The EPA considers Ecology's compliance schedule authorizing provision to be a new or revised WQS and, therefore, expects to take action on the revisions under CWA Section 303(c).

However, unlike individual variances, which must be approved by the EPA, the use of individual compliance schedules is not subject to the EPA's approval under CWA Section 303(c). The EPA maintains NPDES permit oversight, however, to ensure, among other things, that compliance schedules are implemented in a manner consistent with the CWA.

The EPA supports Ecology's new definition for compliance schedules. Below are the EPA's comments on Ecology's revisions to its compliance schedule provision:

1. The EPA requests that Ecology clarify that compliance schedules cannot be established for WQS themselves. Instead, compliance schedules can be authorized for WQBELs that are based on certain WQS.

2. The EPA compared the proposed provision to the language in federal regulations at 40 CFR 122.47(a)(1), which requires "compliance as soon as possible…". Ecology's proposed provision retains language in its current provision, which requires compliance "in the shortest practicable time." Without a definition of "practicable," it is not clear whether "practicable" means the same thing as "possible." The EPA's concern is that it could be implemented in a manner less stringent than "possible." Ecology uses these terms interchangeably throughout the compliance schedule authorizing provision and supporting documentation. The EPA recommends that Ecology use "possible" throughout to ensure the provision is as stringent as federal regulations.

3. The EPA acknowledges that Ecology proposed to replace its existing maximum compliance schedule duration of ten years with language specifying that compliance schedules shall generally not exceed the term of the permit at WAC 173-201A-510(4)(d). This is consistent with applicable EPA guidance[25] and applicable NPDES regulations so long as compliance schedules are authorized to meet a NPDES permit's WQBELs *as soon as possible*.

4. The EPA supports Ecology's decision to delete WAC 173-201A-510(4)(a)(v) from its existing compliance schedule provision. This language regarding "resolution of pending water quality standards issues" is inconsistent with the EPA's guidance and applicable law. In addition, the EPA supports the language Ecology proposed to add to WAC 173-201A-510 (4)(b)(iv). This language clarifies that compliance schedules can be issued for the completion of water quality studies only if such studies are related to implementation of permit requirements to meet WQBELs. Without this clarification, it was unclear if Ecology envisioned such studies to include support for a Use Attainability Analysis (UAA) or a site-specific criteria revision, which would be inconsistent with the EPA's guidance and applicable NPDES regulations.

5. Based on direction from the Washington Legislature, Ecology proposed language regarding how compliance schedules interact with TMDLs at WAC 173-201A-510(4)(e). This new language explains situations in which Ecology can determine a longer time

[25] EPA. May 10, 2007. *Compliance Schedules for Water Quality-Based Effluent Limitations in NPDES Permits.* Memorandum from James A. Hanlon, Director, Office of Wastewater Management. http://water.epa.gov/lawsregs/guidance/wetlands/upload/signed-hanlon-memo.pdf.

period is needed to come into compliance with WQBELs based on applicable WQS beyond the term of a NPDES permit. In any of these situations, the actions specified in the compliance schedule must be sufficient to achieve WQBELs based on WQS *as soon as possible* according to WAC 173-201A-510(4)(e)(iv). This is consistent with the EPA's guidance and applicable NPDES regulations.

6. Lastly, the EPA acknowledges that Ecology constructed the compliance schedule provision to apply to aquatic life uses (WAC 173-201A-510(4)(a)(i)) and uses other than aquatic life (WAC 173-201A-510(4)(a)(ii)). If Ecology adopts this proposed rule language, the state can implement the compliance schedule authorizing provision upon the EPA's approval, without ESA consultation, only for uses other than aquatic life.

D. Implementation Clarification for Combined Sewer Overflows (CSO) Treatment Plants (WAC 173-201A-510(6))

Ecology proposed to add a new provision at WAC 173-201A-510(6) and an associated definition at WAC 173-201A-020 to clarify implementation of human health criteria in NPDES permits for CSO treatment plants. Ecology states that the proposed language does not change current practices.

The EPA supports Ecology's new definition for CSO treatment plants. Ecology relies on federal regulations at 40 CFR 122.44(k) which allow the use of best management practices (BMP) in NPDES permits if it is not feasible to calculate numeric limits. Due to episodic and short-term CSO discharges, Ecology states it is not feasible to calculate numeric effluent limits that are based on criteria with durations of exposure up to 70 years.

However, the EPA does not consider the new provision at WAC 173-201A-510(6) to be a new or revised WQS under CWA Section 303(c); rather it is an NPDES permitting implementation provision. These provisions provide clarity for the implementation of the human health criteria in NPDES permits, but do not change the underlying human health criteria.

From a permitting perspective, the EPA does not believe this new provision is necessary given the existing flexibilities in guidance. Where effluent pollutant concentration data and numeric criteria exist, Ecology must evaluate for RP. There are flexibilities already identified in EPA and Ecology guidance[26] to use appropriate averaging periods, dilution design conditions, and point of application of the criteria as ways to address the long duration associated with human health criteria. CSO BMPs (nine minimum controls) are already required to be in CSO permits as technology-based effluent limits (TBELs). In addition, the EPA's CSO policy[27] (codified under CWA 402(q)) requires that controlled CSO discharges not cause or contribute to exceedances of the WQS.

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[26] EPA. March 1991. *Technical Support Document for Water Quality-based Toxics Control.* Section 4.6. Office of Water. https://www3.epa.gov/npdes/pubs/owm0264.pdf; Department of Ecology. January 2015. *Water Quality Program Permit Writer's Manual.* Page 137 and pages 254-258. https://fortress.wa.gov/ecy/publications/publications/92109.pdf

[27] Federal Register. Vol. 59, No. 75. April 19, 1994. *Combined Sewer Overflow (CSO) Control Policy.* https://www3.epa.gov/npdes/pubs/owm0111.pdf.

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VIA EMAIL: swqs@ecy.wa.gov

April 22, 2016

Ms. Becca Conklin
Water Quality Program
Washington Department of Ecology

Subject: Comments on proposed revisions to WAC 173-201A Water Quality Standards for Surface Waters.

Dear Ms. Conklin,

KapStone Kraft Paper Corporation (KapStone) appreciates the opportunity to provide comments on the proposed revisions to WAC 173-201A Water Quality Standards for Surface Waters. KapStone's comments are presented below.

KapStone fully supports and endorses the comment package submitted by the Northwest Pulp and Paper Association (NWPPA) and other co-signers, including KapStone.

WAC 173-201A-460 Intake Credits

Intake credits are a necessary and appropriate implementation tool for the rule proposal and allowed by the Clean Water Act. KapStone recognizes the improved language in this section over the January 2015 proposal.

The proposed language provides additional details on the use of intake credits and it states that an intake pollutant must be from the "same body of water" as the discharge in order to be eligible for an intake credit. KapStone interprets interpret the rule language about "same body of water" to be applicable as long as the requirements in WAC 173-201A-460(b) are satisfied.

A literal application of the "same body of water" phrase should be avoided since there could be unique situations, including that at the KapStone Longview mill, where the geography and hydrology of the KapStone water withdrawal and discharge is, in essence, the same water (see description below). As such, KapStone would consider the "same body of water" test to be met if the conditions in WAC 173-201A-460(b) are satisfied.

The old mouth of the Cowlitz is a non-free flowing body of water adjacent to the KapStone Longview mill site on the north side of the Columbia River at river mile 67. This water area is an embayment of the main river and is supplied by tidal ebb and flow from the Columbia River and likely some ground water inflow. KapStone's water intake is located approximately 960 meters inside the inlet mouth. The mill's outfall is in the Columbia River approximately 150 meters downstream of the Old Mouth of the Cowlitz.

It is important to note that this body of water and surrounding drainage area are not considered as part of the Cowlitz River drainage basin by the Department of Interior or the USGS.

Sincerely,

Patrick W. Ortiz
Director, Engineering, Environmental and Safety

City of Bellevue

Post Office Box 90012 • Bellevue, Washington • 98009 9012

April 14, 2016

DEPARTMENT OF ECOLOGY

APR 20 2016

WATER QUALITY PROGRAM

Becca Conklin
Department of Ecology
PO Box 47600
Olympia, WA 98503-7600

Re: Proposed water quality standards for protecting human health, Chapter 173-201A WAC

Dear Ms. Conklin:

I am writing on behalf of the City of Bellevue Utilities Department to offer comments on the Department of Ecology's proposed rule regarding water quality standards for protecting human health, Chapter 173-201A WAC.

Bellevue Utilities is supportive of the State retaining control of the water quality standards updates and its approach toward setting human health criteria as opposed to seeing these standards and approaches transferred to the Federal Environmental Protection Agency. We remain committed to improving public health and water quality in the region for both wastewater and stormwater discharges. We are appreciative of the State applying appropriate and reasonable approach's to ensuring the waters of our community and the state achieve water quality and human health outcomes supportive of both the natural environment and the built systems supporting our community.

Bellevue supports the State's recognition of the unique nature of ubiquitous chemicals in our region (such as PCB, mercury, arsenic) and its proposals to address these chemicals. We also agree with the Department of Ecology's (Ecology) stated position regarding application of the new criteria to stormwater discharges. We agree that due to the episodic nature of stormwater and the scientific methods used to develop the proposed human health criteria standards, strict application of these threshold levels to stormwater is inappropriate. We support a continued presumptive approach to stormwater as currently applied in the General Municipal Stormwater NPDES Permits, Phase I and II. This approach does not use numeric standards and recognizes that regulation and permit compliance occurs through application of the Ecology design manual and best practices provisions in the permit. We appreciate the work Ecology has done in developing a well thought out set of implementation tools for both wastewater and stormwater systems.

Thank you in advance for our consideration of our comments on the proposed rule. If you have any questions regarding our comments, please contact Paul Bucich at 425-452-4596.

Sincerely,

Nav Otal, Director
Utilities Department

PB: dhp

The Confederated Tribes of the Colville Reservation
P.O. Box 150, Nespelem, WA 99155 (509) 634-2200
FAX: (509) 634-4116

Friday, April 22, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments on the State's 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon,

The Confederated Tribes of the Colville Reservation (CTCR) have worked with the state of Washington and the US Environmental Protection Agency for many years to support water quality standards that protect the health of tribal people and respect the rights to tribal harvest of fish and shellfish guaranteed by various treaties, agreements, and court decisions. In February 2016, Department of Ecology proposed a second draft rule for human health criteria and implementation tools, and we wish to offer the following comments on the state's proposed rule.

Overall, the proposed state rule falls short of the stated goal of protecting people who consume fish and shellfish. The CTCR supports and endorses a set of comprehensive comments submitted by the Northwest Indian Fisheries Commission to Ecology this month which address numerous shortcomings of the proposed rule. Alternatively, the CTCR wishes to express our support for the more protective draft rule for human health criteria applicable to Washington State, issued by the U.S. Environmental Protection Agency on September 14, 2015.

The harvest and consumption of fish and in some cases shellfish remains at the heart of tribal communities, and is a cultural, nutritional, health, and economic necessity as well as a treaty right. The proposed FCR of 175 g/day is low compared to fish consumption rates at many tribes. Neither does it consider current suppression of fish consumption or heritage consumption rates. Developing human health criteria based on an average fish consumption rate also ignores highly exposed populations such as the tribes. Although the proposed rate is an increase from the current level in the state standards, other provisions of the rule proposed by the Department of Ecology serve to diminish the protective benefit of a higher fish consumption rate.

To illustrate the point of the proposed fish consumption rate being low in comparison with that of tribes, the CTCR completed an extensive consumption and resource use survey for the

Colville Indian Reservation with EPA, Westat, and Environment International in June 2012[i]. The results of this study indicate that Tribal Members who regularly consume fish eat an average of 384 grams per day at the 90th percentile, and the 90th percentile of all adults who live on the Colville Reservation eat 394 grams of fish per day. Based on these results, the Colville Business Council has determined that maintaining water quality to ensure a fish consumption rate of 400 grams per day would protect the vast majority of persons residing on the Colville Indian Reservation and provide a minimal subsistence rate of consumption for Tribal Members.

Other human health criteria proposed by Ecology do not incorporate best available science and fail to account for other sources of toxic chemicals. Again we recommend adoption of the criteria proposed by the EPA, which are significantly different for several key factors in the calculation of criteria that protect the designated uses. By example, for calculating criteria for water quality standards for all non-carcinogens, the state proposes to adopt a Relative Source Contribution (RSC) value of 1.0 (100%). The updated national water quality criteria for RSC is 0.2 (20%). Applying an RSC of 1.0 demonstrates Ecology's selective adoption of specific updates to national water criteria that consistently tend toward higher (less protective) chemical criteria. The state also proposes to selectively adopt water quality criteria for bioaccumulation factors; body weight, and drinking water intake that systematically drive standards toward higher chemical criteria. Unacceptably, the state's proposal would allow the criteria for several highly toxic chemicals including PCBs, arsenic, and dioxin to remain at status quo or become weaker, that is, less protective. The CTCR agrees with the Northwest Indian Fisheries Commission that the state's proposed implementation tools should be adjusted to support accountability and attainment of water quality standards, and not serve to help dischargers avoid compliance.

Washington State is required to meet the provisions of the Clean Water Act to preserve the beneficial uses of water, including fishing, a use central to Native American cultures and populations within the state. The public health protections encompassed by these standards should protect not just Native Americans but everyone in Washington who eats fish. The proposed rules by the state of Washington do not achieve these requirements and will result in continued suppression of fish consumption by tribal Members who fish Washington waters.

Sincerely,

Gary W. Passmore
Director
Office of Environmental Trust

CC
Lorraine Loomis, Chair; Northwest Indian Fisheries Commission
Dennis McLerran, EPA Region 10 Administrator
Dan Opalski, EPA Region 10 Director for the Office of Water and Watersheds

---

[i] Upper Columbia River Site Remedial Investigation and Feasibility Study Tribal Consumption and Resource Use Survey Final Report. June 22, 2012.

Commenter ID: 52

Commenter Name: Norman D. Peck

Commenter Association: Citizen

Comment received via online comment form

Comment:

Sec. 173-210A-240(5)(b) states, in part, that arsenic (As) is to be evaluated as total As. In cases where organo-arsines are present, the contribution of those organo-arsines should be subtracted from the total As value, as they bias bioavailable As toxicity upwards. This is a known contributor to false positives in urinary arsenic testing. Failure of an As criterion should allow the option to rebut the failure through identification of the contribution of organic arsenical compounds, with due consideration of the few toxic organo-arsines.

Footnote dd of Table 240: As water column seasonal budgets are known to closely parallel phosphorous (P) budgets in lentic systems that undergo seasonal stratification and overturn, and As dynamics can be accurately estimated with relatively few data points if P dynamics are known. This factor should be considered in determining whether As seasonal partitioning is known. As level fluctuations should be evaluated especially carefully in peat-bog lakes, as unusual dynamics may exist (e.g. Des Moines Creek Regional Stormwater Detention/Retention facility S. of SeaTac Airport).

It is my assumption that toxicity for the various dichlorotehylene and dichloroethane isomers is based solely on their individual carcinogenicity. It is my opinion that an additional correction factor should be included based on their further breakdown into vinyl chloride, which has considerably higher cancer potency. In most instances the di’s are penultimate breakdown daughters of tetrachloroethylene and/or the tri’s, with the final and extremely persistent ultimate breakdown daughter being vinyl chloride.

Since As is known to associate with soil fines, the distinction between suspended and dissolved As may be an important consideration.

While I support use of the 175 g/day general fish consumption rate as a basis for chronic, long-term exposure risk calculations, use of higher rates for specific populations known to consume higher proportions of fish in their diets should be considered on a local (or specific point-of-harvest) basis where appropriate in setting water quality criteria.

Via E-Mail

April 22, 2016

Maia Bellon, Director
Washington Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
cnie461@ecy.wa.gov

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: CTUIR Comments on the Washington Department of Ecology's Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon:

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Department of Natural Resources (DNR) appreciates the opportunity to comment on the Washington Department of Ecology's Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards (Rule). The latest Rule is a significant improvement over the many past proposed rules by which the State has unsuccessfully attempted to revise its antiquated criteria that fail to protect tribal members and so many others that consume Washington fish. The CTUIR DNR specifically supports your decision to finally adopt a reasonable, compromise fish consumption rate (FCR) of 175 grams per day in conjunction with the commonly-used, widely-accepted cancer risk level of 1 in 1 million (10^{-6}).[1] We believe, however, that other elements in the Rule are unnecessarily and inappropriately weak and less stringent that they should be. We encourage you to reconsider them, and in certain instances further adjust them to more closely correspond to the recent updated EPA recommended criteria.[2]

[1] 175 grams per day is an initial, reasonable "floor" to use in the equation to revise State standards, one which has been adopted by Oregon and one which the CTUIR has found acceptable in establishing state-wide standards. It is, however, a significant compromise and does not accurately reflect the much higher levels of fish consumption by many tribal members that a number of consumption surveys have quantified. In fact, the CTUIR has adopted on-reservation standards based on a rate of 389 grams per day.

[2] U.S. Environmental Protection Agency, *Final Updated Ambient Water Quality Criteria for the Protection of Human Health*, EPA Docket Numbers: EPA-HQ-OW-2014-0135, FRL-9929-85-OW, Document Number: 2015-15912; 80 Fed. Reg. 36986 (June 29, 2015); https://www.federalregister.gov/articles/2015/06/29/2015-15912/final-updated-ambient-water-quality-criteria-for-the-protection-of-human-health, https://federalregister.gov/a/2015-15912.

As you know, the CTUIR ceded lands to the federal government in portions of what is now Washington State. We also have rights and interests in fish that originate in and traverse the State and in the waters that support them—waters that are not strictly confined to artificial jurisdictional boundaries or authorities. Many of those waters—in Washington and throughout the region—are already polluted, and some fish in them have been found to clearly contain various toxic contaminants. Miles of waterways have been listed as water-quality-limited under the Clean Water Act, and multiple advisories have been issued warning against eating certain fish species.[3] Rivers may no longer catch on fire, but water quality problems remain, and fish that inhabit our often less-than-pristine lakes, rivers and streams may present undue health risks. Water quality regulations should be developed, revised and implemented to confront and minimize these risks as much as possible, without excessive burdens on economic activity. We can never forget, however, that healthy sustainable people and communities cannot endure over the long term if the basic resources on which they depend are poisoned and degraded.

The Rule can do more—it can and should be stronger. Instead, it undermines the benefits gained from a more accurate consumption rate and a suitable cancer risk level by including other provisions that appear designed to work to the advantage of dischargers and minimize their obligations to control or reduce pollution. The State proposes to selectively adopt the national revised 304(a) criteria and would exclude relative source contribution and bioaccumulation criteria. All sources of pollution would not be considered or accounted for, and updated scientific information is not utilized to examine accumulation of pollutants in the food chain. Several toxic chemicals or substances are specifically "set aside" and treated independently, regulating them at either current levels and maintaining the insufficient "status quo" (PCBs) or actually weakening existing provisions (arsenic).[4] The methylmercury standard has not been changed to a fish tissue basis from a water column basis, as the recent EPA update recommends. For dioxin, PAHs, phthalates, and pesticides, EPA's draft rule is roughly 100 times more stringent.

Finally, implementation provisions, such as variances and compliance schedules, would allow water quality standards to be violated for possibly lengthy and unspecified periods. The CTUIR DNR acknowledges the need for some flexibility and accommodation in applying any new standards. However, they cannot come at the cost of inadequate assurance that standards will be met and compliance will result within a reasonable time frame.

[3] Fish advisories do not address the problem. It is unacceptable to suggest that tribal members could simply avoid higher risk by simply eating less fish—that eating more fish is "voluntary," and the higher risk is assumed voluntarily (which is the presumption behind advisories). The ability to freely and fully exercise Treaty Rights—protected under the United States Constitution—should not come at the cost of excessive danger to health and well-being. Cancer should not be the penalty for adhering to time-honored rights and traditions.

[4] Changing the arsenic standard to that for drinking water is a poor choice and fails to account for accumulation in fish tissue; EPA's proposed arsenic standard for Washington is more stringent.

CTUIR members fish in Washington waters and those “downstream.” The “right of taking fish” at all usual and accustomed places was guaranteed by the Treaty of 1855 with the United States. Inherent in the right of taking fish is that there are fish to take, and that those fish are safe to eat. Tribal representatives 161 years ago did not sign treaties securing the right to harvest and consume contaminated fish.

We recognize that rigorous point-source criteria alone will not be enough to solve water quality problems and fish contamination. Aggressive, non-point-source measures and, ultimately, source reduction—so that we don’t create the problems in the first place—are vital, essential components of an overall, comprehensive approach to effectively address issues that have been decades in the making. However, that is no reason to wield one of the strongest tools we *do* have under the current state of the law—point-source standards—in anything other than a manner that limits toxic inputs to our waters, fish—and people—to the greatest extent we can.

The CTUIR DNR thanks you for your consideration of our comments. We endorse and incorporate by reference the comments of the Columbia River Inter-Tribal Fish Commission (CRITFC) and the Northwest Indian Fisheries Commission (NWIFC). If you have any questions or wish to discuss this issue further, please contact me at the address/number above or Carl Merkle, DNR Policy Analyst, at (541) 429-7235.

Sincerely,

Eric Quaempts
Director, Department of Natural Resources

EQ: cfm

Cc: Dennis McLerran, Administrator, EPA Region 10
Dan Opalski, Director, Office of Water and Watersheds, EPA Region 10

Commenter ID: 55

Commenter Name: Mark Rhodes

Commenter Association: Citizen

Comment received via online comment form

Comment:

1. Compliance schedules are too long.

Polluters need to meet standards sooner than the windows in this rule.

2. Ignores PCB, mercury and arsenic.

The proposed rule is not strong enough with regards to these toxins. The Spokane River has issues with all of these toxins and the rule should update and tighten the standards on these pollutants.

3. Increased availability of variances. Variances are temporary waivers of water quality standards.

The proposed rule allows polluters to receive "free passes" to meet water quality standards.

Confederated Tribes and Bands
of the Yakama Nation ERWM

Established by the
Treaty of June 9, 1855

April 21, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments on the State's 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon,

The Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) has been working with the Washington Department of Ecology (Ecology) and the US Environmental Protection Agency (EPA) for over two decades to develop and adopt revised water quality standards that will protect the health of Yakama people and the aquatic resources we harvest under treaty-reserved rights guaranteed by the federal government. Yakama Nation requires water quality standards that are protective of all our people, not just a percentage of them. Currently, two draft human health water quality rules are being proposed for Washington waters, one from EPA and one from Ecology. After reviewing the technical information, we have determined that the EPA proposal is the more protective alternative but is still just an initial step towards water quality standards that are protective of all Yakama people. The Yakama Nation supports EPA's proposed rule and recommends that Ecology halt its rulemaking process until the federal rule has been promulgated.

Yakama Nation was integral to the 1994 EPA Columbia River Tribal Fish Consumption Survey that confirmed Yakama People have at least a 100 times greater risk of cancer from eating a traditional diet that includes considerably more Columbia River fish than existing water quality standards assume. This information should have triggered an immediate response from Ecology and EPA, but two decades later there has been no improvement to Washington's human health criteria for establishing water quality standards. It is unjust for our people to be subjected to undue cancer and health risks resulting from exercising our treaty reserved right to harvest fish while industry continues to be permitted to discharge the chemicals responsible for these risks.

I appreciate the difficult situation that Ecology is in and would like to continue the working relationship we have built over the years. However, I have watched Ecology "go back to the drawing board" three times to draft a rule that is acceptable to industry and provides some protection to fish consumers. The current proposal still falls short of what Yakama Nation requires and does nothing to improve the current standards for Polychlorinated Biphenyls (PCBs), one of the largest human health issues in the Columbia River. Unless Ecology plans to revise its draft rule to be more protective than EPA's September 2015 proposal for all chemicals, the best path forward is for Ecology to suspend its current rulemaking process. This would allow EPA to move swiftly with Federal promulgation of human health criteria applicable to Washington State and provide the immediate improvement to water quality that Yakama Nation requires.

A detailed set of technical comments and concerns with Ecology's proposal can be found in Northwest Indian Fisheries Commission comments submitted to Ecology in April, 2016. Yakama Nation incorporates by reference the NWFIC and Columbia River Intertribal Fish Commission comments submitted April, 2016.

If you have any questions please feel free to contact me at 509-865-5121 ext. 4655 or have your staff contact McClure Tosch 509-865-5121 ext. 6413.

Sincerely,

Phil Rigdon, DNR Superintendent
Yakama Nation

cc:
Lorraine Loomis, Chair; Northwest Indian Fisheries Commission (via email)
Dennis McLerran, EPA Region 10 Administrator (via email)
Dan Opalski, EPA Region 10 Director for the Office of Water and Watersheds (via email)

Commenter ID: 57

Commenter Name: John Roskelley

Commenter Association: Citizen

Comment received via online comment form

Comment:

The Department of Ecology's revisions to the Water Quality Standards for Protecting Human Health (WAC Chapter 173-201A) is blatant pandering to industry and public utilities, and a compromise to these entities that has potentially long-term ill effects on a select group of cultures who rely on fish for subsistence. Ecology's rush to rule-making is an obvious reaction to the EPA's protections that have been developed through best available science and will take precedent if the state does not act.

Historical polluters, like pulp mills and sewer treatment plants, hail the DOE's changes, as the revisions allow polluters to continue business as usual for extended periods of time; ignores the science that should require stringent limits on PCB's and arsenic, and a new limit for methyl mercury; and allows polluters a slew of variances that continue the charade of timely compliance.

One only has to read Weyerhaeuser's comment letter dated April 20, 2016 to know that Ecology has buckled to pressure from industry. The industry giant's comments both threaten at times (pg. 9), and praise Ecology. For instance, in its #2 bullet point, Weyerhaeuser commends Ecology for the "practical" and "good-science" for choosing to retain the current National Toxic Rule proposals for total PCB's and total arsenic, and that of mercury (pg. 3). Note that Weyerhaeuser did not reference BAS and that the NTR is out-dated. In #6, Weyerhaeuser praises Ecology again for "inclusion of broad regulatory language providing variances." That statement should give Ecology staff heartburn.

In #4, Weyerhaeuser urges the state to "commit to a legal defense" of the rule against the EPA, which may enforce 40 CFR 131.21. This recommendation on its face by a major polluter indicates Ecology is not protecting the public's interest. Ecology should be working with the

EPA, not fighting it; and relying on current best available science, not hopes and prayers by industry.

With these revisions, Ecology's water division continues its steep decline in credibility with the public (Ecology refuses to enforce current law requiring stock animals to be fenced off waterways). Polluters are asking Ecology to slow the process of complying with the Clean Water Act and ignore best available science. The time to write and enforce common sense water laws is now, not down the road so polluters can continue business as usual.

I ask you to rewrite these revisions to follow the criteria presented by the EPA.

Sincerely,

John Roskelley

10121 E Heron View Lane

Mead, WA 99021

509-954-5653

CITY OF SPOKANE
808 W. SPOKANE FALLS BLVD.
SPOKANE, WASHINGTON 99201-3327
509.625.6250

April 22, 2016

Becca Conklin
Department of Ecology
PO Box 47600
Olympia, WA 98503-7600

Via Email: swqs@ecy.wa.gov

Re: Washington Water Quality Standards
New Human Health Criteria and Tools for Implementation

Dear Ms. Conklin,

The City of Spokane provides these comments to Washington State Department of Ecology's (DOE) request for formal comments on the Water Quality Standards for Protecting Human Health (Fish consumption rates) Chapter 173-201A WAC. DOE's proposal was published on February 3, 2016.

The City of Spokane generally supports the proposed rulemaking by DOE for Water Quality Standards and Fish consumption rates. Below, we provide specific comments related to the draft. The City of Spokane is committed to improving the water quality in the surface waterways that traverse our community, with a particular emphasis on the Spokane River. The City is an active participant and founding member of the Spokane River Regional Toxics Task Force, a collaborative effort to characterize sources of toxics in the Spokane River and to identify and implement actions needed to make measureable progress towards meeting Washington's Water Quality Standards. In the spring of 2014, the City adopted its Integrated Clean Water Plan, which details more than $300 million in investments designed to protect the health of the river, including a number of voluntary components.

Our investments include:

- A series of projects to **control overflows from combined sewers**. Combined sewer overflows occur during large storms. Six major underground tank projects already have been completed, five more projects will start this year, and another four projects will begin in 2017. Additional projects will use green infrastructure techniques to manage overflows. This work will cost about $180 million.

- Management of **stormwater coming from the large Cochran Stormwater Basin** on the North Side of Spokane. Because of the volume of water that reaches the river through this single stormwater outfall, this voluntary project will have a far greater impact on pollutants than the combined sewer projects. Current estimates for this work total $34 million.

- Construction of **tertiary treatment at the Riverside Park Water Reclamation Facility** and plans to operate it year-round will provide additional pollution reduction benefits. The City only is required to run tertiary treatment during a "critical" 8-month season. This work will cost about $126 million.

- **Stormwater management elements as part of street reconstruction**. The City's voters adopted a new Street Levy in November 2014 that uses an integrated approach for public works projects. As part of that approach, the City is committed to managing stormwater on- site during all street construction, thus delivering greater value to our citizens.

- **Removing PCBs from the stormwater system.** The City has removed PCBs entrained in sediments in catch basins. Over half a million pounds of sediment was removed containing over 30 grams of PCBs.

- **Promoting Low Impact Development.** The City adopted an ordinance in 2013 that creates incentives for developers to manage stormwater on-site using green infrastructure rather than discharging stormwater to the City's system.

- **Reducing PCBs in Products.** The City has sampled consumer products to identify sources of PCBs that enter our community and uses the information to educate the public about how to reduce PCBs that might inadvertently enter the City's sewer or stormwater systems. The City adopted an ordinance which establishes requirements for City departments to avoid purchasing products that contain PCBs.

These listed projects will provide greater removal of PCBs, heavy metals, total suspended solids, and phosphorus than if the City had settled just on required work. Funding comes from the City's utility ratepayers, who will repay Water-Wastewater Utility revenue bonds and SRF loan funding. Some stormwater grants from DOE also are included. It should be noted that the City's median household income is much lower than the state or national median household income.

Creating this innovative plan was greatly supported and enhanced by the Eastern Washington regional office of DOE. Local DOE staff was able to provide guidance, and knowledge of the City's systems, and a willingness to work together. This relationship also is embodied in the work of the Spokane River Regional Toxics Task Force, which the City is a member. DOE's expertise and understanding of the particular systems and surface waters has created results through a direct-to-implementation approach to projects that reduce PCBs and other toxics in our waterways.

With this background, the City of Spokane offers the following specific comments to the proposed rulemaking:

- The City understands the need to update the Water Quality Standards for Protecting Human Health. We seek a reasonable approach to meeting such standards; one that considers ability to pay, available technology, achievable timelines, and environmental tradeoffs. New tools for implementation listed in DOE's proposal, such as variances, should help communities meet the new standards if the tools are in fact applied when needed.

- The City supports the creation and management of a new fish consumption rule by DOE, rather than the U.S. Environmental Protection Agency. Our discharge permits and their requirements are already managed by DOE and provide the consistency and reliability that comes with a single regulatory agency for all water quality concerns. DOE is in a better position to understand the unique attributes of our watershed, dischargers to the river system, and efforts undertaken to reduce pollution in our area.

- The City supports the ongoing efforts of the Spokane River Regional Toxics Task Force and the direct-to-implementation approach to reducing toxics in the watershed. Measurable progress has been made toward identifying and reducing pollution sources throughout the Spokane region. We believe this approach results in a "cleaner river faster."

- The City also supports related efforts to provide state funding and policies directed toward source control of toxics, as well as dollars to invest in projects that help achieve water quality goals. Particularly, the state should consider ways to invest in multi-year, holistic approaches that have greater positive impacts on the environment, rather than a piece meal approach which simply funds one project at a time without considering the larger picture.

The City's Integrated Clean Water Plan has been lauded as a model in integrated solutions to water quality both regionally and nationally. The City is a partner with the state in achieving water quality goals. With these comments, the City seeks consistency, predictability, and sensibleness for our community and for our citizens—those who bear the costs of these efforts. Thank you for the opportunity to offer these comments on the rulemaking process.

Sincerely,

Theresa M. Sanders
City Administrator

Commenter ID: 59

Commenter Name: Vicki L. Savage

Commenter Association: Citizen

Comment received via online comment form

Comment:

Please rethink you're idea on allowances for pollution into our waterways. This is UN-ACCEPTABLE. Thank you

Commenter ID: 60

Commenter Name: Darlene Schanfald

Commenter Association: Olympic Environmental Council

Comment received via online comment form

Comment:

I am commenting for the Olympic Environmental Council, a 501c3 organization based on the North Olympic Peninsula.

It is good that surface water standards are being upgraded. However, there is much language that gives too much leeway to the applicant for variances. Since Ecology is losing staff and has a hiring freeze, can Ecology staff be on top of each permit and enforce when needed?

Individual metals should be weighed and reported as well as a cumulative amount.

It is important to know which metals are meetings and not meeting their levels.

A variance may be considered when the standards are expected

to be attained by the end of the variance period or the attainable use

cannot be ... based on 40 C.F.R. 131.14.

Standards should be met before giving a variance.

An evaluation of treatment or alternative actions that were considered to meet effluent limits based on the underlying water quality criteria, and a description of why these options are not technically, economically, or otherwise feasible.

The applicant should have to meet a high standard. The state is trying to clean up Puget Sound and other water bodies. Users that emit effluent, well over one hundered just around the Sound that are municipalities, should be held to the highest standards. Bad behavior, cumulatively among a number of variances, is license to pollute.

Combined sewer overflow treatment plant.

The influent to these facilities is highly variable in frequency, volume, duration,

and pollutant concentration. The primary means to be used for requiring compliance with the human health criteria shall be through the application of narrative limitations which include, but are not limited , to best management practices required in waste discharge permits,

rules, orders and directives issued by the department.

All treatment plant effluent is highly toxic. EPA regulates and tested few. EPA plans to review nearly 200 emerging contaminants, but there are thousands. Effluent has acidified water bodies, impacted the health of marine life, contaminated marine life on human & wildlife diets has pass the contamination to humans and wildlife.

WA State needs to write strong rules that will protect our natural resources.

Respectfully,

Darlene Schanfald

ASSOCIATION OF WASHINGTON CITIES
1076 Franklin Street SE • Olympia, WA 98501-1346

April 22, 2016

Becca Conklin
Washington State Department of Ecology
Water Quality Program
PO Box 47600
Olympia, WA 98504

Re: Ecology's proposed Human Health Water Quality Criteria

Dear Ms. Conklin:

The Association of Washington Cities (AWC) is a private, non-profit, non-partisan corporation that represents Washington's cities and towns before the state legislature, Congress, the executive branch, and with state and federal regulatory agencies. Membership is voluntary. AWC, however, consistently maintains 100 percent participation from Washington's 281 cities and towns.

Cities take seriously our responsibility to provide clean and healthy water to our residents. Many of our cities are subject to Clean Water Act regulation of municipal wastewater treatment plants and stormwater through the NPDES permitting program. Cities collectively operate over 200 wastewater treatment plants with a combined capacity of over a billion gallons of day of treatment capacity – working around the clock to ensure that all residents of the state have access to safe and clean waterways.

Our members stand to be greatly impacted by Ecology's proposed human health surface water quality criteria.

AWC has been an active participant in advisory committees working with the Department of Ecology (DOE) in your efforts to develop human health surface

awcnet.org
360.753.4137 • 800.562.8981

water quality criteria. We appreciate the robust process you have undertaken, and while we do not agree with every element of this proposal we appreciate the thoughtful and transparent effort you made to get here. Given that we have participated throughout the process for several years, we are not going to touch on every issue involved and expect that you will continue to consider the significant and voluminous input we have provided to date.

AWC is supportive of the acknowledgement within this rule that certain unique and ubiquitous chemicals in the waste stream such as arsenic, PCBs and mercury need special attention and treatment. We have shared information with the Department supporting our concern that without such special consideration it will be impossible for cities to meet criteria as stringent as would be generated by the default formulas. We believe you have offered a defensible and approvable approach on these pollutants.

AWC recognizes that some parameters, such as mercury and PCBs are not well suited to Clean Water Act (CWA) controls, yet very low criteria will trigger such requirements. The DOE has a program to develop Chemical Action Plans (CAPs) which describe broader more effective actions than CWA approaches. CAPs have now been developed for PCBs, Mercury, PBDEs, PAHs and Lead. It is noteworthy that the CAPs for PCBs and Mercury do not proscribe significant actions for CWA permitted dischargers. AWC believes that CAPs are the best way to address certain persistent, bioaccumulative toxicants, as opposed to the narrow scope of the CWA which focusses on NPDES permits and TMDLs.

We also support the use of relative source contribution of one. Our consistent perspective throughout this discussion is that the point source dischargers should be held to a strong but achievable set of standards, and that the real place to make progress is with non-regulated sources. We continue to support the need for a more robust chemical action plan process that will produce real tools to make more significant environmental and public health gains.

AWC continues to prefer the earlier version of this rule proposal that included a cancer risk level of 10^{-5}. Although many of the most acute challenges are addressed by the treatment of PCBs, Mercury and Arsenic, the reversion to a 10^{-6} risk level in this proposal causes great long-term uncertainty with other chemicals. We are concerned with parameters with criteria so low that existing analytical methods can't tell us if the receiving waters meet the criteria or even if the parameters are present in treated wastewater. The current analytical limitations coupled with very low criteria make it impossible to determine possible future impacts to permitted dischargers for many parameters. We reiterate our request that in the interest of certainty the testing methodologies be specified and incorporated into the rule. Should more sensitive testing methodologies be approved, this approach would allow careful consideration about implications rather than potentially creating great challenges by locking in unattainably low criteria.

While we appreciate the consistent support that Ecology has shown regarding the need for robust and attainable implementation tools we feel that the current proposal continues to fall short on that front. For municipal treatment plant operators, the only two tools that are potentially relevant are variances and implementation schedules. Both present significant weaknesses. Variances have never been granted in Washington State and must be approved by the Federal Environmental Protection Agency. We are not convinced that the variance approached contemplated by this rule provide a clear pathway to compliance. Similarly we are concerned that compliance schedules will not serve to address the most difficult challenges because they must ultimately end at compliance – which may be impossible in some instances. Particularly given the discussion above concerning the uncertainty with whether the receiving bodies across the state actually meet the proposed new standards, it is critical that there be solid and deliverable implementation tools. We believe that there is still work to do be done here.

Finally, we must note that we are disappointed with the economic impact analysis incorporated into this proposal. We believe it significantly undersells the potential costs particularly for future scenarios where testing methodologies improve and for costs associated with source control implementation for types of sources outside of the jurisdiction of utilities to control.

Sincerely yours,

Carl Schroeder

Association of Washington Cities
1076 Franklin St SE
Olympia, WA 98501

American Forest & Paper Association

April 22, 2016

Becca Conklin
Department of Ecology
PO Box 47600
Olympia, WA 98503-7600

Re: AF&PA Comments on Washington Department of Ecology Proposed Water Quality Standards for Protecting Human Health (Chapter 173-201A WAC) ("The Proposal")

Dear Ms. Conklin:

The American Forest & Paper Association (AF&PA) serves to advance a sustainable U.S. pulp, paper, packaging, tissue and wood products manufacturing industry through fact-based public policy and marketplace advocacy. AF&PA member companies make products essential for everyday life from renewable and recyclable resources and are committed to continuous improvement through the industry's sustainability initiative - *Better Practices, Better Planet 2020*. The forest products industry accounts for approximately 4 percent of the total U.S. manufacturing GDP, manufactures over $200 billion in products annually, and employs approximately 900,000 men and women. The industry meets a payroll of approximately $50 billion annually and is among the top 10 manufacturing sector employers in 47 states. Visit AF&PA online at afandpa.org or follow us on Twitter @ForestandPaper.

AF&PA supports the joint comments filed on the Proposal today by the Northwest Pulp and Paper Association and a number of other organizations and hereby incorporates those comments by reference. AF&PA is a member of the Federal Water Quality Coalition and was actively involved in developing those comments as well. Our members in Washington have a direct interest in this rulemaking because their water permits could potentially include limits calculated from the proposed water quality criteria and the criteria will serve as a precedent for how human health criteria issues are addressed in permits for AF&PA members in other states.

We would like to highlight certain points made in the other comments:

- Ecology correctly decided to retain the current National Toxics Rule (NTR) criteria for polychlorinated biphenyls (PCBs) in light of the technical and cost issues EPA and others have identified with potentially tightening the criteria. Similarly, EPA and Ecology have identified numerous issues with implementing EPA's methylmercury criteria that support Ecology's decision to defer action on criteria for that pollutant.

- Ecology's proposed arsenic criterion is based on the Maximum Contaminant Level for arsenic under the Safe Drinking Water Act. EPA previously approved arsenic criteria based on a similar approach in other states. Ecology should maintain this criterion in the final rule as it is sufficiently protective of water consumers and results in more achievable criteria.
- The Relative Source Contribution (RSC) of 1.0 proposed by Ecology is appropriate and consistent with EPA guidance, since EPA's default national HHWQC on which the Ecology Proposal is based are extremely conservative and Ecology is using an even more conservative Fish Consumption Rate. Further, EPA Region X has approved RSCs of 1.0 in standards developed by Oregon and the Spokane tribe.
- Ecology correctly points out that EPA has used bio-concentration factors (BCFs) for calculating Clean Water Act criteria development at least since 1980 and continues to recommend BCFs for many priority pollutants. While EPA used default bioaccumulation factors (BAFs) to calculate HHWQC for some pollutants in its 2015 update, BAFs are influenced by several local environmental factors, and default BAFs are unlikely to represent bioaccumulation in any water body with characteristics that differ from those used to develop the default value. Moreover, EPA has not provided an opportunity for the scientific community to adequately evaluate and comment on the new bioaccumulation factors. Accordingly, Ecology was correct to continue using BCFs in deriving its HHWQC.
- EPA's national HHWQC on which the Ecology Proposal is based include very conservative default values that result in unnecessarily stringent criteria because of "compounded conservatism." Specifically, EPA's national HHWQC assume that: the concentration of a pollutant in all waters is always equal to the HHWQC; everyone in the U.S. is of average weight; is drinking 2.4 liters of unfiltered and untreated water from rivers, lakes, and streams, each and every day for 70 years; is eating 22 grams of locally caught fish every day for 70 years all of which are contaminated at the criteria level; and none of the pollutants in the fish were lost due to preparation or cooking.
- The Proposal also includes another conservative element. Ecology is using a Fish Consumption Rate (FCR) of 175 grams/day which is representative of average FCRs for all fish and shellfish for highly exposed populations that consume both fish and shellfish from Puget Sound waters. This means Ecology's HHWQC assume everyone in the state has the characteristics described immediately above, except they eat 175 grams/day of fish, instead of 22 gram/day. This is extremely conservative, as Ecology documented 18.8 grams/day as the average consumption rate for consumers only for the general population of Washington,
- Ecology also chose an excess cancer risk level of $1x10^{-6}$. When coupled with the FCR and the other default values in the equation to derive HHWQC, this results in extremely conservative criteria that provide little, if and, human health protection when compared to more reasonable alternatives but imposes potentially exorbitant costs on all Washington residents.

In conclusion, we believe that Ecology should revise the Proposal consistent with the points discussed above. If you have any questions, please contact me at 202/463-2581 or jerry_schwartz@afandpa.org.

Sincerely,

Jerry Schwartz
Senior Director
Energy and Environmental Policy

Commenter ID: 63

Commenter Name: Robert L Seaman

Commenter Association: Ten Mile Creek Clean Water Committee

Comment received via online comment form

Comment:

Recent tests on the salmon populations in Puget Sound are revealing residual concentrations of numerous pharmaceuticals in their flesh.

This is most likely from people not properly disposing of outdated medicines or when a family member passes they are too often flushed down the toilet.

In Whatcom County there are too few pharmacies that routinely take these unneeded meds. to be disposed of properly.

I propose legislation that would make it mandatory for all pharmacies that dispense meds. to take the old/unused ones back .

Another 5 or 10 cents could be added onto the price to cover the expense.

Keep up the great work.

Bob

THE TULALIP TRIBES

Board of Directors:

Melvin R Sheldon Jr - Chairman
Marie Zackuse - Vice Chairman
Les Parks - Treasurer
Bonnie Juneau - Secretary
Glen Gobin, Ti Cetx- Council Member
Theresa Sheldon - Council Member
Herman Williams, Leib Sil Teed – Council Member

Misty Napeahi- Tribal Government General Manager

6406 Marine Dr.
Tulalip, WA 98271-9694
(360) 716-4500
FAX (360) 716-0628

The Tulalip Tribes are the successors in interest to the Snohomish, Snoqualmie, and Skykomish tribes and other tribes and band signatory to the Treaty of Point Elliott

April 21, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments on the State's 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon,

The Tulalip Tribes, as the successors in interest to the Snohomish, Snoqualmie, and Skykomish tribes and other tribes and band signatory to the Treaty of Point Elliott, urge Washington State not to issue regulations that will again fall short of the stated goal of protecting people who consume fish and shellfish. These regulations would result in impairment of the Tribe's treaty-reserved rights to take and consume fish at all our usual and accustomed fishing grounds and stations.

For Tulalip, as with many other tribes across the country, rates of diabetes, obesity and other chronic diseases have become epidemic among our people. In an effort to combat these alarming health trends, we have established several tribal programs aimed at encouraging individual tribal members to return to a healthier diet, including a diet richer in traditional foods. For Tulalip people, that means eating a lot of fish and shellfish. We want to be able to eat fish at levels that are more consistent with our traditional diet and what public health experts recommend. As you know, fish have been an integral part of our traditional diet since time immemorial.

Tulalip along with other Tribal nations expressed concern many years ago that the existing fish consumption rate of 6.5 grams per day grossly under-represents tribal fish consumption. The harvest and consumption of fish and shellfish remains at the heart of our tribal community, and is a cultural, nutritional, and economic necessity. Most importantly, the Tulalip

Tribes has constitutionally protected, treaty-reserved rights to harvest, consume, and manage fish and shellfish in our usual and accustomed areas. Fishing is central to Tulalip culture and the rights reserved to continue our lifeways of fishing in all usual and accustomed waters is a central component of our treaty with the United States government. These rights are as important today as when the treaty was signed, as is reflected in the landmark case of *U.S. V. Washington* (Boldt decision).These comments are submitted to ensure protection of those reserved rights and the health of tribal members.

We strongly agree with the US Environmental Protection Agency's formal determination that Washington State's "existing criteria are not protective of the designated uses," and therefore "new or revised WQS [water quality standards] for the protection of human health are necessary to meet the requirements of the CWA [Clean Water Act] for Washington."[1]

Even though in this second proposal, Department of Ecology proposes a fish consumption rate of 175 grams per day and a cancer risk rate of one-per-million (10-6), many other provisions of the rule, as proposed by the Department of Ecology, would diminish the protective benefit of a higher fish consumption rate. Ecology proposes other human health criteria that do not incorporate best available science and fail to account for other sources of toxic chemicals, and we recommend instead, adoption of the criteria proposed by the EPA. Additionally, the state's proposal will allow the criteria for several highly toxic chemicals including PCBs, arsenic, and dioxin to remain at status quo or to get substantially worse. The state's proposed implementation tools should be adjusted so that they are directed towards accountability and attainment of water quality standards, and not a set of tools to help dischargers avoid compliance.

The Clean Water Act also creates a legal duty upon EPA to act promptly to develop water quality standards after a determination of necessity is made. The Department of Ecology has asserted that the EPA's proposed rule imposes on the state's ongoing process to establish water quality standards. Given that the state is already under federal rule, and has delayed adoption of state standards for years, Ecology's assertion that the EPA is imposing on the state is inappropriate. The state has knowingly delayed revising an under-protective fish consumption rate for Washington for many years, has delayed adoption of new standards at the requests of regulated industry, and has repeatedly failed to meet its own deadlines for rule-making. Immediate action by EPA is clearly justified and legally mandated regardless of state action on a draft rule for water quality standards.

The Tulalip Tribes has been working with the state of Washington and the US Environmental Protection Agency for many years to develop and adopt revised water quality standards that will protect the health of tribal people and respect our treaty-reserved rights to

[1] 80 F.R. 550066 (Sept. 14, 2015)

harvest fish and shellfish. Ecology's proposed state rule once again falls short of the stated goal of protecting people who consume fish and shellfish.

Washington State is required to meet the provisions of the Clean Water Act to preserve the beneficial uses of water, including fishing. As a sovereign nation, the Tulalip Tribes believe that Ecology's draft rule for human health criteria and implementation tools will impair these treaty-reserved rights to take and consume fish at all our usual and accustomed fishing grounds and stations. The Tulalip Tribes hereby, supports, adopts, and incorporates by reference the complete Northwest Indian Fisheries Commission comments submitted to Ecology in April, 2016. Finally, the Tulalip Tribes would like to express our support for the more protective draft rule for human health criteria applicable to Washington State, issued by the U.S. Environmental Protection Agency on September 14, 2015.

Sincerely,

Melvin R. Sheldon

cc. Lorraine Loomis, Chair; Northwest Indian Fisheries Commission
Dennis McLerran, EPA Region 10 Administrator
Dan Opalski, EPA Region 10 Director for the Office of Water and Watersheds

The Boeing Company
P.O. Box 3707
Seattle, WA 98124-2207

April 22, 2016

Via Email to: swqs@ecy.wa.gov
Becca Conklin
Department of Ecology
Water Quality Program
P.O. Box 47600
Olympia, WA 98503-7600

RE: Proposed Amendments to Water Quality Standards for Surface Waters of the State of Washington – Chapter 173-201A WAC

Dear Ms. Conklin:

The Boeing Company ("Boeing") appreciates the opportunity to submit comments on the Proposed Human Health Criteria and Implementation Tools Rule published in February 2016. Boeing is committed to working with the Department of Ecology ("the Department" or "Ecology") and other stakeholders to ensure that meaningful progress is made in developing an effective, efficient and sustainable means for achieving a cleaner environment and improved levels of human and environmental health. However, Boeing is concerned that establishing overly protective Human Health Criteria based on faulty assumptions regarding the fish consumption patterns of Washington residents and extreme risk management decisions will result in expending resources that could otherwise be used for real and meaningful environmental improvements. Boeing believes it will be more effective and meaningful to focus on a combination of measures, such as restoring ecological functions, utilizing green infrastructure, and applying an integrated watershed approach that targets both point and non-point sources in an environmentally and economically sustainable way. These approaches have already been demonstrated to improve water quality as well as provide notable social and economic benefits.

EXECUTIVE SUMMARY

Washington's first proposed Human Health Criteria rulemaking in January 2015 would have established some of the most stringent Human Health Criteria in the nation. The Department abruptly withdrew that proposal in August 2015, and then, in February 2016, issued a new proposal that would establish much more restrictive criteria. This new criteria is not based on sound science and effective policy-making, nor is it technically achievable. The revised proposed criteria do not take into account industry's and municipalities' previous comments on cancer risk level and will likely require implementing large, energy consuming end-of-pipe advanced treatment solutions which could have a significant carbon footprint and are likely to result in no detectable improvement in water quality.

The current proposal is unjustified. The Department itself acknowledges that the new Human Health Criteria will have little practical effect. The Department claims that proposal might result in "unquantifiable positive but likely small reduced cancer risk" and "unquantifiable positive but likely small reduced non-cancer illness risk." WDOE, Preliminary Cost-Benefit and Least-Burdensome

Alternative Analysis vii (Feb. 2016) (hereinafter "Cost-Benefit Analysis"). Significantly, these highly uncertain and unquantifiable benefits are all associated with the proposed new criterion for bis(2-ethylhexyl) phthalate. Id. at 36-40. The Department has proposed to change the Human Health Criteria for 94 other substances, but has been unable to identify any benefit from doing so. According to the Department's own analysis, there is no justification for the vast majority of its current proposal, and therefore, is contrary to law.

Boeing is concerned about the methodology used to develop the proposed Human Health Criteria. Use of a 175 g/day fish consumption rate is wholly unjustified and out of step with the rate used by the United States Environmental Protection Agency ("EPA") and virtually every other state in the nation. Contrary to the Department's claims, only a very small number of individuals, if any, consume fish at this rate throughout their lifetime. Use of such an unreasonably high fish consumption rate results in proposed Human Health Criteria that are far more restrictive than necessary to protect Washington citizens.

Ecology claims that the 175 g/day fish consumption rate is representative of the average consumption rate found in surveys of Pacific Northwest tribal communities. This claim is plainly erroneous. As discussed in detail below, the surveys referenced by the Department indicate that average fish consumption rates of these groups are closer to 50 g/day. In addition, the Department should be focused on the consumption of fish and shellfish that is reared in Washington waters, because only those fish will be affected by Washington State's water quality standards. The Department has previously estimated that only 46 to 67 percent of tribal consumption is made up of locally harvested fish, and much of that is made up of anadromous fish like salmon that may spend only a small portion of their lifespan in Washington waters.

Washington should adopt an incremental approach based on sound science instead of simply adopting new Human Health Criteria based only on the eating patterns of extreme outliers. Given the lack of statewide data available at this time, Washington should use a fish consumption rate consistent with national data to revise the Human Health Criteria. Washington should then initiate an effort to collect sufficient data surrounding the fish consumption rates of both the general population and high consumers to develop a meaningful and scientifically sound fish consumption rate for the state of Washington. After doing so, Washington could further revise the Human Health Criteria, if warranted.

Boeing also strongly disagrees with the Department's current proposal to develop Human Health Criteria based on a 10^{-6} cancer risk factor. In its January 2015 proposal, the Department more appropriately used a 10^{-5} cancer risk factor, but has now changed its position without explanation, and decided to use a 10^{-6} risk factor. Consistent with long-standing EPA guidance, the Department has previously acknowledged that Human Health Criteria is adequately protective of highly exposed groups at a risk level of 1 in 10,000 or 10^{-4}. When the 10^{-6} risk factor is combined with the 175 g/day fish consumption, the calculated Human Health Criteria would reduce cancer risk to less than 1 in 10,000 for individuals who consume up to 17,500 grams (almost 39 pounds) of fish per day. None of the data presented by Ecology indicates that any Washington resident, including the high fish consumers, consumes this amount of fish. The proposed criteria are orders of magnitude beyond what the Clean Water Act requires.

In addition, the Department has failed to comply with the state's Administrative Procedures Act ("APA") and the State Environmental Policy Act ("SEPA"). The cost-benefit analysis and least burdensome alternatives analysis required by the APA are both inadequate. The Draft

Environmental Impact Statement is also inadequate. It makes factual claims that are inconsistent with the conclusions of the Department's own Cost-Benefit Analysis, and it fails to consider a reasonable range of alternatives.

Boeing is also disappointed by the portions of the Department's proposed rule that concern compliance schedules and variances. Over the past four years, the Department has repeatedly expressed its intention to develop rules that would provide meaningful tools to allow the gradual implementation of more stringent water quality standards in a way that would be technologically and economically feasible. Although the proposed rule includes a few improvements, it provides little additional clarity or certainty for regulated entities.

As a result, we are concerned that the proposed changes to the Human Health Criteria could drive hundreds of millions of dollars in costs to Boeing, disrupt our current operations, and severely limit our ability to expand future operations in Washington. Boeing will not be alone - other industries, municipalities, counties, and ultimately, taxpayers, will also be impacted. We believe our mutual investments must be predictable and targeted to achieve real improvements. We urge the Department to carefully consider the impacts on the state's economy and quality of life before moving forward with a proposed rule that it seems to have concluded will have no effect on water quality.

DETAILED COMMENTS

I. Introduction

Boeing is the world's largest aerospace company and the leading manufacturer of commercial jetliners and military aircraft. Formed in Washington almost a hundred years ago, Boeing continues to be a major source of innovation and economic activity in Washington State. Boeing, the largest employer in the state, employs nearly 80,000 people in Washington. We build the 737, 737MAX, P-8, 747-8, 767, 777, 787 and KC-46 Tanker here. In 2015 alone, Boeing paid nearly $6 billion to over 1,700 suppliers in Washington and Boeing and our employees contributed more than $50 million to local charitable organizations.

We are committed to creating a cleaner future. Boeing continually challenges itself to produce more environmentally progressive products, while conserving energy and water, and eliminating waste. We are pioneering research into cleaner alternative fuels. We are improving the efficiency of the global air traffic management system to reduce the global carbon footprint of air travel. And we are investing in bold new technologies, including the 787, 737MAX and the 777X, to reduce our environmental footprint and create a brighter future. At the same time, we are operating in an increasingly competitive international market. Environmental stewardship and the cost of doing business are both important factors in our ability to compete.

II. Human Health Criteria

The Department has derived the revised Human Health Criteria in the proposed rule by using recognized formulas, and making assumptions or decisions related to each factor in the formula. Although Boeing supports some of the decisions made by Ecology as discussed below, the fish consumption rate Ecology has used is unjustifiably high, and the cancer risk level is overly protective. When combined, these factors distort the proposed Human Health Criteria to make them much more stringent than necessary to protect Washington citizens, and would impose undue regulatory burden on the regulated community.

A. Ecology used an inappropriate fish consumption rate to develop the proposed Human Health Criteria.

Ecology's decision to use 175 g/day to calculate the proposed Human Health Criteria is factually unsupported, and not necessary to protect Washington citizens. As explained in more detail below, this rate is as much as ten times higher than that used by EPA and 48 other states. It reflects neither the typical fish consumption of Washington residents, nor even the typical consumption of Native Americans, Asian Pacific Islanders, or subsistence fishers.

Furthermore, it is a rate that is purportedly based on data that includes the consumption of large amounts of fish reared wholly or primarily outside of Washington. Including these fish is inappropriate because fish reared outside of Washington are not affected by the water quality standards that govern Washington waters.

1. Ecology's proposal to base Human Health Criteria on a fish consumption rate of 175 g/day is out of step with the vast majority of regulatory authority in the United States.

Ecology's proposal to base its Human Health Criteria on a fish consumption rate of 175 g/day is out of step with regulatory decisions made by EPA and virtually every state in the nation. Washington's current Human Health Criteria are the result of EPA's promulgation of the National Toxics Rule in 1992. EPA based the National Toxics Rule on a fish consumption rate of 6.5 g/day, which reflected the average per capita consumption rate of freshwater and estuarine fish for the U.S. population. 57 Fed. Reg. 60848, 60863 (1992). Although EPA adopted the National Toxics Rule more than twenty years ago, EPA's fish consumption determinations have not changed drastically since then. In 2000, EPA increased its fish consumption rate to 17.5 g/day. EPA, <u>Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health</u> 1-8 (Oct. 2000). Most recently, in 2014, EPA updated the fish consumption rate to 22 g/day. EPA, <u>Human Health Ambient Water Quality Criteria: Draft 2014 Update</u> (May 2014). Both EPA's 2000 and 2014 revision were based on national data and selection of the 90th percentile fish consumption rate. In other words, EPA concluded that 90% of the population eats less than 22 g/day of fish.

All states, with one exception, have developed Human Health Criteria using fish consumption rates of the *general population* similar to those used by EPA in its development of national criteria. Thirteen states continue to use 6.5 g/day, and twenty-four states now use 17.5 g/day. <u>See</u> WDOE, <u>Fish Consumption Rates Used in Human Health Criteria Calculations</u> (Sept. 9, 2013). Although Oregon recently adopted criteria based on 175 g/day, it is an outlier. All 49 other states use fish consumption rates of less than 34 g/day. <u>Id.</u> In the rule proposal package, the Department emphasized that 175 g/day is an "endorsed value" because EPA recently approved Oregon's criteria, but that value has only been endorsed by one state. WDOE, <u>Washington State Water Quality Standards: Human health criteria and implementation tools – Overview of key decisions in rule amendment</u> 18 (Jan. 2016) (hereinafter <u>Overview of Key Decisions</u>). Much lower fish consumption rates have been endorsed much more frequently, in EPA's own rules and the rules of every state other than Oregon.

The Clean Water Act certainly does not require Washington to use such a high rate. In doing so, the Department has proposed criteria that are orders of magnitude more stringent than necessary to protect Washington citizens. For the reasons explained in more detail below, the use of 175 g/day is not supported by the scientific research.

2. The proposed fish consumption rate of 175 g/day does not reflect the fish consumption patterns of Washington residents.

The Department proposes to revise the state's Human Health Criteria based upon a fish consumption rate that does not reflect the fish consumption patterns of Washington residents. In fact, the Department declined to conduct a fish consumption survey of Washington's population, which would have provided a scientific basis for fish consumption rate assumptions. Ecology refused to undertake the necessary research despite repeated requests from stakeholders, and despite guidance from EPA to base its criteria on state-specific data.[1]

In the absence of state-specific data, the Department must consider the extensive peer reviewed national data that are available. These data indicate that the vast majority of people eat far less than 175 g/day of fish. Data from the National Health and Nutrition Examination Survey (NHANES), analyzed using the National Cancer Institute methodology, indicate that the 50th percentile *of fish consumers* eat only 12.7 g/day of fish, and the 90th percentile eat only 56.6 g/day. WDOE, Fish Consumption Rates: Technical Support Document 43-44 (Jan. 2013) (hereinafter "FCR TSD"). Of course, these percentiles ignore the 72% of the adult population that EPA estimates does not regularly eat fish. FCR TSD at 13. Similarly, the Department has previously indicated that somewhere between 25% and 73% of Washington residents do not eat fish regularly. Id. at 12. When all residents are considered, EPA estimates that the 90th percentile fish consumption rate is only 17.5 g/day. FCR TSD at 100.

As recently as 2013, EPA emphasized that a fish consumption rate representing the 90th percentile of the general population is appropriate to use in establishing Human Health Criteria under the Clean Water Act. EPA, Human Health Ambient Water Quality Criteria and Fish Consumption Rates: Frequently Asked Questions (Jan. 18, 2013). Despite this guidance, the Department proposes to use a 175 g/day fish consumption rate. EPA estimates that more than 99.9 percent of the United States population eats substantially less fish than reflected in the proposed rate. See FCR TSD at 2, 100.

It is also important to keep in mind that the Human Health Criteria are calculated assuming consistent fish consumption throughout a 70-year lifespan. The Department is, therefore, assuming that individuals consume an average of 175 grams of fish every day of their life. The available data cited by both EPA and the Department indicate that virtually no one eats that much fish.

The Department, nonetheless, ignores the vast majority of the state's residents, and instead focuses on a small number of statistical outliers who reported consuming an extraordinary amount of fish during the short sampling periods of fish surveys of high consuming groups. The Department acknowledges that "[h]igh fish consumers make up a relatively small portion of the whole

[1] In the absence of adequate state-specific data, Washington should instead use a fish consumption rate consistent with the robust national data relied upon by EPA and most other states. Washington could then collect data concerning the fish consumption habits of both the general population and high consumers to determine a scientifically defensible fish consumption rate for the State and make revisions to the Human Health Criteria in the future if necessary.

population, and may represent extreme upper percentiles in a distribution that includes both consumers and non-consumers of fish." FCR TSD at 84. This is a huge understatement. Washington State has more than 7 million residents. In the four tribal studies upon which Ecology now relies to set statewide Human Health Criteria, fewer than 115 individuals claimed to eat 175 grams or more of fish per day during the short periods of the surveys. FCR TSD, Appendix C, Tables E-1 and 5-8. There is no data indicating that any of these individuals do so frequently, much less every day of their lives. The Department's proposal is arbitrary and capricious.

3. The Department's stated rationale for selecting 175 g/day is incorrect – 175 g/day is not the average consumption rate of the highly exposed populations surveyed.

The Department justifies its decision to use a fish consumption rate of 175 g/day as follows:

> 175 g/day is representative of average FCRs ("all fish and shellfish," including all salmon, restaurant, locally caught, imported, and from other sources) for highly exposed populations that consume both fish and shellfish from Puget Sound waters.

Overview of Key Decisions at 18. This statement is simply incorrect.

Following this statement, the Department summarized data collected in four tribal surveys. Its own data summary plainly indicates that 175 g/day is far above the average rate of consumption from the "highly exposed populations" to which it refers. The median consumption levels for surveyed members of the Columbia River Tribes, the Tulalip Tribes, the Squaxin Island Tribe, and the Suquamish Tribes were 41 g/day, 45 g/day, 45 g/day and 132 g/day, respectively. Id. at 19. The median consumption level for all of the surveyed tribes combined was likely closer to 50 g/day.[2] Nonetheless, the Department states that "[t]he mean of the three tribal studies combined is 127 g/day" and that 175 g/day is "representative of the average value of these surveys." Id. at 19. There are at least three problems with the Department's reasoning.

First, a rate of 175 g/day is not "representative" of 127 g/day. It is almost 40% greater. If the Department thought it was appropriate to use the mean fish consumption rate from those three tribal surveys, it should have used 127 g/day. Using 175 g/day is arbitrary and capricious according to the Department's own rationale.

Second, Ecology was only able to calculate the combined mean of 127 g/day by ignoring the fourth study – Columbia River Tribes study – that it has repeatedly referenced and the results of which it presented in the same table. Id. at 19 Table 3. The Department focuses only on the three studies with the highest mean values without explanation. Significantly, the three surveys on which the Department focuses concerned smaller tribes. Only a total of 282 individuals were surveyed, and the tribes they were intended to represent have a total of only about 5000 members. If the results of the much larger Columbia River Tribes survey is included, the combined mean drops to 87 g/day, less than half the value Ecology is proposing.

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[2] The Department's current rationale is contradicted by the Department's own conclusions about the available data. In the Technical Support Document, the Department concluded that the surveyed tribal members averaged consumption between 60 and 80 grams of fish per day, and that the average consumption of Asian Pacific Islanders and recreational anglers fell within the same range. FCR TSD at 75.

Third, Ecology does not explain its decision to focus on the mean rather than median values from these surveys. The survey data set includes some extreme outliers on the high end, which distorts the mean. It would make more sense to use the median – or 50th percentile – value. The combined median value is likely to be around 50 g/day, approximately one-third the value that Ecology proposes to use. In contrast, the rate the Department proposes to use – 175 g/day – is likely to be around the 90th percentile value when all four tribes are considered.

Thus, even if the Department could legally base the Human Health Criteria on the average consumption rate of high consuming tribal populations, 175 g/day would not be the proper rate. The rationale the Department has provided is plainly incorrect, unsupported by the scientific data in the record, and therefore, arbitrary and capricious.[3]

4. The Department has misled the public by failing to acknowledge how few Washington residents consistently eat 175 g/day of fish.

When speaking of high fish consumers, the Department has generally avoided providing population data, and as a result has misled the public. It frequently implies that most, or at least many, Washington residents of Native American heritage eat 175 g/day of fish. In fact, the fish consumption surveys upon which Ecology relies focus on small groups of tribal members that live on or near reservations, and only the highest fish consumers in those small groups reported eating 175 grams per day of fish during the short-term survey.

The four tribal surveys referenced by the Department surveyed a total of only 746 people. Overview of Key Decisions at 19. The 90th percentile was about 175 g/day, so that means approximately 75 individuals indicated that they ate that much fish during the survey. Even if we assume that these short-term surveys of tribal members living on or near reservations reflect the eating habits of the entire populations of these tribes, the numbers remain small. The populations addressed in the four tribal surveys referenced in Ecology's Technical Support Document total about 22,000 people, which means fewer than 2,200 people consume fish at rates at or above the 90th percentile level.[4] In a state with a population exceeding 7 million people, the Department appears to be basing its proposed Human Health Criteria on the consumption patterns of a remarkably small number of people. This makes no sense from a public policy standpoint, but if it is the basis of the decision, the Department should clearly and honestly communicate that basis to the public.

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[3] At times, the Department has also referred to Asian-Pacific Islanders as high consumers, but does not appear to base its proposal on consumption rates of that group. A referenced survey found median fish consumption levels of only about 78 g/day. FCR TSD at 65. However, when EPA analyzed that survey data more closely, it ultimately concluded that the 95th percentile fish consumption rate was only 57.1 g/day. Id. at 67. These data, therefore, provide no support for Ecology's 175 g/day proposal.

[4] Tribal membership numbers for the Yakama, Warm Springs, Umatilla, Nez Perce, Tulalip and Squaxin Island tribes are referenced at the following websites:

http://www.yakamanation-nsn.gov/history3.php
http://warmsprings.com/warmsprings/Tribal_Community/
http://www.umatilla.nsn.us//
http://nezperce.org/Official/FrequentlyAskedQ.htm
http://www.tulaliptribes-nsn.gov/
http://www.npaihb.org/member_tribes/tribe/squaxin_island_tribe/

The Suquamish tribe is described in the Technical Support document. See FCR TSD at 57.

5. The proposed use of a 175 g/day fish consumption rate fails to take into account the source of the fish consumed by Washington residents.

The Department's discussion of fish consumption rates also consistently ignores the source of the fish consumed by Washington residents. The Human Health Criteria applied to Washington waters only have the potential of affecting the concentrations of pollutants in fish that reside in Washington waters. The consumption of fish raised in other geographic locations has no relevance to the policy decisions surrounding Washington's water quality standards.

Without explanation, the Department has decided to base its Human Health Criteria on a fish consumption rate that includes all fish, whether caught locally or from other sources. See Overview of Key Decisions at 18. Significantly, the Department's approach is contrary to the approach historically used by EPA, which has used a rate that excludes marine species. See, e.g., 57 Fed. Reg. at 60863.

Including non-Washington fish in the fish consumption rate significantly increases the rate without any justification. There was likely a time in Washington's history when most fish consumed in Washington were raised and harvested in Washington waters, but that is no longer the case. Fresh, frozen, smoked and canned seafood from all over the world is easily purchased in local fish markets, grocery stores and restaurants. In Washington, Pacific salmon is the most frequently consumed fish, and much of it comes from Alaskan waters. Washington residents commonly consume halibut and crab from Alaska, trout from Idaho, mussels and oysters from Oregon, and a wide variety of fish and seafood from elsewhere in the U.S. and the world. Indeed, a relatively small portion of the fish and seafood available in most Washington markets, groceries and restaurants is actually raised and harvested in Washington waters.

The previous section referenced Ecology's conclusion that the average member of high consuming populations consume between 60 and 80 g/day of fish. FCR TSD at 75. The Department has provided different estimates about the proportion of this fish that is raised and harvested in Washington waters. Ecology has previously claimed that between 46.5 and 67.25 percent of the fish consumed by state tribal populations is likely to be local. WDOE, Draft Preliminary Cost-Benefit Analysis and Least Burdensome Alternative Analysis 42 (2014). Applying those percentages suggests that the average consumption of local fish by high consuming populations would be only 27.9 to 50 g/day. In the Technical Support Document, however, Ecology states that the average member of these subpopulations consumes 55 to 60 g/day of local fish. FCR TSD at 76. Even the higher estimates are only one-third of the fish consumption rate that the Department used to calculate the proposed Human Health Criteria.

The Department's decision to ignore the distinction between local and imported fish is unjustified, and compounds the arbitrary and capricious nature of its decision to use 175 g/day to develop the state's new Human Health Criteria.

6. The proposed use of a 175 g/day fish consumption rate is improperly based upon data indicating significant consumption of salmon and other anadromous fish.

The Department's use of a 175 g/day fish consumption rate is also arbitrary and capricious because a significant portion of that rate is associated with the consumption of salmon and other anadromous fish. Even anadromous fish that are harvested in Washington do not spend most of their lifespan in Washington waters. The majority of their tissue mass gain occurs outside Washington waters. For the same reason that imported fish should be excluded from the fish consumption rate used to calculate Washington's Human Health Criteria, salmon and other anadromous species should be excluded.

The Department's decision to include salmon and anadromous fish in the fish consumption rate is out of step with accepted practice. EPA has long excluded Pacific salmon from the national default consumption rate because they are harvested from marine environments. EPA, Technical Support Document for Action on State of Oregon's New and Revised Human Health Water Quality Criteria for Toxics 48 (June 1, 2010). Similarly, in the sediment clean up context, EPA's tribal framework does not include salmon in calculating the consumption rates of the Tulalip Tribes or Suquamish Tribe for risk-based decision making at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites.

The Department's decision to include salmon consumption in its fish consumption rate causes the Human Health Criteria to be much more stringent than necessary. Salmon is the most frequently consumed fin fish in Washington. FCR TSD at C-3. For some of the subpopulations upon which the Department bases its 175 g/day fish consumption rate assumption, salmon makes up 25-50% of the fish consumed. Id. at C-4. On this basis alone, the proposed Human Health Criteria may be as much as twice as stringent as necessary to protect Washington residents.

B. Ecology has based Human Health Criteria on factors that substantially overstate exposure to pollutants through fish consumption in Washington.

1. Ecology's failure to distinguish between the types of fish and shellfish consumed in Washington results in significantly overstating potential exposure to pollutants through fish consumption.

Ecology's decision to group together the consumption of all fish and shellfish in determining Human Health Criteria exacerbates the arbitrariness of relying upon high fish consumption rates. Ecology has acknowledged the importance of understanding the type of fish consumed in order to characterize risks presented because different fish may have different contaminant levels. See FCR TSD at 34. In fact, the type of fish or shellfish can make a significant difference in the lipid content of the organism and the application of bioconcentration factors ("BCFs") used to develop Human Health Criteria.

Bioaccumulation differs substantially across species. Mean whole-body concentrations of PCBs found in different fish and shellfish species from non-urban locations in Puget Sound vary by 47-fold. See Windward Environmental, Supplemental remedial investigation report: East Waterway Operable Unit supplemental remedial investigation/feasibility study (2012). Mean concentrations sampled varied by over eight-fold across species, with Dungeness crab and clams having much lower levels than Rockfish species. Id.

Accordingly, PCB bioconcentration factor estimates vary widely across species. For hydrophobic organics, which tend to accumulate in lipids, bioaccumulation is substantially impacted by the lipid fraction of the organism, which is highly variable across species. The BCFs used by EPA assume 3% lipid concentration. 57 Fed. Reg. 60848, 60863 (1992). This may be reasonable for finfish, but lipid concentrations in shellfish tend to be much lower. Given that the surveys of tribal and Asian Pacific Islanders on which the Department has focused show significant portions of shellfish consumption, the combination of the 175 g/day fish consumption rate assumption and the bioconcentration factors used significantly overstate the risk presented by fish consumption in Washington, and resulted in the proposed unduly stringent Human Health Criteria.

2. The proposed use of a 175 g/day fish consumption rate fails to take into account information about different cooking and preparation techniques.

The Department has also failed to take into account how cooking and preparation methods can effect exposure, making Ecology's Human Health Criteria unduly stringent. Ecology acknowledges that cooking and preparation methods may significantly affect exposure, but did not make appropriate adjustments in its analysis to reflect this reality. See FCR TSD at 82.

Some preparation and cooking methods may dramatically decrease concentrations of some chemicals, particularly hydrophobic chemicals such as PCBs. For example, the concentrations of PCBs in raw fillet tissue have been shown to decrease by approximately 50% through the removal of the skin. EPA, Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (3d ed. 2000). Cooking may also reduce PCB concentrations in tissue, in some cases by as much as 87%, depending on the cooking method.[5] Preparation methods such as skin removal and filleting are practices that the Washington Department of Health recommends to reduce chemical exposures. Of course, many of these recommendations are already common practice for consumers based on their consumption preferences. Although these preferences may differ among different population subgroups, the Asian-Pacific Islander and tribal studies referenced by the Department indicate that most fish and shellfish consumed undergo some preparation (e.g., filleting, trimming) and some sort of cooking prior to consumption. Ecology has nonetheless failed to take cooking and preparation methods into account, and by doing so, overstates exposure from fish consumption.

C. Ecology's proposal to use the 10^{-6} cancer risk level is unjustified, and when combined with the extremely high fish consumption rate, results in unjustifiably stringent Human Health Criteria.

When Ecology issued its January 2015 draft rule, Ecology properly proposed using a 1 in 100,000 (10^{-5}) cancer risk level in calculating the Human Health Criteria for carcinogenic substances. Ecology's proposal was consistent with EPA's long-standing position and guidance. "EPA's Office of Water's guidance to the States has consistently reflected the Agency's policy of accepting cancer risk policies from the States in the range of 10^{-6} to 10^{-4}." 57 Fed. Reg. at 60864. In 2013, EPA again reaffirmed that states could use either 10^{-5} or 10^{-6} cancer risk levels so long as the risks presented to sensitive subpopulations did not exceed 10^{-4}. See EPA, Human Health Ambient Water Quality Criteria and Fish Consumption Rates: Frequently Asked Questions (Jan. 18, 2013). Consistent with EPA's recommendation, more than a dozen states have calculated Human Health Criteria based on a 10^{-5} risk level. See WDOE, Risk Levels Used in Human Health Criteria (2013).

When the 175 g/day fish consumption rate was combined with a 10^{-5} risk level, the resulting criteria are actually far more protective of both the general population and high fish consumers than the Clean Water Act requires. In order to achieve the 10^{-5} risk level for 90% of the population, a fish consumption rate of no higher than 17.5 g/day (the 90th percentile) could be combined with the 10^{-5} risk level. By combining 175 g/day with the 10^{-5} risk level, the resulting Human Health Criteria

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[5] N. Wilson, N. Shear, D. Paustenbach, and P. Price, The Effect of Cooking Practices on the Concentration of DDT and PCB Compounds in the Edible Tissue of Fish, J. Expos. Anal. Environ. Epideliol.423-440 (1998).

would effectively reduce the risk level for 90% of Washington residents to no more than 1 in 1,000,000. In other words, the Department's January 2015 proposal was 10 times more protective than necessary to meet the requirements of the Clean Water Act.

Using 175 g/day and a 10^{-5} risk level would have also resulted in criteria that are much more protective of high fish consumers than the 10^{-4} risk level recommended by EPA. In order to achieve the 10^{-4} risk level for the average member of the subgroups Ecology identified, a fish consumption rate of between 40 and 80 g/day (the averages in the tribal and API surveys relied upon by Ecology) could be combined with a 10^{-4} risk level. By combining 175 g/d with a 10^{-5} risk level, the resulting Human Health Criteria would be roughly 20-40 times more protective than necessary to meet the requirements of the Clean Water Act.

Put another way, by using a 175 g/day fish consumption rate and a 10^{-5} cancer risk level, the resulting Human Health Criteria would allow an individual to eat 1750 grams (approximately 3.75 pounds) of fish every day for 70 years of his or her life without being exposed to more than a 1 in 10,000 (10^{-4}) additional cancer risk.[6] None of the data presented by Ecology indicates that any Washington resident, including the high fish consumers, consistently consumes such an extraordinary amount of fish.

Unfortunately, the Department now proposes, without explanation, to use a 10^{-6} cancer risk factor to derive the new Human Health Criteria. Although the 10^{-6} risk factor may by itself be permissible under the Clean Water Act, when it is combined with an extremely high fish consumption rate, it results in Human Health Criteria that are arbitrary and capricious.

As explained above, EPA ordinarily recommends that criteria be designed to ensure that average members of high consuming populations do not face more than a 1 in 10,000 risk of cancer. By using 175 g/day fish consumption rate and 10^{-6} to calculate the criteria, Ecology proposes to ensure that the top 10% of high consuming subpopulations does not face more than a 1 in 1,000,000 risk of cancer. Given that the average local fish consumption rate of high consuming populations is around 50 g/day, Ecology is proposing Human Health Criteria that are 300 times more stringent than necessary.

Simply stated, when the 10^{-6} risk factor is combined with the 175 g/day fish consumption rate, the results are Human Health Criteria that would reduce cancer risk to less than 1 in 10,000 for individuals who consume up to 17,500 g (almost 39 pounds) of fish per day. None of the data presented by Ecology indicates that any Washington resident, including the high fish consumers, consumes this amount of fish. The proposed Human Health Criteria are, therefore, orders of magnitude beyond what the Clean Water Act requires, and serve no public policy objective.

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[6] EPA has provided a similar explanation for Human Health Criteria calculated using 17.5 g/day for the fish consumption rate and 10^{-6} for the cancer risk factor: "For a criterion derived on the basis of a cancer risk level of 10^{-6}, individuals consuming up to 10 times the assumed fish intake rate would not exceed a 10^{-5} risk level. Similarly, individuals consuming up to 100 times the assumed rate would not exceed a 10^{-4} risk level. Thus, for a criterion based on EPA's default fish intake rate (17.5 g/day) and a risk level of 10^{-6}, those consuming a pound per day (i.e., 454 grams/day) would potentially experience between a 10^{-5} and a 10^{-4} risk level (closer to a 10^{-5} risk level). (Note: Fish consumers of up to 1,750 g/day would not exceed the 10^{-4} risk level.) If a criterion were based on high-end intake rates and the relative risk of 10^{-6}, then an average fish consumer would be protected at a cancer risk level of approximately 10^{-8}." EPA, Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health 2-7 (Oct. 2000).

D. Ecology properly used 1.0 as the Relative Source Contribution to develop the Human Health Criteria of non-carcinogens.

Boeing supports Ecology's use of 1.0 as the Relative Source Contribution or "RSC" to calculate the Human Health Criteria for non-carcinogens. The Department fully explains its rationale for this policy judgment and risk management decision in its rulemaking documents. Although EPA has recently begun recommending the use of 0.2 as a default RSC value, Ecology has properly declined to follow EPA's recommendation for several reasons.

First, the Clean Water Act does not require a state to use any particular RSC value. Indeed, the Clean Water Act never mentions a "relative source contribution" and does not require a state to use any particular methodology to develop Human Health Criteria.

Second, EPA's recent recommendation does not have the binding power of law. EPA has not promulgated regulations requiring states to use any particular RSC value. Without going through the rulemaking process required to promulgate binding regulations, EPA cannot impose its opinions on the states. Indeed, in this case, EPA has not even consistently held the same view about RSC values. In 1992, it adopted the National Toxics Rule focused solely on surface water exposure, effectively using a RSC value of 1.0. 57 Fed. Reg. 60848, 60862-63 (1992). EPA's guidance continued to follow that approach in 2012. See EPA, Water Quality Standard Handbook § 3.1.3 (2d Ed. 2012). Now it has switched to 0.2, but provides no reason or support for the notion that the Clean Water Act requires states to utilize any particular value.

Third, EPA's recommendation assumes that the exposure to these pollutants through the consumption of marine fish species has not been included in the fish consumption rate. See EPA, Human Health Ambient Water Quality Criteria: Draft 2014 Update (May 2014); EPA, Human Health Ambient Water Quality Criteria and Fish Consumption Rates: Frequently Asked Questions (2013). As explained above, unlike EPA, the Department included marine species in its fish consumption rate. Adopting a lower RSC in order to take exposure from these species into account would double count those exposures, which in any event are beyond the regulatory jurisdiction of the Department's Human Health Criteria. See Oregon Department of Environmental Quality, Human Health Criteria Issue Paper: Toxics Rulemaking at 14 (May 24, 2011).

III. Human Health Criteria for Specific Parameters

Although the Department has used the same general approach to develop Human Health Criteria for most of the toxic pollutants covered by this rulemaking, the Department has justifiably used a different approach for determining criteria for a few pollutants. As explained more specifically below, Boeing supports the proposed criteria for PCBs and arsenic as consistent with the Clean Water Act.

A. PCBs

Boeing supports Ecology's retention of the current criteria for PCBs. The Department calculated a Human Health Criteria value using a cancer risk factor that was based on the toxicity factors that the Washington Department of Health uses for fish advisories, which is based on a cancer risk factor of 4.0 x 10^{-5} (four additional cancers in 100,000), and the inputs used to calculate other criteria, including the 175 g/day fish consumption rate. This would have resulted in a Human

Health Criteria that was less stringent than the existing Human Health Criteria. Instead, Washington made the risk management decision to retain the existing Human Health Criteria.

Risk management, and the appropriate level of risk protection, are fundamentally state and not federal policy decisions under the Clean Water Act. 57 Fed. Reg. 60848, 60884 (1992). EPA has previously acknowledged that states have the flexibility under the Clean Water Act to use different risk levels for different substances. 57 Fed. Reg. 60848, 60864 (1992). In fact, other states have used different risk levels to calculate Human Health Criteria for different pollutants. See, e.g., Oregon Department of Environmental Quality, Human Health Criteria Issue Paper: Toxics Rulemaking at 14. Ecology's approach is reasonable and fully consistent with the Clean Water Act.

B. Arsenic

Boeing supports the Department's proposed Human Health Criteria for arsenic of 10 ug/L. This criteria corresponds to the maximum contamination level established to protect public health under the Safe Drinking Water Act. Almost half of the states in the country have proposed this criteria for arsenic, and in each case, they have received EPA's approval. See DEIS at 24. Ecology's approach is reasonable, consistent with regulation under the other regulatory statutes, and fully compliant with the Clean Water Act.

IV. Ecology has failed to provide an adequate justification for the proposed rule, in violation of RCW 34.05.328.

In Ecology's rule proposal packet, the Department repeatedly states that its purpose in proposing revised Human Health Criteria for toxic substances is to protect people who drink surface water and consume fish from Washington waters. Yet, the Department also claims that the new Human Health Criteria will have virtually no effect on water quality, and will provide no more protection for Washington citizens than existing standards.

After spending a significant amount of time developing revised Human Health Criteria for 98 different toxic substances, the Department did not consider the potentially significant costs likely to be incurred by regulated entities and identified only the possibility of some unquantifiable, and at most small, benefits that might result from more stringent discharge limits on bis(2-ethyulhexyl) phthalate. Cost-Benefit Analysis at 65. The Department concludes, without explanation, that the uncertain and unquantifiable benefits are greater than the identified cost of more stringent limits.

Remarkably, Ecology nonetheless proposes to adopt more stringent Human Health Criteria for 94 other substances. The Department claims that these criteria will not have any practical effect on or cost to the regulated community, will not require any change in behavior and likewise, will then have no effect on water quality in the state. The Department has failed to justify the proposed rule, and as a result, its adoption would violate RCW 34.05.328, which requires Ecology to develop a rule that has greater benefits than costs and is the least burdensome alternative option for regulated entities in the state of Washington.

A. Ecology has failed to demonstrate that the probable benefits of the rule are greater than its probable costs, as required by RCW 34.05.328(1)(d).

RCW 34.05.328(l)(d) requires an agency adopting a significant legislative rule to "[d]etermine the probable benefits of the rule are greater than its probable costs." Washington Laws 1995 ch. 403, § 201. The Washington Legislature adopted this requirement as part of the Regulatory Reform Act of

1995. In doing so, the Legislature found that "Washington's regulatory system must not impose excessive, unreasonable or unnecessary obligations; to do so serves only to discredit government, makes enforcement of essential regulations more difficult, and detrimentally affects the economy of the state and the well-being of our citizens." Id. § l(l)(d). The proposed rule, if enacted, would violate RCW 34.05.328(1)(d) because Ecology has concluded that, except for the change in the criteria for phthalate, the proposed Human Health Criteria will have neither costs nor benefits.

In an attempt to comply with this statutory requirement, the Department published the Cost-Benefit Analysis as part of the rule proposal package. This document is remarkable in that it claims that the proposal to revise the Human Health Criteria for 94 toxic substances will have absolutely no effect. It will require no changes in behavior, and therefore, will have no costs and no benefits. On its face, the document demonstrates that the proposed rule violates RCW 34.05.328(1)(d).

In the Cost-Benefit Analysis, the Department claims to have analyzed every waterbody, every NPDES permit, and every TMDL, and concluded that the proposed Human Health Criteria would not require any changes in behavior, other than the possibility of additional treatment for bis(2-ethylhexyl) phthalate. The Cost-Benefit Analysis concludes that the proposed criteria has the potential to impose more stringent discharge limitations on 15 facilities in Washington. Cost-Benefit Analysis at 36. 13 of those facilities could be subject to more stringent phthalate limits. Id. Two other facilities could become subject to other limits, but the analysis concludes that one of those facilities is already curtailing operations and the other will not need to change its technology to comply with the new limits. Id. at 40.

If the rule will require no changes in behavior, it cannot affect water quality or benefit the environment or public health. This means that the proposed new criteria for 94 substances, other than phthalates, will have no benefit.

The Cost-Benefit Analysis also considers what it describes as the "hypothetical" scenario that future testing methodologies may lower detection levels. Future improvements in test methods combined with the revised Human Health Criteria could result in much more stringent limitations on dischargers that would require changes in behavior. The Department found that "[t]here is too much uncertainty" associated with this scenario to "assess the impacts of these future actions quantitatively." Id. at 56.

Inexplicably, the Cost-Benefit Analysis concludes by stating that "Ecology believes the likely benefits of the rule exceed its likely costs." Id. at 67. No explanation accompanies this conclusion. The analysis indicates that 13 facilities may face more stringent phthalate limits. The cost of compliance is estimated at $10,000 per facility. The more stringent limits might or might not result in changes to ambient water quality, and therefore might or might not have some very small, but admittedly unquantifiable, health benefit. That theoretical health benefit depends upon the possibility that more stringent limits cause an improvement of water quality, the possibility that any water quality improvement causes a change in the tissue concentrations of fish that someone consistently eats over the course of his or her lifetime, and the possibility of a change in that person's health. The benefit is not only unquantifiable, but highly improbable.

It is clear that the proposed revisions to Human Health Criteria would violate RCW 34.05.328(1)(d) because even the rule's proponent, Ecology, is unable to explain why its benefits would exceed its costs.

B. Ecology has failed to demonstrate that the rule is the least burdensome alternative, as required by RCW 34.05.328(1)(e).

RCW 34.05.328(1)(e) requires that any significant legislative rule be "the least burdensome alternative for those required to comply with it that will achieve the general goals and specific objectives" identified by the agency. Like the requirement to balance costs and benefits, the Legislature enacted this requirement as part of the Regulatory Reform Act of 1995. The Legislature wanted to ensure that agencies developed regulations thoughtfully, and avoided unnecessary burdens on the regulated community and state economy. Ecology's proposed revisions to the Human Health Criteria fail to comply with this requirement.

Ecology states its objective in proposing the new Human Health Criteria is to protect public health. The Department has articulated this goal:

- "To retain and secure high quality for all waters of the state." Cost-Benefit Analysis at 70.

- "To protect the public health or welfare, enhance the quality of the water, taking into consideration their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial and other purposes." Id.

The Department boldly concludes, again without explanation, that "the proposed rule represents the least burdensome alternative possible to meet the goals and objectives of the rule." Cost-Benefit Analysis at 72. In a series of conclusory sentences, the Department dismissed the current Human Health Criteria, and other Human Health Criteria based on a lower fish consumption rate as alternatives that would not be sufficiently protective of human health. Id. at 71. These conclusions are overly broad and unjustified in light of admissions the Department has made elsewhere in the same document. As explained above, the Department concedes that the only one of the new Human Health Criteria that may have any practical effect is the new phthalate criterion. The other 94 criteria will not result in changes in effluent limitations for any permit holder in Washington. Therefore, one less burdensome alternative would be to make no change to the criteria for those 94 substances.

According to the Department's own analysis, the new criteria for those 94 substances will be no more effective at protecting public health than the existing Human Health Criteria. The criteria are more stringent than existing criteria, and therefore, more burdensome in theory. Even if Ecology were correct that they will not require any changes of behavior by existing or future dischargers, the analysis required to verify that existing and future dischargers do not have the potential to exceed the more stringent standards will make the proposed criteria more burdensome for regulators and dischargers than the existing criteria. The proposed rule, therefore, violates RCW 34.05.328(1)(e).

The Department's analysis is also flawed because it fails to consider the alternative of adopting criteria based on a fish consumption rate of 175 g/day and a cancer risk factor of 10^{-5}. The Department's failure to consider this alternative is particularly shocking given that the Department proposed this alternative in January 2015, and at that time, the Department concluded that it was the least burdensome alternative that would meet its objectives. Without mentioning this alternative, the Department now concludes that another even more burdensome option is the least burdensome alternative. This conclusion is arbitrary and capricious.

V. Ecology's proposed rule is based upon a faulty cost-benefit analysis because the Department fails to present the underlying analysis necessary to support its conclusions.

The Department's Cost-Benefit Analysis concludes that the proposed Human Health Criteria will not require any changes in behavior, other than with respect to the phthalate criterion, and therefore, will have no other benefits or costs. As discussed above, if this is the case, the vast majority of the proposed rule is entirely unjustified and the Department should not (and cannot legally) go forward with its promulgation.

In order to serve its purpose under RCW 34.05.328, a cost-benefit analysis must provide a credible assessment of a proposed rule's costs and benefits, and the assessment must be explained clearly and with sufficient detail to allow the public to understand it and provide meaningful comment. As the Washington Legislature has found, "[m]embers of the public affected by administrative rules must have the opportunity for a meaningful role in their development; the bases for agency action must be legitimate and clearly articulated." Washington Laws ch. 403, §1 (1995). In this case, the Cost-Benefit Analysis fails to clearly articulate the bases for its assessment, or relies upon assumptions that are unsupported in the document.

The Department has published a cursory and conclusory document that falls far short of the type of analysis of costs and benefits that the Washington Legislature requires an agency to publish in connection with such a significant legislative rule. In this portion of the report, the Department claims to have performed several types of detailed analyses, but does not present them in a way that allows the public to understand and comment upon them. In order to comply with the letter and intent of RCW 34.05.328, the Department must "show its work."

The Department's Cost-Benefit Analysis is severely flawed. It fails to present or explain the underlying analysis. It bases its conclusions on assumptions that are neither supported by the language of the proposed rule or the facts presented. The Cost-Benefit Analysis is both an important part of the agency's decision-making process, and a document that is essential to allowing meaningful public comment on a proposed rule. The Department should revise the Cost-Benefit Analysis to address its shortcomings, and extend the public comment period on the proposed rule until it is reissued.

VI. Ecology's proposed rule is based on an inadequate Environmental Impact Statement.

Under the State Environmental Policy Act, an Environmental Impact Statement ("EIS") should present a reasonably thorough discussion of the significant environmental impacts associated with the agency's proposed action. In doing so, it should compare the proposed action to a reasonable range of alternatives, so that the decision makers and the public can understand and assess the likely effects of the proposed action. The Department first issued a draft EIS in January 2015. See WDOE, Draft Environmental Impact Statement (Jan. 2015). Along with its revised rule, the Department published a revised DEIS in January 2016. See Draft Environmental Impact Statement – Revised (Jan. 2016) (hereinafter "DEIS").

The DEIS has several fundamental inadequacies. Its analysis of the proposed Human Health Criteria is contradicted by and fundamentally inconsistent with the analysis presented in the Cost-Benefit Analysis, and it fails to consider a reasonable range of alternatives to the proposed Human Health Criteria.

A. The DEIS is inconsistent with Ecology's Cost-Benefit Analysis.

In its summary, the DEIS explains that "[t]he objective of the draft rule is to adopt Human Health Criteria for the state of Washington that protect people who consume fish and shellfish in waters regulated by Ecology." DEIS at 1. The document then goes on to compare four alternatives for Human Health Criteria with respect to the level of environmental protection provided and usability. The analysis and conclusions of this critical part of the DEIS are inconsistent with the analysis Ecology presented in its Cost-Benefit Analysis.

Specifically, the DEIS concludes that the existing Human Health Criteria provide a "Moderate-Low" level of environmental protection, but that the proposed Human Health Criteria will provide a "High" level of environmental protection. DEIS at 22. The DEIS appears to reason that, in theory, more stringent criteria are more protective. However, the DEIS never considers the practical effect of the new criteria. It does not compare the environmental conditions expected after adoption of the proposed criteria to current environmental conditions. The Department attempted to do so in the Cost-Benefit Analysis. As discussed above, the Department concluded that the only potential positive improvement would be the possibility of a reduction in phthalate discharges to the environment. The new proposed criteria for the other 94 substances would have absolutely no effect. It is, therefore, inaccurate and incredibly misleading to the public to issue a DEIS that claims that the proposed rule will increase the level of environmental protection from Moderate-Low to High.

B. The DEIS fails to consider a meaningful range of alternatives.

An EIS must consider a reasonable range of alternatives. With respect to most of the Human Health Criteria proposed, the Department's DEIS considers only three:

1. Human Health Criteria based on fish consumption rate of 6.5 g/day and risk level of 10^{-6}. (No Action Alternative)

2. EPA's proposed Human Health Criteria, which are based on fish consumption rate of 175 g/day and risk level of 10^{-6}.

3. Human Health Criteria for most substances based on fish consumption rate of 175 g/day and risk level of 10^{-6}, but criteria for copper and asbestos based on SDWA levels.

Although the DEIS identifies these as three alternatives, for 94 of the covered substances there are only two alternatives: the first and second listed above. The third alternative is identical to the second, except for copper and asbestos.

The DEIS ignores at least two obvious additional alternatives. The first is the proposed Human Health Criteria the Department published in January 2015, which was based on 175 g/day fish consumption and a risk level of 10^{-5}. The second is an alternative set of criteria based on a fish consumption rate in the range of 30 to 60 g/day, which would much more closely approximate the average consumption of Washington-reared fish by high consuming populations, and a risk level of 10^{-5}. These alternatives in addition to those identified in the DEIS would reflect a reasonable range of alternatives. By failing to evaluate such a range, the Department has set up a false choice—either stick with the status quo, or support the Department's current proposal. Ecology should revise the document to include a meaningful analysis and range of alternatives, and reissue the DEIS for further public comment

VII. Implementation Tools

During the more than four years that the Department has been developing its proposal to revise the Human Health Criteria, the Department has tried to reassure the regulated community that it intended to develop tools to ensure that the new criteria could be implemented gradually, giving the regulated community the time necessary to come into compliance with the more stringent requirements.

We appreciate the Department's recognition that implementation tools must be provided with any revision to Human Health Criteria. Unfortunately, the proposed Implementation Tools rule does little to ensure that these tools will provide any meaningful relief from more stringent permitting requirements. The general language of the proposed rule provides little clarity and even less assurance that the tools will be available to particular existing dischargers and provide meaningful relief. Furthermore, the Implementation Tools rule does not provide any tool or ability for a new or expanding business to gradually come into compliance with the more stringent requirements.

The Clean Water Act and its implementing regulations have always authorized the use of compliance schedules to provide time for dischargers to come into compliance with permit requirements. See 33 U.S.C. § 1362(17); 40 C.F.R. §§ 122.2, 122.47. Washington regulations also authorize the issuance of compliance schedules. See WAC 173-220-140, 173-201A-510(4). The proposed rule does not grant any compliance schedules and does nothing to clarify when the Department will grant compliance schedules.

Boeing supports the proposal to eliminate any limit on the maximum length of a compliance schedule. Federal law does not limit the length of compliance schedules, and the Legislature directed Ecology to change Washington's regulations more than five years ago. See RCW 90.48.605. The proposed revision is welcome, albeit long overdue.

The Clean Water Act and its implementing regulations have also always authorized water quality standard variances. See 40 C.F.R. § 131. The generality of the federal regulations has provided no certainty about when a discharger is entitled to a variance, and the proposed rule offers little improvement. The rule merely outlines in a general way what information should be presented in a variance application. It does not grant any variances, or even indicate what specific circumstances would entitle a discharger to a variance. The Department should revise subsection WAC 173-20 1A-420 so that it does not merely indicate when a variance or the renewal of a variance might be considered, but instead spells out when the Department will grant variances.

Likewise, the rule should identify when the Department will grant state-wide or waterbody-wide variances. Only then will the variance provide a meaningful tool to help dischargers achieve compliance with more stringent permitting requirements.

VIII. Conclusion

Thank you again for the opportunity to comment on the proposed Human Health Criteria and Implementation Tools Rule. Many of our concerns with the proposed rule remain. Boeing requests that the Department reconsider several important aspects of the proposal. In addition, the law requires that the Department revise and republish the Cost-Benefit Analysis and DEIS so that the public and the regulated community can understand the rationale for the proposed rule. The Department should extend the public comment period on the proposed rule until those revised documents are published.

The revision of statewide Human Health Criteria has the potential to significantly impact the state and its economy. The Department should not, and legally cannot, make any revisions unless the benefits outweigh the costs, and the proposed rule is the least burdensome alternative to meet its objectives. Here, the Department proposes a rule despite its astonishing claim that the rule will require no changes in behavior and have no benefit to public health or the environment, other than the possibility of some changes in phthalate discharges. This is exactly the kind of significant legislative rule that the Washington Legislature has prohibited. In order to avoid the risk of adverse consequences as a direct result of this rulemaking, Washington should consider a more incremental approach that would allow Washington the opportunity to develop a meaningful and effective solution based on appropriate scientific data and analysis.

Boeing is committed water quality improvement approaches that focus on a combination of measures, such as restoring ecological functions, encouraging utilization of green infrastructure and applying an integrated watershed methodology that targets all sources in an environmentally and economically sustainable way. These approaches have already demonstrated meaningful water quality improvements as well as greater social and economic benefit than that proposed by Ecology in this rulemaking. We urge Ecology to work with us and other stakeholders to address these significant issues.

Sincerely,

SL Shestag

Steven Shestag
Director, Environment
Environment, Health & Safety

Washington State Department of Transportation

Transportation Building
310 Maple Park Avenue S.E.
P.O. Box 47300
Olympia, WA 98504-7300
360-705-7000
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www.wsdot.wa.gov

April 22, 2016

Ms. Becca Conklin
Washington State Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

RE: WSDOT Comments on the *Proposed Human Health Criteria and Rule Implementation Plan*

Dear Ms. Conklin:

The Washington State Department of Transportation (WSDOT) appreciates the opportunity to share our perspective and provide comments on the *Proposed Human Health Criteria and Rule Implementation Plan.*

1) The cost- benefit analysis[1] states, "*Because most human health criteria (HHC) are based on lifetime exposures, direct comparisons of receiving water criteria with pollutant concentrations in intermittent stormwater discharges are not appropriate. This, and the high variation in stormwater pollutant concentrations and discharge volumes between storms and during a single storm, make the application of HHC to stormwater particularly problematic. Based on the authority of 40 CFR 122.44(k)(3), Ecology instead requires the implementation of Best Management Practices (BMPs) to control or abate pollutants in stormwater discharges, as it is not feasible to derive appropriate numeric effluent limits for the HHC.*" WSDOT suggests adding this wording to the Rule Implementation Plan for consistency and additional clarity.

2) WSDOT believes Ecology intends to use compliance schedules as an implementation tool to provide reasonable time for technological advances in stormwater treatment to lead to technology-based BMPs that are widely available and cost-effective. If so, suggest clarifying how Ecology plans to develop compliance schedules and how permittees can obtain those schedules. WSDOT remains concerned that existing stormwater best management practices are likely unable to remove carcinogenic pollutants, such as C-PAH, to a level that meets the proposed criteria.

3) WSDOT remains concerned about the effect of the proposed criteria on the construction stormwater general permit process. It is important that the permitting process for contaminated sites be clear and consistent statewide to minimize confusion and permitting delays. Clarification should be added to the Rule Implementation Plan to describe how and when the new human health criteria will be used to set trigger levels

[1] Ecology 2016. Preliminary Cost-Benefit and Least-Burdensome Alternative Analyses. Chapter 173-201A WAC. Water Quality Standards for Surface Waters of the State of Washington. February 2016. Ecology Pub# 16-10-009.

for contaminants. If the new criteria are going to apply to construction discharges, the Rule Implementation Plan must include reasonable lead time for technological advances in stormwater treatment to allow for technology-based approaches to compliance that are widely available and cost-effective.

WSDOT appreciates the opportunity to submit comments on this draft rule and support Ecology's efforts to address water quality impacts to human health from toxics. Please contact me or Jana Ratcliff (360-570-6649; RatcliJ@wsdot.wa.gov) if you would like WSDOT to discuss or provide additional clarification on our comments.

Sincerely,

Kenneth M. Stone
Resource Programs Branch Manager
Washington State Department of Transportation
PO Box 47332
Olympia, WA 98504

cc: Dick Gersib, Stormwater and Watershed Program Manager
Jana Ratcliff, Municipal Stormwater Permit Coordinator

Commenter ID: 67

Commenter Name: Kara Stucker

Commenter Association: Citizen

Comment received via online comment form

Comment:

We absolutely must do better. People joke about how nasty the river is. This needs to be taken more seriously. We need to hold polluters accountable. We should be allowed to benefit from the river. By continuing to poison and neglect we're only hurting ourselves and those who follow.

Commenter ID: 68

Commenter Name: Robert Swanson

Commenter Association: Citizen

Comment received via online comment form

Comment:

The proposed measures are way too slack. Please tighten restrictions such that polluters will keep our wonderful water in good shape. This is no time to backslide on water quality.

The water rule is unacceptable for the following reasons.

1. Compliance schedules are too long.

Polluters need to meet standards sooner than the windows in this rule.

2. Ignores PCB, mercury and arsenic.

The proposed rule is not strong enough with regards to these toxins. The Spokane River has issues with all of these toxins and the rule should update and tighten the standards on these pollutants.

3. Increased availability of variances. Variances are temporary waivers of water quality standards.

CITY OF
AUBURN
WASHINGTON

Nancy Backus, Mayor

25 West Main Street * Auburn WA 98001-4998 * www.auburnwa.gov * 253-931-3000

April 6, 2016

Becca Conklin
Department of Ecology
PO Box 47600
Olympia, WA 98503-7600

Re: City of Auburn Comments on Proposed Water Quality Standards for Protecting Human Health, Chapter 173-201A WAC

Dear Ms. Conklin:

The City of Auburn (Auburn) provides wastewater collection services to its residents, and contracts with the King County Wastewater Treatment Division for regional wastewater treatment. Auburn is one of 34 members of the Metropolitan Water Pollution Abatement Advisory Committee (MWPAAC) that provides recommendations to the King County Executive and King County Council regarding the regional wastewater services that King County provides.

King County's regional wastewater treatment system includes combined sewer systems. Although Auburn's wastewater does not flow to the combined sewer systems, we are particularly interested in the language of the proposed Water Quality Standards rule as it relates to combined sewer overflow (CSO) treatment plants. These plants represent a significant regional financial investment in improving water quality. The State is proposing to use narrative water quality standards and require a set of best practices specifically for these intermittent CSO treatment plants. Auburn supports the State approach as it will ensure that intermittently-treated discharges are protective of human health and that King County's long-term CSO control plan will be successful.

In addition, Auburn supports the State's approach to regulating PCBs, mercury, and arsenic as compared to the U.S. Environmental Protection Agency's more stringent approach. Furthermore, the State's proposed implementation tools will provide wastewater dischargers such as King County sufficient opportunity to reduce toxics in their wastewater discharges, recognizing the treatment technologies currently available.

We appreciate the opportunity to share with you our comments on the proposed rule. If you have any questions regarding our comments, please contact me at (253) 804-5062 or ltobin@auburnwa.gov.

Sincerely,

Lisa D. Tobin, P.E.
Utilities Engineering Manager
Community Development & Public Works Department

LT/as

King County
Department of Natural Resources and Parks
Director's Office
King Street Center, KSC-NR-0500
201 South Jackson Street
Seattle, WA 98104-3855

April 11, 2016

Becca Conklin
Washington State Department of Ecology
Water Quality Program
P.O. Box 47600
Olympia, WA 98504-7600

Dear Ms. Conklin:

King County would like to thank the Washington State Department of Ecology (Ecology) for the opportunity to comment on the proposed Human Health Water Quality Criteria.

King County provides wastewater treatment for 1.6 million residents and businesses within a 2,100 square mile service area, as well as manages stormwater for over 250,000 residents. King County also administers an industrial pretreatment permitting program, one of the first in the country. These services are managed under National Pollution Discharge Elimination System (NPDES) permits with Ecology. King County is also a designated Water Pollution Control Authority under state law. As both a regulated entity and jurisdiction actively managing and protecting water quality and quantity, we have a strong interest in how the responsibility for maintaining and restoring water resources is shared amongst local, state and federal agencies.

Protection of public health and the environment is our highest priority and we have consistently supported Ecology's efforts to retain state control and develop effective and meaningful human health criteria. The draft rule updates our fish consumption rate and defines water quality standards that are more protective than the standards in place today. This is a positive step towards enhanced water quality and achieving desired human health outcomes.

Because King County's regional service area includes combined sewer systems, we are particularly interested in the language of the proposed rule as it relates to combined sewer overflow treatment plants. King County supports Ecology's incorporation of language within the rule defining how human health water quality standards will be applied to treatment plants that operate on an intermittent basis. We support this approach as it will ensure intermittently treated discharges are protective of human health while providing certainty to King County's long-term combined sewer overflow control plans.

King County is also appreciative of the state's recognition and approach to addressing the unique nature of ubiquitous chemicals in the waste stream (such as PCB, mercury and arsenic) and the challenges the state faces in managing these chemicals. We continue to urge the state to take a comprehensive and holistic approach to the control of these chemicals through stronger chemical action planning, product stewardship and non-point pollution controls.

We also appreciate the state's update of implementation tools since they are key components of successful control. These tools will ensure that the improved standards effectively achieve the desired maximum practical pollution reductions and public benefit.

Looking at the draft criteria as a whole, we believe that there are several aspects of the rulemaking and supporting documentation that could be improved.

The economic analysis document supporting this draft rule is one such component which seems significantly out of line based on our experience and that of other control agencies. For example, King County and other jurisdictions, such as Spokane and Seattle, have a long history of source control actions. Based on this experience, Ecology's estimated cost of $1,000 one-time per utility to conduct source control implementation is not reasonable. Ecology's analysis further states that source control costs statewide would be $11,000 to attempt to control Bis (2-ethylhexyl) phthalate (DEHP) sources. Many legal in-use products contribute DEHP and other toxic contaminants to wastewater systems, and thus these types of sources are outside the jurisdiction of utilities to remedy or control. Source control efforts are potentially required for many pervasive urban pollutants beyond arsenic and DEHP as cited in the cost-benefit analysis.

Similarly the costs of monitoring efforts are not accurately addressed. The criteria will result in additional monitoring of effluent and surface water quality. This will be further impacted by the inevitable change to more sensitive analytical methods and increasingly strict effluent limits. Ecology should publish a rule that makes it clear that significant changes to the regulatory will lead to much higher costs for implementation. We urge the state to revise the economic analysis to assess the true complexities and costs.

The subject of variances is another topic which needs to be further addressed. While King County recognizes that variances may be an implementation tool when water quality standards improvement is not readily in sight, Ecology's ability to issue variances is constrained by the requirements of 40 CFR 131.10(g). For many wastewater utilities, these EPA criteria are very challenging to meet. As noted in the implementation tools and least burdensome analysis, variances may be needed for ubiquitous widespread contaminants. Because variances are challenging and unlikely to be approved in the timeframe of a normal permit cycle, King County recommends that ubiquitous chemicals receive priority consideration in future chemical action plans, and other upstream toxic reduction actions. Statewide efforts focused on source control rather than costly removal of chemicals after they have entered the waste stream will be more successful in reducing toxics in surface water and sediments. Therefore, we continue to advocate for meaningful toxics reduction legislation and state product stewardship for current-use chemicals and chemical by-products in industrial and consumer products.

Finally, Ecology has recently indicated that the Listing Policy 1-11 will be revisited. King County urges Ecology to move quickly on improvements so that the next Waterbody Assessment process will be conducted using the most robust, up to date and scientifically-based criteria. As noted in the supporting documentation for this rulemaking, many new waterbodies are likely to be designated as impaired under the revised human health criteria. Given the significance of this effort, such designations should be made with proper data and process.

Thank you again for administering a thorough rulemaking process with significant stakeholder involvement. Protecting the public and regional water remains our priority. We look forward to continuing to work with Ecology on the best approach to achieve the quality of life we want to see.

Sincerely,

Christie True
Director

cc: Sandra Kilroy, Assistant Division Director, Wastewater Treatment Division
Mark Isaacson, Division Director, Water and Land Resources Division
Ngozi Oleru, Division Director, Environmental Health Services Division, Department of Public Health

DEPARTMENT OF ECOLOGY

APR 14 2016

WATER QUALITY PROGRAM

Commenter ID: 71

Commenter Name: Mike Visintainer

Commenter Association: Silver Bow Fly Shop

Comment received via online comment form

Comment:

Water quality sustains ecological processes that support native fish populations, vegetation, wetlands and birdlife.

Water is essential to humans and the health of our environment.

The proposed Water Quality Standards for Protecting Human Health does not meet these standards and should be equal to EPA or better.

1. Compliance schedules are too long. Polluters need to meet standards sooner than the windows in this rule.

2. Ignores PCB, mercury and arsenic.

The proposed rule is not strong enough with regards to these toxins. The Spokane River has issues with all of these toxins and the rule should update and tighten the standards on these pollutants.

3. Increased availability of variances. Variances are temporary waivers of water quality standards.

The proposed rule allows polluters to receive "free passes" to meet water quality standards.

Thank You.

April 21, 2016

Becca Conklin
Department of Ecology
PO Box 47600
Olympia, WA 98503-7600

I am writing the following comments on behalf of the Spokane Riverkeeper regarding Water Quality Standards for Protecting Human Health (Fish consumption rates) Chapter 173-201A WAC (referred to as the "Fish Consumption Rule". The Riverkeeper program works for a "fishable and swimmable" Spokane River and endeavours to protect it from those conditions and forces that threaten its health and the well-being. The Spokane River is the heart and soul of our city and a healthy river is essential for a healthy community. Our mission to keep the river "fishable" is actually an effort to protect the designated uses of fishing and eating local fish without the risk of ingesting toxins.

- **Background**

Currently, the Spokane River is on the states 303(d) list for PCB (Polychlorinated biphenyls) pollution. All species of fish in the Spokane River bio-accumulate PCBs, mercury and heavy metals such as arsenic. Because our river has been the recipient of legacy toxins like heavy metals and older, industrial Aroclor PCBs, we have hot spots in the river where these toxins begin to feed in the food chain. We have numerous dischargers that still discharge pollutants, including PCBs, into the system. Some species bio-magnify pollutants to the extent that they are many times over the recommended levels for eating on a regular basis. As a result, we have local and State-wide fish advisories in our river. Complicating this is a large population of sport fishers, immigrant populations, native people and others who regularly fish for bass, walleye, pike, rainbow trout, carp, perch, sunfish, crappie and other species of fish. Recently Avista Corporation has begun stocking over 150,000 rainbow trout in our river for a "put and take" fishery. This fishery has become enormously popular with local Spokane anglers. Most if not all of these fish are kept and eaten. Numerous species of warm water fish reproduce naturally and are sought after by anglers. The Spokane Walleye Club actually has a pull down menu selection on heir website wherein visitors can find recipes for the fish caught in the Spokane (and Columbia) River. These fisheries make it very important that our Fish Consumption Rule be very stringent and protective of the public.

Unfortunately, the Washington Dept of Ecology (WDOE) proposed water quality standards and fish consumption rule would fall short of protecting these uses (fisheries) and the public that depends on them.

- **WDOE would use older standards for PCBs (polychlorinated biphenyl's), Mercury and Arsenic that are weaker than the EPA currently recommends.**

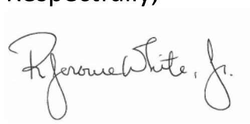
  WDOE proposes maintaining the National Toxics Rule (NTR) standard of 170pg/L while the EPA suggests a more conservative 7.3 pg/L. Additionally, the downstream, Spokane Tribal standard is1.3 pg/L. The NTR was developed in 1993 and is not an appropriate standard for 2016. We should be issuing standards that will mark progress and exert pressure to clean up our waterways and protect the public. Additionally the standards for mercury and arsenic, two very toxic chemicals, continue to stay the same. Arguably, arsenic standard would actually become weaker. Arsenic is a chemical of great concern as our river receives metal tainted waters from Coeur d'Alene Lake. Mercury too, is a powerful toxin that biomagnifies in our waters and poses a risk to anglers and their families. The proposed rule makes no progress in updating the standards, in spite of the EPA's adoption of new, more protective criteria.

- **Increased timeframes for Compliance Schedules. "**Compliance schedules" are the amount of time a discharger has to meet state water quality standards. The proposed WDOE rule opens Compliance Schedules to be far too open ended. It says dischargers must meet water quality standards "as soon as possible". This vague language allows the discharger control of the time-frame in which they will comply. Spokane Riverkeeper maintains that it's far too idealistic to assume that dischargers will do everything in their power to stop polluting. The rule should have concrete time-limits, inside of the 5 year permit schedule, that dischargers need to meet in order to ensure accountability.
- **Increased availability of Variances.** Variances are temporary waivers of water quality standards. They are given if it is believed that a discharger will take an exceedingly long time to or may never be capable of meeting water quality standards, and because of this a variance excuses them from meeting the standards. Because PCBs and other challenging chemicals have proved difficult to fully remove from Washington's waters, WDOE is considering allowing waterbody variances in regards to these challenging chemicals. This kind of variance would excuse waterbodies that have pollution problems from becoming cleaner because it doesn't seem doable in the short term. This is contrary to the direction we need to move. We should be pushing dischargers to lower their output of dangerous chemicals precisely because of the nature and amount of pollution in a waterbody. Giving NPDES holders an off-ramp from the standards moves in the wrong direction.
- **Implementation of Intake Credits.** The rule proposes Intake Credits that excuse a discharger from being responsible for removing pollutants entering their facilities. This is problematic as dischargers need to ensure that there is no net increase in the amount of pollutants leaving their facility. Intake Credits will have the effect of encouraging dischargers to do the bare minimum with regards to cleaning up pollutants like PCBs. If intake credits were to be given, there should be some sort of incentive to having a net

decrease in pollutants to encourage dischargers to work towards cleaning up Washington's waters.

Thank you for the opportunity to comment.

Respectfully,



Jerry White Jr.
Spokane Riverkeeper

35 W Main St Suite 300
Spokane WA 99201
(509) 464-7614
jerry@cforjustice.org

Commenter ID: 73

Commenter Name: Margaret Wiggins

Commenter Association: Citizen

Comment received via online comment form

Comment:

Re: Proposed water quality standards for protecting human health, Chapter 173-201A WAC

Dear Ms. Conklin:

Thank you for working on this important issue. I am a recently reelected water and sewer commissioner with 18 years of experience. There isn't much time before you have to make a decision so I am writing as a citizen and not on behalf of my district or its board.

The water quality standards for protecting human health, Chapter 173-201A WAC recommended changes need to be linked to actual studies of injury to humans that indicate a need for remediation. Has this provision in the WAC changed? Are we to create a new rule that benefits meter companies that have made test equipment that is more sensitive than the human body? Wouldn't it be better if they dedicated their R&D efforts to make smaller, cheaper equipment so more agencies can afford it and water gets tested more often in places that have ignored water quality conditions for lack of affordable equipment?

The dedicated pollution control people of the MWPAAC committee have been informed of your efforts to change the rule to support certain special interest groups. My concern is not that there is a source of pollution that needs to be regulated, but to put the cost of unnecessary regulation onto the ratepayers connected to the cleanest treatment in the state, the country even, will put the cost out of reach for some people still connected to septic systems. Failing septic systems in the suburbs are a definite hazard to humans.

My district, Northshore Utility District, contracts with the King County Wastewater Treatment Division for sewage treatment along with the other 1.6 million residents in the Puget Sound region. I am a regularly attending member of the Metropolitan Water Pollution Abatement Advisory Committee (MWPAAC) monthly meetings that provides recommendations to the King County Executive and King County Council regarding water pollution abatement. MWPAAC's membership includes 33 other local sewer agencies.

Generally, the State has been helpful in supplying high water quality to the citizens, we don't have the issues here of Flint, Michigan. But trying to put all water treatment into the same category isn't reasonable, and way too costly. Because King County's regional service area includes some parts with combined sewer systems, I am particularly interested in the language of the proposed rule as it relates to combined sewer overflow (CSO) treatment plants.

The State is proposing to use narrative water quality standards and require a set of best practices specifically for these intermittent CSO treatment plants. These plants are critical investments that move us towards improved water quality. We support the State approach as it will ensure the intermittent need for treating and reducing the total number of these discharges will be protective of human health. The County's long-term CSO control plan will be successful considering the very high cost of the occasional need for treatment.

Please, making rules without actual need for them makes it that much harder for my district to connect those still on septic systems. We have almost 900 customers with sewer available who won't pay to connect.

Sincerely,

Honorable Margaret Wiggins

QUILEUTE TRIBAL COUNCIL

POST OFFICE BOX 279
LA PUSH, WASHINGTON 98350-0279
TELEPHONE (360) 374-6163
FAX (360) 374-6311

QUILEUTE

April 21, 2016

Maia Bellon, Director
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments on the State's 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Dear Director Bellon,

The Quileute Tribe has been working with the state of Washington and the US Environmental Protection Agency for many years to develop and adopt revised water quality standards that will protect the health of tribal people and respect our treaty-reserved rights to the harvest of fish and shellfish. The Department of Ecology has now proposed a second draft rule for human health criteria and implementation tools, and we offer the following comments on the state's proposed rule, issued in February, 2016. First, the proposed state rule once again falls short of the stated goal of protecting people who consume fish and shellfish. Additionally, the Quileute Tribe hereby, supports, adopts, and incorporates by reference the complete Northwest Indian Fisheries Commission comments submitted to Ecology in April, 2016. Finally, the Quileute Tribe would like to express our support for the more protective draft rule for human health criteria applicable to Washington State, issued by the U.S. Environmental Protection Agency on September 14, 2015.

Tribes entered this discussion many years ago with their concerns that the existing fish consumption rate of 6.5 grams per day grossly under-represents tribal fish consumption. The harvest and consumption of fish and shellfish remains at the heart of tribal communities, and is a cultural, nutritional, and economic necessity as well as a treaty right. The proposed FCR of 175 g/day is low compared to fish consumption rates at many tribes. Additionally, in reviewing the impact on public health from toxic chemicals in the food chain, we have learned that many other provisions of the rule proposed by the Department of Ecology may greatly diminish the protective benefit of a higher fish consumption rate.

Ecology proposes other human health criteria that do not incorporate best available science and fail to account for other sources of toxic chemicals, and we recommend adoption of the criteria proposed by the EPA. Additionally, the state's proposal will allow the criteria for several highly toxic chemicals including PCBs, arsenic, and dioxin to remain at status quo or to get substantially worse. The state's proposed implementation tools should be adjusted so that they are directed towards accountability and attainment of water quality standards, and not a set of tools to help dischargers with their compliance concerns.

Washington State is required to meet the provisions of the Clean Water Act to preserve the beneficial uses of water, including fishable rivers. Implicit in that is safe fish consumption. The public health issues that are determined by these standards affect everyone in Washington who eats fish. On top of this concern, the state must not impair the tribe's treaty-reserved rights to take *and consume* fish at all their usual and accustomed fishing grounds and stations. The proposed rules by the state of Washington do not meet these requirements.

Sincerely,

Charles Woodruff

Charles Woodruff, Chairman
Quileute Tribal Council

cc: Lorraine Loomis, Chair; Northwest Indian Fisheries Commission
Dennis McLerran, EPA Region 10 Administrator
Dan Opalski, EPA Region 10 Director for the Office of Water and Watersheds

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DEPARTMENT OF ECOLOGY
OFFICE OF DIRECTOR

Stillaguamish Tribe of Indians

Natural Resources Department

April 18, 2016

Maia Bellon, Director
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600

ATTN: Water Quality Program
swqs@ecy.wa.gov
Becca Conklin

RE: Comments to the State's 2016 Draft Rule for Human Health Criteria and Implementation Tools in Washington State Water Quality Standards

Director Bellon,

In 2015 Washington State proposed water quality standards to address the Human Health Criteria which the Stillaguamish Tribe opposed for many reasons. The State withdrew that proposal, and later that year the US EPA proposed a rule, due to Washington State's delay and because the state's rule was not protective of designated uses. The Stillaguamish Tribe supported EPA's rule in preference to the State's, even though some of the language was still considered a compromise from the Tribe's perspective. The State again proposes amendments to water quality standards that are still not protective of high fish consumers, namely members of the Stillaguamish Tribe. In 2010 the Stillaguamish Tribe learned that Washington State was going to develop water quality standards to address the human health criteria as part of the triennial review process. Six years later, we are still commenting on proposed rules while Tribal members and the public continue to put their health at risk while consuming fish and shellfish in the State of Washington.

The state's proposed fish consumption rate of 175 grams per day is viewed as a compromise to the Stillaguamish Tribe, especially when compared to heritage rates and consumption without suppression due to decreased fisheries resources or closures from pollution. The Stillaguamish Tribe only supports a fish consumption rate of 175 gpd as long as other provisions in the Human Health Criteria are based on best available science and are not less protective of our members. This proposal by the State of Washington does not incorporate best available science and fails to account for other sources of toxic chemicals. As a result a fish consumption rate of 175 gpd ceases to be protective of Tribal members when other aspects of the Human Health Criteria are unchanged or weakened.

Although this proposal by the state maintains the 10^{-6} cancer risk rate that the Stillaguamish Tribe advocated for during the State's first draft rule proposal, there are other areas where cancer risk seemingly increases. The State's proposal will allow criteria for several highly toxic chemicals including PCBs, arsenic and dioxin to remain at status quo or get substantially worse. Methylmercury, a new standard implemented by EPA, is deferred indefinitely. The State's proposal has updated some of the human health criteria to new national standards, particularly those that favor dischargers like body weight and toxicity factors, but this proposal has kept other factors at older values (such as relative source contribution and bio-concentration factors) that fail to protect consumers.

The state also proposes implementation tools that allow more leniency for dischargers to comply with water quality standards for longer periods of time. These tools, such as variances and compliance schedules, allow dischargers to violate water quality standards for long unspecified time periods which put Tribal members at greater risk. Implementation tools should be geared to direct dischargers towards accountability an attainment of water quality standards, not to delay or avoid compliance.

Washington State has the opportunity to develop water quality standards that are not only protective of the health of its current citizens, but also to those citizens for generations to come from exposure to toxic chemicals in water and fish. The first proposed draft rule did not do this, nor does this second attempt. The draft rule continues to put disproportional risk on Tribal members and other fish consumers. The proposed rules are geared to help dischargers avoid compliance instead of holding them accountable. The Stillaguamish Tribe would like to express our support for the more protective draft rule for human health criteria applicable to Washington State issued by the U.S. Environmental Protection Agency on September 14, 2015, and the Tribe would like to see the EPA finalize that rule immediately, as required by the Clean Water Act.

Washington State is also required to meet the provisions of the Clean Water Act and to preserve the beneficial uses of water, including fishing. The Stillaguamish Tribe has a treaty reserved right to take fish at our usual and accustomed fishing grounds, and the State has a duty to ensure that these fish are safe to eat so that the Tribe can exercise this right. Furthermore, the Tribe has reserved hunting and gathering rights, and uptake of toxins in wildlife and plants also has a serious negative impact on these reserved treaty rights. At an even deeper level, these treaty rights reflect spiritual and cultural lifeways of the Stillaguamish people that have existed from time immemorial. To be able to fish, hunt, gather and use these animals and plants in their diet, ceremonies, art and so many other ways are crucial to the Stillaguamish people, and we need clean water for all of this.

The State should reconsider the provisions in the draft rule and restore critical elements that will protect fish consumers and all tribal members in Washington. The Stillaguamish Tribe also supports the comments on this draft rule that are being submitted by the Northwest Indian Fisheries Commission in April 2016.

PO Box 277
Arlington, WA 98223
22712 6th Ave NE

Sincerely,

Shawn Yanity
Tribal Chair
Stillaguamish Tribe of Indians

Cc: Lorraine Loomis, Chair, Northwest Indian Fisheries Commission
Ann Seiter, Fish Consumption Rate Project Coordinator, NWIFC
Tara Boser, Cultural Resources Director, Stillaguamish Tribe
Dennis McLerran, EPA Region 10 Administrator
Dan Opalski, EPA Region 10 Director of Water and Watersheds