RIDOLFI Environmental

M E M O R A N D U M

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TO: Kerry Graber, Washington Department of Ecology
Hazardous Waste and Toxics Reduction Program

FROM: Bill Beckley, Sherrie Duncan, and Bob Dexter – RIDOLFI Inc.

SUBJECT: **Review and Evaluation of Risk Assessment Documents for the Occidental Chemical Corporation Corrective Action Site**

1.0 Purpose and Scope of Review

The objective of this technical memorandum is to present a summary and evaluation of specific documents related to human health and ecological risk posed by the Occidental Chemical Corporation (OCC) Corrective Action site. To support the Department of Ecology (Ecology) Hazardous Waste and Toxics Reduction Program in overseeing ongoing investigation and remediation efforts at the Occidental Site, the Ridolfi project team reviewed risk assessments performed by the Environmental Protection Agency (EPA) for the Commencement Bay Nearshore Tideflats (CB/NT) Superfund Site, and a Streamlined Risk Assessment and Exposure Pathway Assessment Report prepared by OCC. This memorandum provides Ridolfi's professional opinions regarding the evaluation of risk that has been completed by OCC so far, and makes recommendations for further study and assessment.

2.0 Background Review

2.1 EPA Risk Assessment Summary

The primary background documents reviewed relative to previous risk assessment work performed by EPA for the Hylebos problem area included: *Commencement Bay Nearshore/Tideflats Record of Decision* (September 1989); *Explanation of Significant Difference for the Record of Decision: Commencement Bay, Near Shore/Tide Flats, Operable Unit 01 - Sediments and Operable Unit 05 - Source* (July 28, 1997); and *Third Five-Year Review Report for Commencement Bay Nearshore/Tideflats Superfund Site Tacoma, Washington* (December 23,

2009). A brief description and evaluation of the relevant portions of these documents is provided in the following sections.

2.1.1 Commencement Bay Nearshore/Tideflats Record of Decision (1989)

Human health and environmental risk assessments were conducted as part of the Remedial Investigation (RI) for the CB/NT Superfund site. The risk assessments were based on exposure of marine biota to contaminated sediment and exposure of humans to contaminated seafood. Health risks were estimated for consumers of CB/NT fish and shellfish for both carcinogens and non-carcinogens.

Sediment Quality Objectives (SQOs) for all "problem chemicals" were set based on an evaluation of the ecological and human health risks posed by those chemicals. The SQO for polychlorinated biphenyls (PCBs) was based on the human health risk assessment. The SQOs for all other chemicals were based on the ecological risk assessment, as it was determined that the ecologically-based cleanup levels were also protective of human health.

2.1.1.1 Human Health Risk Assessment

For the human health risk assessment, the average concentration of each chemical in English sole from the study area was used to calculate exposure, based on two seafood consumption rates (1 pound/day and 1 pound/month) and a 70-year exposure duration. Based on these exposure assumptions, six chemicals were predicted to result in a cancer risk greater than 10^{-6} at the maximum fish consumption rate of 1 pound/day (453 grams/day). Those chemicals included PCBs, arsenic, hexachlorobenzene, hexachlorobutadiene, bis(2-ethylhexyl)phthalate, and tetrachloroethene. Only PCBs and arsenic had predicted risk levels greater than 1×10^{-4} (although hexachlorobenzene risks were predicted to be *equal to* 1×10^{-4}). At a fish consumption rate of 1 pound/month (12.3 grams/day), only PCBs and arsenic would exceed the 10^{-6} risk level. A lifetime excess cancer risk of 2×10^{-4}, or 2 in 10,000, was estimated for a person eating one pound of Commencement Bay fish per month.

Arsenic was not subjected to further evaluation relative to human health because of its lower cancer risk level (compared to PCBs) and because arsenic concentrations in CB/NT fish were similar to concentrations in fish from the reference area.

For non-carcinogens, three metals (antimony, lead, and mercury) were present in fish muscle tissue in concentrations that would exceed the Acceptable Daily Intake (ADI) values at the consumption rate of 1 pound/day. However, the ADI values would also be exceeded for fish

from Carr Inlet (a reference area) at the 1 pound/day consumption rate. Limiting consumption of fish to 0.5 pounds/day would result in exposure below the ADI values for all three metals.

Bioaccumulation data indicated that sediment contamination by metals in Commencement Bay was not resulting in significantly increased tissue levels for metals. Therefore, risks of non-carcinogens in fish tissue were not evaluated further in estimating sediment cleanup levels. Additionally, based on the information available on the toxicity of PCBs at that time, it was concluded that the potential for non-cancer impacts was not of concern.

The baseline risk assessment concluded that the most significant human health risks were associated with elevated concentrations of PCBs in the tissues of resident seafood, and the SQO for total PCBs was set at 150 micrograms per kilogram (µg/kg).

2.1.1.2 Ecological Risk Assessment

The chemical SQOs for protection of aquatic life were set using the Apparent Effects Threshold (AET) method. The AET method does not address bioaccumulation, and thus may underestimate risks to organisms who eat invertebrates or fish contaminated with bioaccumulative compounds like PCBs. It was determined that the SQO for PCBs should be set based on the risks to human health from eating PCB-contaminated seafood, because a lower PCB cleanup level was necessary to protect human health.

The ecological risk assessment identified adverse biological effects, primarily toxic effects to the benthic infaunal community.

2.1.1.3 Discussion/Evaluation

The risk assessments performed in support of the Remedial Investigation/Feasibility Study (RI/FS) and Record of Decision (ROD) for the CB/NT site were conducted prior to the promulgation of State cleanup standards (either under the Model Toxics Control Act [MTCA] or the Sediment Management Standards [SMS]), and were generally similar to other Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) risk assessments of that era. However, the assessments would not necessarily be consistent with regulations and guidance that were promulgated, revised, or finalized shortly after the ROD was signed. The "acceptable range of risk" used to develop cleanup standards (10^{-7} to 10^{-4}) is less protective than the risk range that would be allowable under the MTCA regulations. The MTCA regulations [Washington Administrative Code (WAC 173-340)] require that cleanup levels do not

result in cancer risks exceeding 1 x 10^{-6} for individual carcinogens and 1 x 10^{-5} for multiple carcinogens, and that effects from non-carcinogens do not exceed a hazard quotient (HQ) of 1.

Additionally, Risk Assessment Guidance for Superfund (RAGS), finalized shortly after the ROD, recommends the use of an upper confidence limit on the mean concentration for characterizing exposures, rather than a simple arithmetic mean, which is the value that was used in the human health risk assessment to represent contaminant concentrations in English sole tissue. The ROD acknowledges that "for English sole, there was considerable variability in PCB concentrations among the waterways and within the waterways." Maximum PCB concentrations in English sole from the Hylebos Waterway were six times higher than the average concentration used for the risk assessment. Use of an upper confidence limit on the mean would have likely resulted in higher risk estimates and may have resulted in a greater number of chemicals exceeding risk thresholds.

Finally, while the ROD acknowledged that the AET method may underestimate risks to higher trophic level species from bioaccumulative compounds, it is not clear that SQOs for other bioaccumulative compounds, including hexachlorobenzene, were set at levels protective of higher trophic level species (PCBs and hexachlorobenzene were selected as chemical indicators at the mouth of Hylebos waterway).

2.1.2 Explanation of Significant Difference for the Record of Decision (1997)

In 1997, EPA published an Explanation of Significant Difference (ESD) for the 1989 ROD. The purpose of the ESD was to modify the cleanup level for remediation of marine sediments contaminated with PCBs at the CB/NT Superfund site.

2.1.2.1 Human Health Assessment

EPA updated the human health risk evaluation as a basis to evaluate the risks associated with a variety of potential PCB cleanup levels. Although EPA's risk assessment methodology had not been modified substantially since the original risk assessment was performed in 1988, some of the exposure and toxicity assumptions had been changed based on new information and new Superfund guidance.

Because the Puyallup Tribe of Indians has treaty rights to fish in Commencement Bay, "high-end Tribal fishing" was used as the reasonable maximum exposure scenario for EPA's decision-making purposes. An average and high-end recreational fishing scenario and an average Tribal fishing scenario were also calculated for purposes of comparison. Fish consumption rates for the

recreational fishing scenario were the same as those used in the 1989 ROD. Because no studies had documented Tribal fish consumption rates in Commencement Bay, rates were estimated from recently completed surveys (1996) of fish consumption by members of two other Puget Sound tribes, the Tulalip Tribes and the Squaxin Island Tribe.

The high-end Tribal scenario was intended to represent risks to "a tribal fisherperson who consumes a relatively large amount (upper 90th percentile) of fish compared to other tribal members."

The estimated post-cleanup cancer risks at a PCB SQO of 300 µg/kg were determined to be within EPA's acceptable risk range of 10^{-4} to 10^{-6}. Cleanup to a PCB sediment remedial action level (SRAL) of 450 µg/kg was determined to result in interim risks that were also within EPA's acceptable risk range. Although the estimated risk was 1.4×10^{-4} for the CB/NT Site and 1.6×10^{-4} for the Hylebos Waterway, EPA indicated that its policy states that the upper boundary of the risk range is "not a discrete line at 1×10^{-4}". Cleanups to levels "slightly greater than" 1×10^{-4} may be considered acceptable if justified based on site-specific conditions. EPA assumed that people were more likely to fish in more than one location in Commencement Bay than in Hylebos Waterway alone, so the CB/NT Site-wide risk estimate was determined to be the best estimate of risks to area fisherpersons.

The National Oil and Hazardous Substances Contingency Plan (NCP) does not set a numeric target range for non-cancer risks, but states that acceptable exposure levels shall represent "concentrations to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety." Cleanup to 300 µg/kg PCBs was determined to result in a CB/NT Site-wide Hazard Quotient (HQ) of 7. EPA reasoned that "the HQ of 7 is not appreciably different than the HQ of 6 estimated for cleanup to 150 µg/kg PCBs under the 1989 ROD."

2.1.2.2 Discussion/Evaluation

During pre-design sampling, new data were collected from the Hylebos Waterway that indicated approximately twice the amount of sediment originally estimated in the ROD would require cleanup, and that cleanup costs would also be about twice the estimate in the ROD. This appears to be a primary driver for increasing the PCB SQO. However, in 1996 the cancer slope factor for PCBs was decreased from 7. 7 to 2.0 milligrams/kilograms-day^{-1}, and the risk evaluation updated for the ESD includes the new cancer slope factor, as well as a new exposure duration, and a new range of fish consumption rates.

Although not prominently explained in the text of the ESD, the tribal "high-end" and average consumption rates (listed as 123 grams/day and 41.7 grams/day, respectively) were modified to reflect that only a portion of that rate (69 percent) would be associated with the site, effectively making the rates 85 grams/day and 29 grams/day. Further, rather than assuming a 70-year (lifetime) exposure duration, as was assumed in the ROD, the ESD assumes a shorter, 30-year exposure duration. Consumption rates of 85 grams/day and 29 grams/day over a 30-year exposure duration are equivalent to 36 grams/day and 12.4 grams/day over a 70-year exposure duration. While intended to represent Tribal fisher exposure scenarios, these rates may underestimate a Tribal exposure scenario.

Since the ESD only updated the human health risk assessment for PCBs, it did not account for risks from other carcinogens that may result from leaving higher levels of contamination in place. The allowable risk range cited by EPA (10^{-4} to 10^{-6}) is intended to address *cumulative site risk* from multiple carcinogens.

In addition to these updates, the ESD also acknowledges that "[s]ince publication of the ROD, the State of Washington has promulgated Sediment Management Standards (SMS), which require that contaminant levels in sediments within the State be protective of human health and aquatic life." There is not a further acknowledgement that the cleanup standards in the MTCA regulations, including maximum allowable risk levels, had also been revised and updated since publication of the ROD.

In a letter of qualified concurrence with the ESD, the Department of Ecology states that "[a]s the proposal currently stands, the termination of cleanup after dredging to 450 parts per billion (ppb) will not achieve a level of protection for humans or wildlife that will meet Ecology's requirements. Ecology's goals for acceptable human health risk for carcinogens are 1×10^{-6} to 1×10^{-5} and for noncarcinogens, hazard indices for human or ecological health are not to exceed a value of one." Since the requirements of MTCA are considered applicable requirements for CERCLA cleanup actions, the proposed changes in the ESD do not appear to comply with Applicable or Relevant and Appropriate Requirements (ARARs) that existed in 1997, which is one of the "threshold criteria" for CERCLA cleanups.

Despite the fact that the proposed change would not meet Ecology's requirements, Ecology did concur with the proposed increase in the PCB SQO, noting that the agency would "endorse the implementation of a 10 year natural recovery period as an element of the cleanup to achieve further reduction of PCBs." Ecology's concurrence was subject to the following conditions:

- Active Remediation to 450 ppb PCBs throughout Commencement Bay
- Recovery within ten (10) years to a maximum level of 300 ppb
- Monitoring to confirm recovery will be achieved
- Additional remedial action triggered if recovery will not meet cleanup levels
- Cleanup action to commence no later than year 2001

The Puyallup Tribe of Indians did not concur with the selected PCB cleanup level.

2.1.3 Third Five-Year Review Report (2009)

The purpose of a Five-Year Review (FYR) is to determine whether the remedy at a site is protective of human health and the environment.

2.1.3.1 Human Health Risk Assessment

Since the 1989 ROD, new information had become available on Tribal seafood consumption rates and exposure durations for Tribal populations. In the Third FYR EPA considered this new information for the Sediments Operable Unit (OU).

In August 2007, EPA Region 10 issued a "*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*". The Framework was designed to assist EPA Region 10 with managing hazardous waste cleanup sites with Tribal seafood consumption exposures and concerns.

In areas of the Sediments OU where PCBs remain in sediments (including the Hylebos Waterway), PCBs are a human health contaminant of concern. Therefore, for its Third FYR, EPA identified the consumption rates and exposure duration in the Framework (97.6 grams/day over 70 years) as new information that could impact the estimated risk associated with residual PCBs that could call into question the long-term protectiveness of the remedy.

The "high end" Tribal fishing scenario used in the 1997 ESD, which modified the PCB goals for the CB/NT Sediments OU, used a rate of 123 grams/day over 30 years and estimated the post-cleanup residual excess cancer risk associated with that level at 1.2×10^{-4}. In the ESD, EPA stated that "The analysis focused on cancer risks as the most conservative estimate of risks to human health. The risk assessment estimated cancer risks only, because a PCB cleanup level based on cancer risks was shown to be protective of non-cancer risks as well." EPA indicated in the FYR that the Agency was "still evaluating whether the revised exposure assumptions could make a significant difference to non-cancer risk. "

Application of the Framework exposure assumptions discussed above resulted in a revised post-cleanup estimated residual excess individual lifetime cancer risk of 2.2×10^{-4}.

Based on this evaluation, EPA did not believe that this difference was significant enough to call into question the protectiveness of the remedy nor to require any additional action at this time. EPA believed that the PCB SQO (300 µg/kg) remained protective.

The Third FYR notes that since the ROD, the Dredged Material Management Program (DMMP) had listed both Chlordane and dioxins/furans as bioaccumulative chemicals in the Hylebos Waterway. Neither chemical was evaluated for human health risks in the RI/FS.

2.1.3.2 Discussion/Evaluation

Since there was no indication in the Third FYR that additional fish tissue sampling had been conducted, it is assumed that the updated risk assessment was based on the same tissue concentrations as the previous risk assessments.

It appears that the revised risk estimate (2.2×10^{-4}) was calculated by simply determining the difference between the previous exposure assumptions (123 grams/day over 30 years) and the revised Framework assumptions (97.6 grams/day over 70 years). A consumption rate of 123 grams/day over 30 years is equivalent to an exposure of 52.7 grams/day over 70 years. The relationship between these two rates (97.6 and 52.7 grams/day) is identical to the relationship between the calculated risk levels (1.2×10^{-4} and 2.2×10^{-4}).

However, as noted previously, the 1997 ESD used a modified Tribal consumption rate based on the assumption that only 69 percent of the consumption was attributable to the Site, so the effective rate, over a 70-year exposure, would be 36.3 grams/day (52.7 x 69 percent). Based on the actual difference in exposure assumptions, the revised post-cleanup risk level would be 3.2×10^{-4}, and as noted previously, this is only for a single carcinogen, and does not account for cumulative risk. It is not clear whether this difference is "significant enough to call into question the protectiveness of the remedy." The potential risks from other carcinogens were not evaluated based on the revised exposure assumptions.

Based on updated exposure assumptions regarding fish consumption, and the level of protection required by State regulations, it is possible that other contaminants, that may not be co-located with higher concentrations of PCBs, may still be present at unacceptably high

concentrations. As noted in the Third FYR, certain bioaccumulative chemicals, including dioxins, were not evaluated for human health risks in the RI/FS, and may be present at levels that present unacceptable risks to human health.

2.1.4 Other Relevant Background

In addition to the documents discussed in the preceding sections, other relevant background documents were reviewed and are briefly summarized below.

Explanation of Significant Difference for the Record of Decision (2000)
EPA published another ESD for the CB/NT Site in 2000. Among other changes, this ESD required the inclusion of the Endangered Species Act (ESA) as an ARAR for remedial actions conducted under the ROD.

Measurement of VOCs in Finfish and Shellfish Harvested from Commencement Bay, Washington (2009)
EPA worked with Ecology to measure volatile chemicals in resident fish and shellfish to assist in evaluating human health exposures related to the Occidental site. The Washington Department of Fish and Wildlife provided EPA with 23 specimens of resident finfish and crab harvested from "an area affected by releases of chlorinated VOCs from Occidental."

VOCs analyzed for the Occidental site were perchloroethylene (PCE), trichloroethylene (TCE), vinyl chloride, and hexachlorobutadiene. At least one VOC was detected in all samples. Vinyl chloride was not detected in any samples, but EPA noted that it "probably was not present as a contaminant in the immediate area where the tissue samples were obtained". The highest VOC concentrations were detected in crab hepatopancreas samples, the highest being 79.8 µg/kg PCE. PCE, TCE, and hexachlorobutadiene were detected in 90 percent, 83 percent, and 40 percent of all samples, respectively.

EPA indicated that the study, while limited, "demonstrates that the common assumption that VOCs will not be present in fish or shellfish tissue where VOCs have been released to surface waters is not necessarily true." Further, EPA noted that because anadromous species, particularly salmon, were not included in this study, this remains a data gap.

2.1.4.1 Discussion

The majority of risk assessment work related to the Occidental Site has been conducted as part of the larger CB/NT Site, and has focused primarily on PCBs in sediment. While the human health risk assessment done in support of the 1989 ROD ultimately focused on health risks from PCBs, it did identify PCE as one of three carcinogens present in fish tissue above background concentrations (in addition to PCBs and BEHP). At a fish consumption rate of one pound/day, the cancer risk from PCE was estimated to be 1×10^{-5}. EPA noted that "as the predicted risk values for tetrachloroethene and BEHP are so much lower than those for PCBs, they would not significantly add to the CB/NT Site risk due to PCBs", and no additional risk evaluation of PCE or other VOCs was conducted.

The primary VOCs present at the Occidental Site (PCE, TCE, and vinyl chloride) have a low tendency to bioaccumulate in the food chain, but can bioconcentrate in fish and shellfish tissue by exposure through the water column. VOCs have been measured in shallow groundwater potentially discharging to the Hylebos Waterway at concentrations several orders of magnitude higher than applicable water quality criteria for the protection of human health based on the consumption of fish and shellfish. They have also been detected in fish and shellfish tissue in the "area affected by releases of chlorinated VOCs from Occidental." While the most common route of exposure to VOCs is inhalation, ingestion of VOCs in contaminated foods may lead to both cancer and non-cancer health effects.

Based on a number of factors, including current MTCA and SMS requirements, known concentrations of VOCs in shallow groundwater, and the limited number and age of tissue samples, additional fish and shellfish tissue sampling would support a more robust evaluation of potential human health exposures.

3.0 Summary of Review Comments

Based on a review of both the *Streamlined Risk Assessment* (April 2011) and Appendix V (Exposure Pathway Assessment Report) of the *Draft Site Characterization Report Groundwater and Sediment Remediation* (August 2014), we recognized that the documents are sufficiently similar that we have focused our comments on the more recent Exposure Pathway Assessment Report. The Exposure Pathway Assessment Report includes a Site Characterization, which provides a discussion of the Conceptual Site Model (CSM); a Human Health Exposure Pathway Assessment (HHEPA); and an Ecological Health Exposure Pathway Assessment (EHEPA). General

comments regarding the Exposure Pathway Assessment Report are provided in the following section, followed by specific comments in the next section.

3.1 General Comments

1. The Exposure Pathway Assessment Report does not provide adequate characterization of natural resources, including habitats and species and their life histories, present at the Site and in the surrounding area. The Exposure Pathway Assessment Report also does not adequately describe the human activities that occur in the area. This incomplete information results in major gaps in the risk assessments and the CSMs, which in turn results in an inadequate selection and assessment of exposure pathways, receptors, and endpoints.

2. Because contamination remains in the sediments and embankment area of Hylebos Waterway, including contamination resulting from bioaccumulative chemicals, and has or will potentially reach Commencement Bay, the assessment should be revised to adequately evaluate the potential risks to human health and the environment.

3. While the Site and the surrounding areas are not pristine, they are certainly not devoid of life. Commencement Bay and the Hylebos Waterway provide important rearing, foraging, migratory, and adult habitat for numerous aquatic and terrestrial species. These estuarine waters are an important transitional area for juvenile salmonid species, bottom fish, forage fish, crab, bivalves and many other resident marine species. All of these species are found in these waters during every month of the year. The riparian buffers, salt marshes, and mudflats in the area provide important habitats for these aquatic species including plants, birds, and mammals. Commencement Bay and the Hylebos Waterway also provide recreational access and opportunities to the communities residing in and outside of the area.

4. The 2000 ESD added the ESA as an ARAR to the CB/NT ROD, which includes the Hylebos Waterway and Commencement Bay. The Hylebos Waterway and Commencement Bay provide habitat for federally-listed species, and critical habitat for several of these species has been designated in both waterbodies. Additionally, the area is home to several non-listed species, including forage fish, flatfish, crab, bivalves, and other inshore resident marine fish and benthic species which provide important prey resources to the federally listed fish, bird, and mammal species. Federally listed species for the area include Chinook salmon, steelhead trout, bull trout, three rockfish species, two whale species (including Southern resident killer whale), marbled murrelet, and streaked horned lark.

Several other bird and mammal species including but not limited to purple martin, great blue heron, kingfisher, osprey, bald eagle, peregrine falcon, raccoon, river otter, seal, and sea lion are also found in the area.

5. The Exposure Pathway Assessment Report does not provide adequate information regarding the existing and proposed mitigation and habitat restoration that has, is, and will continue to occur in the Hylebos Waterway in the vicinity of the Site and in Commencement Bay. Aside from the habitat restoration related to the Commencement Bay Natural Resource Damage Assessment settlement and mitigation related to Port of Tacoma development, millions of dollars have been and continue to be spent on salmon recovery efforts in the Puyallup River Watershed, which includes habitat restoration in the nearshore areas of Commencement Bay and its tributaries. As shown in Figure 3-1 of the Fourth FYR for CB/NT, several of the mitigation and restoration sites are in Commencement Bay and the Hylebos Waterway in the vicinity of the Site. These areas are backed by undeveloped wooded bluffs and green belts that provide terrestrial habitat for several bird species. These sites provide terrestrial, riparian, and aquatic habitat to the species discussed above, several of which have been observed in the Hylebos Waterway, and at the habitat restoration and mitigation areas and wooded bluffs and green belts across from the Site.

6. The Exposure Pathway Assessment Report does not provide adequate information about the human uses of Commencement Bay and the Hylebos Waterway. Human uses in the area include recreational and tribal fishing, crabbing, marina use, boating, sailing, diving, kayaking, paddle boarding, beach play, and bird and wildlife viewing. Commencement Bay supports both hatchery and listed- and non-listed salmon species including Chinook, coho, chum, and pink salmon for which run sizes have increased in recent years. These salmon species support a robust recreational fishery and provide food and sustenance to sport and tribal fishers in the area. The area is also within a tribal Usual and Accustomed fishing area.

7. The Exposure Pathway Assessment Report does not consider that it is unknown what development and future use will occur on the Puyallup Tribe's properties across the Hylebos Waterway from the Site. It should be assumed that humans will continue to access the beaches and riparian areas along the Hylebos Waterway.

8. As stated in the Exposure Pathway Assessment Report, the area is in an active shipping and industrial area. Because of this, more information should be provided regarding the potential for contaminated sediments below the biologically active zone [BAZ (0 to10

centimeters)] to be brought to the surface as a result of dredging activities and scouring related to shipping.

9. In addition to providing more robust information on ESA-listed species, designated critical habitats and human uses, the Exposure Pathway Assessment Report should include additional descriptive information for the area and reference the following:
    - Washington State designated uses and criteria for the Hylebos Waterway and Commencement Bay (WAC-173-201A-210; WAC-173-201A-612), which among other parameters includes criteria for pH and temperature.
    - Washington Department of Fish and Wildlife Priority Habitats and Species.
    - Mitigation and restoration sites in the Hylebos Waterway and Commencement Bay.

10. The guidance listed for performing the Exposure Pathway Assessment should also include the revised SMS, and the guidance for implementing the SMS included in the Sediment Cleanup User's Manual II (SCUM II).

    Because the revised SMS are an ARAR for the Site, the Exposure Pathway Assessment Report should be updated to include the current marine sediment chemical criteria to ensure that risks to human health and the environment are adequately assessed at the Site.

    The Exposure Pathway Assessment Report should be revised to include the appropriate methods and procedures from the SCUM II for assessing risks to human health and the environment, which are presented in Chapters 8 and 9 and Appendices E and K of the Manual. It should also be noted that the Manual suggests reviewing the Lower Duwamish Waterway and Portland Harbor risk assessments for additional guidance. The Lower Duwamish Waterway CSMs are included as examples in the SCUM II manual.

11. Per the SMS, sediment cleanup objectives and cleanup screening levels for contaminants based on protection of human health "shall be calculated using reasonable maximum exposure scenarios that reflect the highest exposure that is reasonably expected to occur under current and potential future site use conditions" (WAC 173-204-561). The default reasonable maximum exposure scenario "shall be tribal consumption of fish and shellfish." The sediment exposure pathway description should be updated to include this exposure scenario.

    Additionally, the SCUM II notes that "exposure scenarios for human health typically assume activities such as beach play and clam digging that may involve exposure to

sediment at least as deep as targeted shellfish species are found. Depending on the activities, depth of exposure may exceed the BAZ." Since site-related contaminants are known to exist at elevated levels in embankment and intertidal sediments, these activities should be considered as part of a recreational user exposure scenario, and the HHEPA should be modified to include this scenario.

12. Chapter 9 of the SCUM II provides detailed guidance on approaches for addressing risk-based sediment concentrations for bioaccumulative chemicals, and should be followed. This chapter notes that the preferred approach for setting cleanup standards where only sediment data are available (and not both sediment and tissue data) is to base cleanup levels on background concentrations or Practical Quantitation Limits (PQLs), whichever is higher. It further notes that this approach is appropriate "for sites where it is expected that risk-based sediment concentrations would be below background, which is the case for most bioaccumulative carcinogenic chemicals (e.g., dioxin/furan congeners, PCB congeners, and cPAHs)." Bioaccumulative contaminants are known to be present at elevated concentrations in the embankment, intertidal, and subtidal sediments, including PCBs, DDT, dioxins/furans, hexachlorobenzene, and hexachlorobutadiene.

13. The SMS also require that sediment cleanups are protective of "higher trophic level species", and that sediment cleanup objectives and cleanup screening levels based on protection of higher trophic level species shall be established at concentrations that have no adverse effects. The Exposure Pathway Assessment Report should consider "the potential for the contaminant to bioaccumulate or biomagnify through the food chain. According to the SMS, a contaminant will be presumed to have this potential if any of the following conditions are met:
    - The contaminant is listed as a persistent, bioaccumulative, or toxic (PBT) contaminant on the department's PBT list in WAC 173-333-310; or
    - The log of the contaminant's octonal-water partitioning coefficient is greater than 3.5 (log Kow > 3.5).

    Note that Site-related contaminants of concern (COCs) including PCBs, DDT, dioxins/furans, hexachlorobenzene, and hexachlorobutadiene are listed on the PBT list. In general, the high fish/shellfish consumption rates and the exposure factors for individual humans based on the tribal fisher scenario will also be protective of most of the higher trophic level species at the population level.

14. Because groundwater at the Site has been determined to be non-potable, and because contaminated groundwater discharges to surface water, groundwater cleanup levels are based on the protection of surface water. While this requirement is noted in the

Exposure Pathway Assessment Report, recently updated national water quality criteria have not been included. MTCA requires that surface water cleanup levels be at least as stringent as "water quality criteria based on the protection of aquatic organisms (acute and chronic criteria) and human health published under Section 304 of the Clean Water Act." The Section 304 human health criteria for a number of site-related contaminants have been updated, and the report should be updated to reflect this. Note that the criteria for most Site-related contaminants have become more stringent than those listed in the Exposure Pathway Assessment Report.

Additionally, the potential for Washington State water quality criteria to be updated prior to the final Cleanup Action Plan should be evaluated. On September 14, 2015, EPA published draft revised federal water quality criteria applicable to Washington in the Federal Register.

Because surface waters at the site are marine waters, and not suitable for drinking water, the applicable human health water criteria are those based on the consumption of organisms only.

15. Certain site-related chemicals, including PCE, TCE, and vinyl chloride, do not have applicable numeric water quality criteria for the protection of aquatic life. The EHEPA proposes addressing ecological effects from these chemicals in porewater through a narcosis-based screening approach. To address the potential site-specific toxicity of these chemicals, both individually and cumulatively, and to address other factors potentially affecting toxicity (e.g. elevated pH or temperature), toxicity testing of sediment porewater should be considered.

16. For various media, including soil, groundwater, and sediment, the Exposure Pathway Assessment Report should include a discussion of the likely point of compliance based on MTCA requirements. This will be important when considering and evaluating remedies in the FS.

    Soil Point of Compliance

    - For soil cleanup levels based on the protection of ground water, the point of compliance shall be established in the soils throughout the Site.
    - For soil cleanup levels based on protection from vapors, the point of compliance shall be established in the soils throughout the Site from the ground surface to the uppermost ground water saturated zone (e.g., from the ground surface to the uppermost water table).
    - For soil cleanup levels based on human exposure via direct contact or other exposure pathways where contact with the soil is required to complete the

pathway, the point of compliance shall be established in the soils throughout the Site from the ground surface to fifteen (15) feet below the ground surface. This represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of Site development activities.

The Exposure Pathway Assessment Report discusses only the upper 10 feet of soil, and it is not clear how deeper soils will be assessed. Table 3.10 indicates that the depth to groundwater at the Site is 12 feet below ground surface (bgs).

MTCA recognizes the remedies that rely on containment may not meet cleanup levels at these points of compliance. If the selected remedy involves containment of hazardous substances and the cleanup levels will not be met at the standard points of compliance, the cleanup must meet all the requirements included at WAC 173-340-740(6)(f).

Groundwater Point of Compliance

The Exposure Pathway Assessment Report, while not specifically discussing a groundwater point of compliance, leads the reader to understand that compliance with groundwater cleanup levels based on the protection of surface water will be determined based on porewater concentrations. The standard point of compliance for groundwater is "throughout the site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the site." Under specific conditions, Ecology can allow an off-property conditional point of compliance in surface water "as close as technically possible to the point or points where ground water flows into the surface water" (WAC 173-340-720(8)(d)). However, there are several conditions that must be met before Ecology can allow such a point of compliance, including the following:

- It has been demonstrated that the contaminated groundwater is entering the surface water and will continue to enter the surface water even after implementation of the selected cleanup action;
- It has been demonstrated that it is not practicable to meet the cleanup level at a point within the groundwater before entering the surface water, within a reasonable restoration time frame;
- Use of a mixing zone under WAC 173-201A-100 to demonstrate compliance with surface water cleanup levels shall not be allowed;

- Groundwater discharges shall be provided with all known available and reasonable methods of treatment before being released into surface waters;
- Groundwater discharges shall not result in violations of sediment quality values published in chapter 173-204 WAC;
- Groundwater and surface water monitoring shall be conducted to assess the long-term performance of the selected cleanup action including potential bioaccumulation problems resulting from surface water concentrations below method detection limits; and
- Before approving the conditional point of compliance, a notice of the proposal shall be mailed to the natural resource trustees, the Washington state department of natural resources, and the United States Army Corps of Engineers. The notice shall be in addition to any notice provided under WAC 173-340-600 and invite comments on the proposal.

Sediment Point of Compliance

The point of compliance for sediments "shall be established at a location that is protective of both aquatic life and human health." To protect aquatic life, the point of compliance shall be established within the BAZ (the upper 10 cm). However, in cases where humans could be exposed to deeper sediments, the point of compliance may be established at a different location that is also protective of human health. In areas including the embankment and intertidal areas of the Site, which includes intertidal areas on the east side of the Hylebos Waterway, the potential for recreational users or fishers to be exposed to deeper sediments should be considered.

3.2 Specific Comments

Section 2.2.1, 2.2.3 and Figures 2.1 and 2.3: The Exposure Pathway Assessment Report does not seem to include Commencement Bay in the CSM and does not evaluate risks to human health and the environment of Commencement Bay. It should be revised to do so. The SCUM II manual should be referenced for guidance on how to develop an adequate CSM.

Section 2.2.2, 2.2.3, and Figures 2.2 and 2.3: The human health CSM should be revised to include direct contact to sediments for recreational users, recreational fishers, and tribal fishers. The SCUM II manual should be referenced for guidance on how to develop an adequate CSM.

Section 2.2.2, 2.2.3, and Figures 2.2 and 2.3: As required by the SMS (WAC-173-204-564), the Exposure Pathway Assessment Report needs to consider risks to higher trophic levels including birds, fish, and mammals. The assessment should evaluate higher trophic level species that currently utilize, may potentially inhabit, or have historically inhabited the Site. Higher trophic level species should be included in the CSM and evaluated in the risk assessments. Species to consider for inclusion include the following:

- Insectivorous birds
- Crab, flatfish, sculpin
- Great blue heron, belted kingfisher, hooded merganser, bald eagle, osprey
- River otter, harbor seal

Additional information can be found in Chapters 3, 4, 9, and in Appendices E and K of the SCUM II manual. The Lower Duwamish Waterway CSM and risk assessments should also be referred to for more guidance.

Section 2.2.2: The evaluation of terrestrial ecological risks should follow the procedures outlined in MTCA for the Terrestrial Ecological Evaluation (WAC 173-340-7490 through 7492), including completion of Table 749-1.

Section 2.2.2: The ecological risks are only considered for the limited areas of identified groundwater discharge and adjacent nearshore sediments. It would be useful to include a figure to identify the specific areas of the Site the authors are addressing.

Section 2.2.2: The Exposure Pathway Assessment Report should consider whether deeper soils and sediments (greater-than3 feet) may be exposed with future development, particularly since the Port of Tacoma is projected to receive larger, deeper draft ships in coming years.

Section 3.2.2: While this section acknowledges that site-related COCs may migrate through "leaching or partitioning from one medium to another", this route is not discussed in Section 3.2.2.2 (Fate and Transport in Receiving Media). The potential for soil contamination to migrate from soil to groundwater should be thoroughly evaluated.

Section 3.2.2.2: Where hazardous substances are released to the surface water as a result of groundwater flows, no mixing zone shall be allowed to demonstrate compliance with surface water cleanup levels. The recreational user surface water exposure pathway should be maintained.

Section 3.2.2.4: Human exposure to contaminants in sediment through consumption of biota should be evaluated.

Section 3.2.3: The recreational user exposure scenario, including potential exposure to sediment, should be maintained in the evaluation.

Section 3.3: This list should include the SMS, SCUM II manual, National Toxics Rule, and the most up-to-date Clean Water Act Section 304(a) water quality criteria.

Section 3.3.4: In addition to sediment ingestion and dermal contact, the sediment to biota to human consumer should be evaluated. Per the SMS, the default human health exposure scenario for sediment is tribal consumption of fish and shellfish. This scenario should be included. (While the fish consumption pathway is included in the Fisher exposure scenario, it is only considered with respect to the surface water to biota pathway, and does not consider bioaccumulation from the sediment or food chain pathways.)

Section 3.3.5: MTCA cleanup levels for surface water include "Water quality criteria based on the protection of aquatic organisms (acute and chronic criteria) and human health criteria published under Section 304 of the Clean Water Act." The national 304 water quality criteria for human health have recently been updated, and should be included as ARARs for surface water and groundwater discharging to surface water.

Section 4.2.2: The phrase "at least temporarily" should be removed. There is no reason to believe that federally listed salmonids will not continue to use the Hylebos Waterway, and given the focus for salmon recovery in the watershed their numbers are expected to increase.

Section 4.2.2: Columbia River coho salmon should be removed, and the ESA-listed species and designated critical habitat for Commencement Bay and the Hylebos Waterway should be added.

Section 4.2.6: The discussion of assessment endpoints should be refined. "Productivity" is a complex concept that is difficult to assess. It would be better to consider using the more typical metrics of survival, growth, and reproduction. In addition, the report should clearly identify the specific measurement endpoints, according to the guidance that will be used to evaluate whether the assessment endpoints are protected.

Section 4.2.6: As noted above, the report improperly limits the species to be addressed in the assessment. In addition, the benthos are stated to include "benthic" fish, although it is not clear what species or feeding guild the authors are referring to. Exposure to contaminated sediments is an important exposure route that should be identified, rather than simply assuming that exposure through shallow contaminated groundwater discharge is the most important.

Section 4.2.6: PCBs and DDT may have greater groundwater transport in association with higher concentrations of volatile organic compounds (VOCs), and this potential for greater transport should be considered. The risks posed by "moderate" concentrations and "very limited areas" should be evaluated quantitatively, and not simply discounted. At the screening level, there should be no assumptions used to *a priori* limited exposure areas. It is also not clear whether the whole of the non-dredged area was considered as previously stated in the earlier sections of the Exposure Pathway Assessment Report.

Section 4.2.6: Direct toxicity to benthos (which would apply only to benthic infauna) has little to do with the protection of the food web via bioaccumulation. In fact, the more healthy the benthos, the greater the transfer from sediments to higher organisms may be. Toxicity data for aquatic species are limited, and the "true" exposure conditions are poorly estimated with available data. There is a difference between identifying the "conservative" (i.e., reasonable worst-case) situation and deciding whether that situation warrants corrective action. As the text notes early on, the screening risk assessment is intended to identify those worst-case scenarios.

Section 4.3, Table 4.1 and 4.2: The Exposure Pathway Assessment Report uses several Site SQOs as ecotoxicity screening values (ESVs) to calculate screening quotients (SQs). These SQOs are cleanup levels, and they are not risk based. The Report should be revised to include the applicable water quality criteria and SMS marine sediment chemical criteria for ESVs to more adequately assess potential risks to human health and the environment related to the Site.

Additionally, it is unclear how the estimated exposure concentrations (EEC) were calculated for each constituent. The report should clarify what was used to develop each EEC (i.e. maximum, 95 percent upper confidence level, and mean concentration).

The report makes judgements on level of risk related to the SQs. For a screening level risk assessment all SQs greater than 1 should be further evaluated.

Section 4.3.1.1: The Washington State aquatic life criteria for PCBs and DDTs should be used, as they are legally applicable requirements. There are both avian and mammal species to be protected. At the screening stage, "home range" considerations should not be included.

Section 4.3.1.1: The Exposure Pathway Assessment Report states that new information was used to revise the Site's previous clean up goals for VOCs, but does not apply the same reasoning to the criteria for other substances.

Section 4.3.1.1: The list of "qualifiers" on this page are uncertainties, and should be moved to a separate discrete section. In addition, the items listed include unsupported assumptions, and unnecessary qualifiers on the meaning of SQs greater than one.

Section 4.3.1.2: As noted in the text, the 300 µg/kg cleanup goal for PCBs is not protective of natural resources. A much lower concentration is appropriate. At the Portland Harbor site, for comparison, the accepted lowest preliminary remedial goal (PRG) for PCBs in sediments is 36 µg/kg for the protection of predators of the benthos, and the cleanup objective for PCBs is even lower for the Lower Duwamish Waterway site where it is 2 µg/kg, based on a "natural background" concentration.

Section 4.3.2.5: High concentrations of VOCs can have a solvent effect on PCBs and DDTs in groundwater, potentially increasing their mobility. The post-construction monitoring at Area 5106 found concentrations of VOCs that could indicate free product. The distribution of the PCBs and DDTs should be carefully compared to the locations of the discharge of contaminated groundwater to determine if evidence exists for enhanced transport.

Section 4.4: The Exposure Pathway Assessment Report summary section continues to use professional judgment to dismiss risks to natural resources from all exposures. This section is based on faulty evaluations in the previous sections.

4.0 Summary and Recommendations

Based on our review of the Draft Exposure Pathway Assessment Report, a summary of significant issues and recommendations follows.

1. The characterization of ecological and human use is inadequate.

The Exposure Pathway Assessment Report does not provide adequate characterization of natural resources, including habitats and species and their life histories that are present at the site and in the surrounding area.

Commencement Bay and the Hylebos Waterway provide important rearing, foraging, migratory, and adult habitat for numerous aquatic and terrestrial species. These estuarine waters at and in the vicinity of the Site are an important transitional area for juvenile salmonid species, bottom fish, forage fish, crab, bivalves and many other resident marine species. All of these species are found in these waters during every month of the year. The riparian buffers, salt marshes, and mudflats in the area provide important habitats for these aquatic species including plants, birds, and mammals. Commencement Bay supports both hatchery and listed- and non-listed salmon species including Chinook, coho, chum and pink salmon for which have run sizes have increased in recent years.

The Exposure Pathway Assessment Report does not provide adequate information regarding the human uses of Commencement Bay and the Hylebos Waterway in the vicinity of the Site. Human uses in the area include recreational and tribal fishing, crabbing, marina use, boating, sailing, diving, kayaking, paddle boarding, beach play, and bird and wildlife viewing. Anadromous and resident fish species support a robust recreational fishery and provide food and sustenance to sport and tribal fishers in the area. The area is within a tribal Usual and Accustomed fishing area.

This incomplete information results in major gaps in the exposure pathway assessments and their associated CSMs which leads to inadequate selection and assessment of exposure pathways, receptors, and endpoints.

Recommendation: The Exposure Pathway Assessment Report should be revised to fully characterize ecological and human uses, including potential futures uses of the Site and surrounding area, and the CSMs should be revised to more fully address all potentially complete

exposure pathways. Further evaluation of current and potential future human uses and associated exposure pathways should be considered.

2. References to and use of applicable regulations and guidance are incomplete.

The Exposure Pathway Assessment Report omits reference to and inclusion of a variety of applicable regulations and relevant guidance documents that affect Site cleanup requirements, including most notably the Washington Sediment Management Standards (SMS) and supporting guidance included in the Sediment Cleanup Users Manual II (SCUM II). Requirements related to the protection of human health and higher trophic level species are not addressed in both the development of CSMs and the evaluation of exposures. Federal regulations and guidance not referenced include the recently revised Clean Water Act Section 304 water quality criteria and the federal Endangered Species Act.

Recommendation: The Exposure Pathway Assessment Report should be revised to include all relevant regulations and guidance. Most significantly, the Exposure Pathway Assessment Report should ensure that the exposure assessment fully complies with SMS requirements and is consistent with the guidance provided in the SCUM II manual. Further, all screening levels should be reviewed and updated as appropriate, including updating the Clean Water Act Section 304 human health water quality criteria.

3. The discussions of human health and ecological exposure pathways are incomplete.

For both the reasons discussed above, the Exposure Pathway Assessment Report provides an incomplete discussion and evaluation of human health and ecological exposure pathways. The incomplete evaluation of sediment and food-chain exposures to fishers and to higher trophic level species is a significant gap in the exposure assessment. The SMS requires that sediment cleanup objectives for the protection of human health are based on tribal consumption of fish and shellfish, unless that scenario is not appropriate.

Recommendation: Since tribal fish and shellfish consumption is a recognized use and treaty-reserved right, the exposure pathway assessment for the fisher scenario should be revised to include consumption of biota impacted by contaminated sediments. The recreational user exposure scenario should also be revised and fully evaluated and should include exposures to contaminated sediments through ingestion and dermal contact, exposure to shallow groundwater discharging to surface water through ingestion and dermal contact, and ingestion of contaminated biota. Ecological exposures should consider exposure to bioaccumulative

chemicals of higher trophic level species, as required by the SMS. Finally, the evaluation of terrestrial ecological exposure should be consistent with the terrestrial ecological evaluation requirements of MTCA.

4. The discussion of points of compliance is inadequate.

The Exposure Pathway Assessment Report does not include a discussion of the relevant points of compliance for the media evaluated. An understanding of the standard and conditional points of compliance for soil, groundwater, and sediment are critical for understanding what data and exposure pathways need to be considered. This is also a critical element in evaluating the protectiveness of remedies that will be evaluated in the feasibility study.

Recommendation: For each of the media and exposure pathways evaluated, a relevant discussion of the regulatory points of compliance should be included to assist in determining the adequacy of both the existing data and the appropriate exposure pathways.

5. The discussion of total site risk is incomplete.

The human health risk assessment procedures included in MTCA state that "[a]t sites where the same individuals or groups of individuals are or could be consistently exposed through more than one pathway, the reasonable maximum exposure shall represent the total exposure through all of those pathways" (WAC 173-340-708). The Exposure Pathway Assessment Report does not include a discussion of the potential or likelihood of exposures to the same individuals through multiple exposure pathways.

Recommendation: In addition to ensuring that all potentially complete human health exposure pathways are adequately evaluated, the Report should include a discussion of the potential and probability of individuals being exposed through multiple pathways (e.g. as both a site worker and a fisher), and the combined risk of multiple exposures. Cleanup levels based on one pathway of exposure must be adjusted downward to take into account exposures from more than one exposure pathway if the total risk exceeds the maximum allowable cancer risk or poses a non-cancer health hazard. This may be particularly important to consider since different regulatory authorities (Ecology and EPA) are addressing different exposure areas within the same site.

5.0 References

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