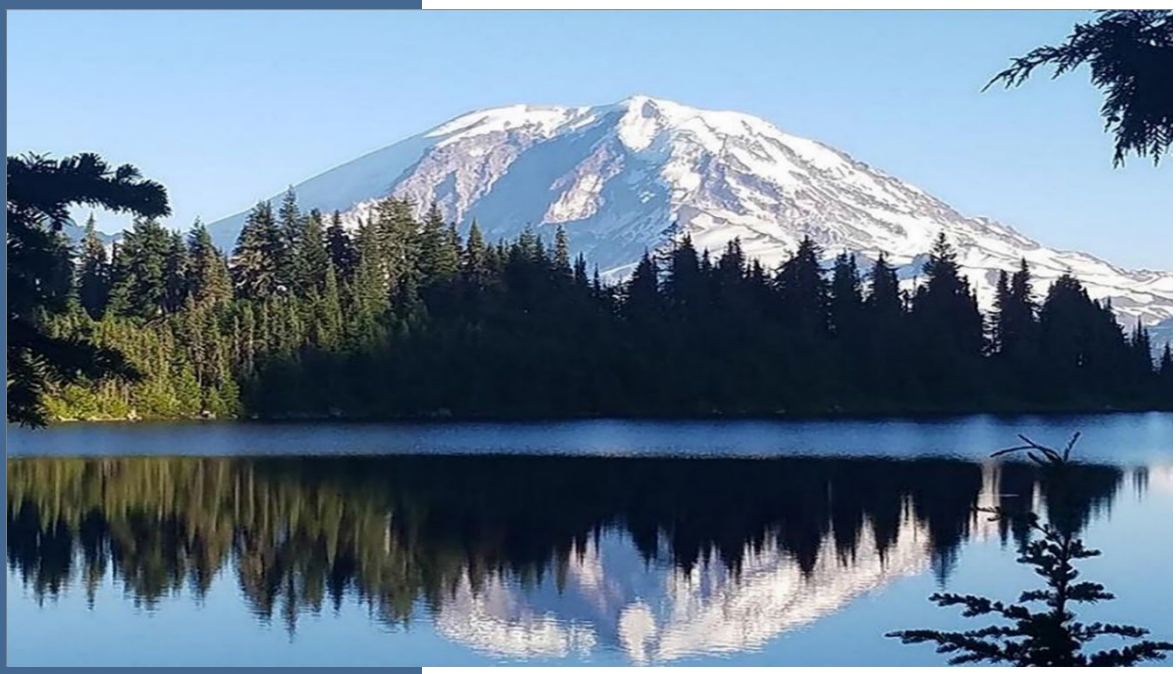

Updates to Natural Conditions Provision in Chapter 173-201A WAC

Technical Support Document

Water Quality Program

Washington State Department of Ecology

Olympia, Washington

November 2024, Publication 24-10-051

DEPARTMENT OF ECOLOGY
State of Washington

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Publication 24-10-053: Final Regulatory Analyses
Publication 25-10-001: A Performance-Based Approach for Developing Site-Specific Natural Conditions Criteria for Aquatic Life in Washington

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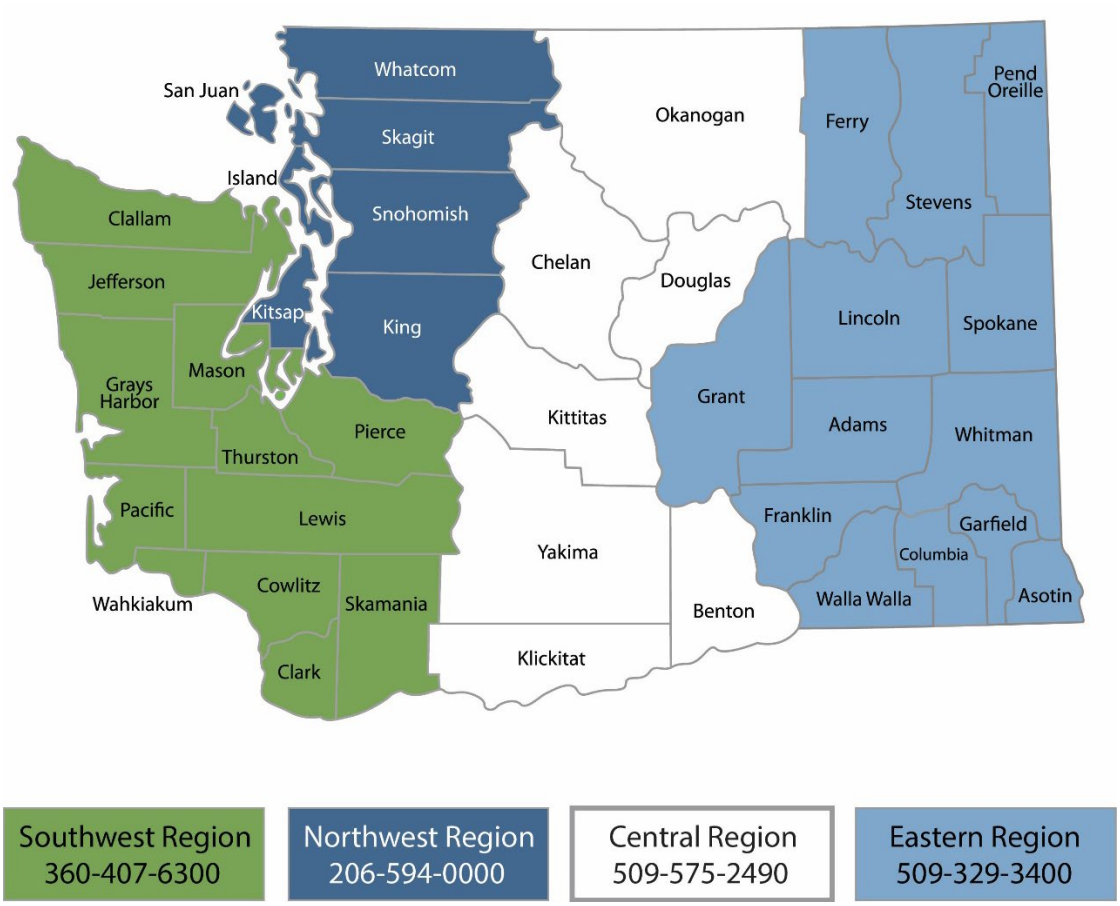

Southwest Region 360-407-6300	Northwest Region 206-594-0000	Central Region 509-575-2490	Eastern Region 509-329-3400

Region	Counties served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	PO Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	PO Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	PO Box 46700 Olympia, WA 98504	360-407-6000

Updates to Natural Conditions Provisions in Chapter 173-201A WAC

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Acknowledgements

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- The Natural Conditions Technical Workgroup for their assistance in development of this rule.

Abbreviations and Acronyms

BE	Biological Evaluation
BiOp	Biological Opinion
CFR	Code of Federal Regulations
CWA	Clean Water Act
EAP	Environmental Assessment Program
EIM	Environmental Information Management
EPA	Environmental Protection Agency
ESA	Endangered Species Act
IDAPA	Idaho Administrative Procedures Act
mg/L	milligrams per liter
NMFS	National Marine Fisheries Service
OAR	Oregon Administrative Rules
USFWS	United States Fish and Wildlife Services
WAC	Washington Administrative Code
WQS	Water Quality Standards

Executive Summary

The Department of Ecology is adopting amendments to chapter 173-201A Washington Administrative Code (WAC) Water Quality Standards for Surface Waters of the State of Washington. These adopted changes include: new definitions related to natural condition provisions in WAC 173-201A-020; revising the human action allowances in WAC 173-201A-200 and -210; updates to the natural conditions provisions in WAC 173-201A-260; updates to site-specific criteria in WAC 173-201A-430; and introducing a new performance-based approach for developing site-specific natural conditions criteria in a new section WAC 173-201A-470. The purpose of this document is to provide background and technical analysis for the adopted natural conditions criteria.

We compared Environmental Protection Agency (EPA) policy and guidance documents against Washington's current criteria to determine if updates were needed. If updates were deemed necessary, we evaluated these guidance documents, previous natural conditions approvals, past EPA Biological Evaluations, and previous Endangered Species Act (ESA) Biological Opinions from the National Marine Fisheries Service and United States Fish and Wildlife Service to determine what additional considerations are needed to protect ESA-listed species in Washington.

We reviewed other state and Tribal water quality standards and rules regarding natural conditions criteria to inform decisions on if and how to update our water quality criteria. We evaluated information provided by EPA to Washington in past approval and disapproval decisions as well as EPA staff-level recommendations on performance-based model requirements in water quality standards.

In determining human action allowances that are protective of aquatic life, we evaluated biological studies and instrument precision to ensure human allowance values remained *de minimis* and had no significant impact on protection of existing and designated aquatic life uses. We also reviewed past Biological Opinions, Biological Evaluations, and region-specific EPA guidance documents to inform our decisions.

Decisions for our natural condition criteria provisions are provided in this document alongside information on previous natural conditions criteria, guidance documents, new science, and performance-based approaches.

Background

Updating the natural conditions criteria was a high priority for Ecology and was included in the 2021 Triennial Review's list of planned actions for 2022 – 2024[2] and in our performance partnership agreement with EPA. EPA's 2021 disapproval[3] of Washington's prior natural conditions criteria affects the state's ability to identify when natural conditions in waters, sometimes seasonally, may not meet numeric water quality criteria but are still protective of designated and existing uses. These prior natural conditions criteria were regularly applied when implementing Clean Water Act actions (e.g., wastewater discharge permits, Total Maximum Daily Loads) as a necessary complement to biologically-based numeric criteria.

During the triennial review, we did not receive any public statements that were not supportive of updating our natural conditions criteria. We also decided to update and adopt all related natural conditions criteria (including the general provision and human action allowances) in a single rulemaking, partially as this will be more efficient than multiple rulemakings. Stakeholders, Tribes, and other interested parties were able to engage in the full scope of natural conditions criteria within one rulemaking without Ecology placing one aspect of the natural conditions rulemaking on an earlier rule schedule or higher priority than others.

[2] https://apps.ecology.wa.gov/publications/summarypages/2210002.html
[3] https://fortress.wa.gov/ecy/ezshare/wq/standards/EPA_ActionsNCC_Nov192021.pdf

Introduction

Overview

Natural conditions criteria have been a core part of Washington's surface water quality standards (WQS) since the first regulations were adopted in 1967. Since then, various updates to these criteria and releases of related guidance documents ensure continued protection of designated and existing uses. The Environmental Protection Agency (EPA) provided regional guidance for incorporating temperature into WQS in 2003 (USEPA, 2003). Washington previously adopted its last major updates to natural conditions criteria in 2003 and 2006, receiving EPA approval in 2008. During those WQS updates, the Department of Ecology (Ecology) adopted human-use allowances for fresh water and marine water temperature and dissolved oxygen and a general natural conditions provision. While these adoptions were made during a shift from class-based criteria to designated use-based criteria for aquatic life, many of the natural conditions provisions were found in prior versions of the WQS. Since adoption of these criteria in 2003 and 2006, EPA has released additional guidance on determining natural condition criteria values for certain parameters. Further, in 2021, EPA acted on these 2003 and 2006 revisions, disapproving some natural conditions criteria that had been previously approved (Opalski, 2021).

Under the Clean Water Act (CWA), any revisions to a state's surface WQS must be approved by EPA and may be subject to review of potential impacts to endangered species before use in federal CWA actions (e.g., Total Maximum Daily Loads, or TMDLs). In this rulemaking, we adopted updates to our national conditions criteria. During the rulemaking, we compared our previously adopted (but disapproved for federal CWA actions) natural conditions criteria against EPA guidance for natural conditions and determined updates were needed. We considered EPA's prior Biological Evaluation (BE) from Ecology's 2003 and 2006 WQS submittal. We also considered draft, Washington-specific EPA recommendations for natural conditions. Further, we evaluated previous Endangered Species Act (ESA) consultations from the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS). We also explored how other states and authorized Tribes in Washington incorporate natural conditions criteria into their WQS. Finally, we considered EPA's Region 10 guidance for establishing temperature criteria (USEPA, 2003).

Clean Water Act – Water quality standards

The CWA regulates discharges of pollutants into waters of the United States and water quality for surface waters. The CWA requires states to adopt WQS that consist of designated uses, water quality criteria that protect these uses, and an antidegradation policy. Section 303(c) of the CWA and federal implementing regulations at 40 Code of Federal Regulations (CFR) § 131.4 gives the primary responsibility for reviewing, establishing, and revising water quality standards to states and authorized Tribes. Those standards must protect the public health or welfare, enhance the quality of the water, and serve the purposes of the Act.

40 CFR § 131.3(b) defines criteria as elements of the water quality standards (expressed as constituent concentrations, levels, or narrative statements) that represent a quality of water that supports a particular use, such that when criteria are met water quality will generally protect the designed use. States and authorized Tribes must adopt water quality criteria that protect these designated uses (*see* 40 CFR § 131.11). EPA has compiled a list of nationally recommended water quality criteria for the protection of aquatic life and human health in surface waters. These recommendations are published pursuant to CWA Section 304(a) and provide guidance to establish WQS and provide the foundation for controlling the release of pollutants and identifying impaired waters. States and authorized Tribes may adopt other water quality criteria that differ from these Section 304(a) recommendations, so long as the water quality criteria are:

- Based on sound scientific rationale,
- Contain sufficient parameters or constituents to protect the designated use or uses, and
- Support the most sensitive designated use of the waterbody.

States and authorized Tribes may also adopt criteria that are modified to reflect site-specific conditions, so long as they are based on sound scientific rationale and protect the designated uses of the waterbody (see 40 CFR § 131.11(b)(1)(ii)).

State and authorized Tribal water quality standards are federally approved by EPA and describe the level of protection for waters of the state. Thus, adopted WQS by states and authorized Tribes must be submitted to EPA for review and approval (or disapproval). If EPA does not approve state WQS, then EPA may be required to promulgate federal water quality standards (e.g., Section 304(a) recommendations) for states that do not adopt federal recommendations, unless the state or authorized Tribe submits a revised rule package to EPA. In this process:

1. Ecology submits adopted rules to EPA.
2. EPA reviews the submittal for acceptability under the CWA.
3. EPA has 60 days to approve the rule or 90 days to disapprove the rule.

Natural conditions criteria are not EPA CWA Section 304(a) recommended criteria; therefore, should EPA not approve portions of the adopted rule, we would need to revise the rule package, conduct a new rulemaking, and resubmit to EPA; EPA would not be able to promulgate natural conditions provisions for the State.

Endangered Species Act consultation

EPA is required to evaluate potential impacts of the state-adopted criteria to endangered species. To fulfill these requirements, EPA writes a BE that describes the effects that the rule package (i.e., the “action”) may have on endangered species. If EPA’s approval of the rule is likely to adversely affect endangered species, EPA will request ESA Section 7(a)(2) consultation with NMFS and USFWS (the “Services”) to determine if the action would jeopardize those species. Alternatively, EPA can make a not likely to adversely affect determination.

The Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 *et seq*.), as amended, establishes the national program for conserving threatened and endangered wildlife, plants, fish, and their habitat. Section 7(a)(2) of the act requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitats ("jeopardy"). This may be done, as appropriate, with consultation from NMFS and USFWS. Further, ESA Section 7(a)(4) requires federal agencies to confer with the Services where either the federal agency or the Services have determined that a proposed or ongoing federal action is likely to jeopardize the continued existence of species proposed to be listed under Section 4 of the ESA or result in the destruction or adverse modification of critical habitat proposed to be designated for such species. The USFWS also encourages federal agencies to consult with them on actions that may affect a proposed species or critical habitat. In these cases, concurrence determinations or opinions can be adopted as formal concurrences or biological opinions, respectively, after a proposed species is listed or the critical habitat is designated.

In reviewing possible jeopardy calls from federal actions, the analysis relies on:

- The **Status of the Species** – Evaluation of the species' rangewide condition, the factors responsible for that condition, and its survival and recovery needs.
- The **Environmental Baseline** – Evaluation of the species' conditions in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species.
- **The Effects of the Action** – Determination of the direct and indirect impacts of the proposed action and the effects of any interrelated or interdependent activities on the species.
- **Cumulative Effects** – Evaluates the effects of future, non-federal activities in the action area on the species.

A jeopardy call is made by evaluating the effects of the proposed action in the context of the species' current status, taking into account cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the survival and recovery of the species in the wild. The BE (written by EPA) and the Biological Opinions (BiOps; written by the Services) each contain a discussion of the effects of the WQS adopted by the state or authorized Tribe and submitted to EPA. The result of these analyses can result in one of three potential outcomes for each action: (1) no effect; (2) not likely to adversely affect, or (3) likely to adversely affect.

If a "likely to adversely affect" determination is made, the BiOps will identify what part of the WQS, if any, is likely to jeopardize the continued existence of a listed species or harm critical habitat. A jeopardy call can lead to the partial or full disapproval of a WQS if EPA cannot conclude that the rule is protective of the applicable designated uses. BiOps can include conservation recommendations or other actions to minimize impact ("take") on listed species. A "likely to adversely affect" determination with no jeopardy call means that effects to endangered species are measurable, observable, and likely to occur, but will not affect the existence of the species at a population or landscape scale (i.e., critical habitat).

See 50 CFR § 402 for further details on the process for the federal interagency cooperation regarding the ESA, which had revisions that became effective on May 6, 2024.

Previous natural condition Biological Evaluations and Biological Opinions in Washington

As part of EPA's review and approval process for Washington's 2003 and 2006 WQS rule amendments, EPA prepared a BE for the Services in April 2007 (USEPA, 2007). Subsequently, NMFS (NMFS, 2008) and USFWS (USFWS, 2008) each produced a BiOp evaluating the proposed action. Within each of these documents are the agencies' evaluation of the previous natural conditions criteria. These criteria included:

- WAC 173-201A-200(1)(c)(i) and WAC 173-201A-210(1)(c)(i): Allowable human contribution to natural conditions provisions for aquatic life temperature (fresh water and marine water, respectively)
- WAC 173-201A-200(1)(d)(i) and WAC 173-201A-210(1)(d)(i): Allowable human contribution to natural conditions provisions for aquatic life dissolved oxygen (fresh water and marine water, respectively)
- WAC 173-201A-200(1)(c)(v) and WAC 173-201A-200(1)(d)(ii): Natural condition narrative aquatic life temperature and dissolved oxygen, respectively, for lakes
- WAC 173-201A-260(1): Natural conditions and other water quality criteria and applications (i.e., the "general provision").

EPA 2007 Biological Evaluation

EPA released their BE of Washington's adopted 2003 and 2006 WQS in April 2007 (USEPA, 2007).

Temperature

EPA determined the allowable 0.3° C increase in temperature for fresh waters under natural condition scenarios is consistent with recommendations in EPA's Region 10 Temperature Guidance (USEPA, 2003). This provision allows for an insignificant level of heat from human actions when natural conditions are the applicable criteria or where waters are exceeding the biologically based numeric criteria. EPA noted that absent such a provision, no heat would be allowed from human sources when the natural conditions criteria are the applicable criteria. This would be unnecessarily restrictive for the protection of salmonid uses and lead to unnecessary and costly expenditures. Further, EPA believed that a 0.3° C or less temperature increase above the natural condition temperature is insignificant because monitoring measurement error for recording instruments typically used in field studies are approximately 0.2° C to 0.3° C. That said, EPA recognized that temperatures within the mixing zone of some National Pollutant Discharge Elimination System (NPDES) discharges may result in temperatures near the vicinity of the discharge that may adversely affect salmonids. EPA concluded that the approval of the provision is likely to adversely affect endangered species, but that the 0.3° C

increase above the natural condition criterion generally would not adversely affect listed salmonids.

In lakes, EPA provided the same justification for supporting the 0.3° C or less temperature increase. However, EPA concluded that approval of the provision is not likely to adversely affect endangered species.

In marine waters, EPA provided the same justification for supporting the 0.3° C or less temperature increase, and similar to fresh waters, identified that temperatures within the mixing zone of some NPDES discharges may result in temperatures near the vicinity of the discharge that could adversely affect salmonids. Thus, EPA concluded that the approval of the provision is likely to adversely affect endangered species, but that the 0.3° C increase above the natural condition criterion generally would not adversely affect listed salmonids.

Dissolved oxygen

EPA determined the allowable 0.2 milligram per liter (mg/L) decrease of dissolved oxygen (DO) for fresh waters and lakes under natural condition scenarios are considered insignificant decreases. EPA noted that DO is a characteristic of the waterbody that can be affected by several parameters (e.g., temperature). Meeting the natural condition criterion without an allowance of some insignificant decrease would require disallowing any discharge of any pollutant that would affect DO. EPA believed this to be unnecessarily restrictive for the protection of designated uses and lead to unnecessary and costly expenditures. Further, 0.2 mg/L is within the monitoring measurement error for recording instruments typically used to monitor dissolved oxygen. Therefore, EPA determined that approval of these provisions is not likely to adversely affect endangered species.

General provision

EPA reviewed Ecology's natural condition provision that recognized portions of waterbodies cannot meet assigned criteria due to the natural conditions of the waterbody. When this occured, the natural conditions constitute the water quality criteria.

EPA stated that it views criteria based on natural conditions to "be fully protective of salmonid uses, even if the natural conditions are higher than the numeric criteria for some waterbodies, because the pollutant level prior to human impacts clearly support healthy salmonid populations" (USEPA, 2007). Therefore, even if natural conditions criteria would result in pollutant levels that cause adverse effects to salmonids, those effects would be viewed as naturally occurring adverse effects.

EPA also noted that the CWA regulatory framework ensured Washington's natural condition provisions are appropriately implemented. Under the CWA, EPA is required to approve or disapprove Washington's TMDLs and CWA 303(d) listing of impaired waters. In both cases, EPA has the authority to disapprove or reject Washington's submittals if natural condition determinations are inconsistent with the adopted criteria. Further, these actions may also include ESA consultation. In addition, EPA can review NPDES permits in Washington to determine consistency with the natural conditions criteria, and if inconsistent and not

addressed by the state following EPA's objection, EPA's oversight authority over the NPDES program could result in EPA federalizing the permit.

EPA concluded that the provision may affect all the listed species addressed in the BE as it could apply anywhere in the state. However, because the effects are natural and not attributable to the provision itself, EPA concluded that approval of the provision is not likely to adversely affect endangered species.

NMFS 2008 Biological Opinion

The NMFS released their BiOp regarding Washington's 2003 and 2006 WQS amendments in 2008 (NMFS, 2008).

NMFS concurred with EPA's statement that temperatures in fresh waters within the mixing zone of some NPDES discharges may result in temperatures that may adversely affect salmonids, noting that Ecology does not have temperature thermal plume limitations for point source dischargers that are specific to protect salmon and steelhead spawning . For lakes, NMFS concluded that the agency believes the provision does not undermine the protection of uses due to monitoring measurement error and that the temperature difference is within the range of uncertainty for understanding thermal requirements of salmonids.

For the general natural conditions provision, EPA concluded that it may affect all listed species, but any adverse effects are natural and not attributable to the provision itself. NMFS concurred with EPA's effect determination.

NMFS summary concluded that EPA's proposed approval of revised Washington WQS for temperature and DO, including natural conditions, are not likely to jeopardize the continued existence of endangered species and critical habitat covered in the Opinion.

USFWS 2008 Biological Opinion

The USFWS released their BiOp regarding Washington's 2003 and 2006 WQS amendments in 2008 (USFWS, 2008).

USFWS agreed that the allowable decrease for dissolved oxygen of 0.2 mg/L in fresh waters and lakes is insignificant. However, the agency noted there is no reasonable assurance that the existing DO standard will provide adequate protection for bull trout. Therefore, the USFWS was unable to make a determination on the overall effect of approving this provision.

For the natural condition general provision, USFWS agrees the effects would be insignificant and points to EPA's conclusion that approval of the general natural conditions provision may affect, but is not likely to adversely affect, endangered species like bull trout.

USFWS concluded that the various temperature criterion and provisions proposed are likely to provide better thermal protection than existing temperature standards and result in long-term improvements in baseline conditions in areas where temperature standards become more stringent.

Endangered and threatened species in Washington

The following aquatic and aquatic-related species are federally listed endangered and threatened in Washington.

Endangered

- Blue whale (*Balaenoptera musculus*)
- Bocaccio rockfish (*Sebastes paucispinis*) and critical habitat
- Chinook salmon (Upper Columbia River Spring DPS; *Oncorhynchus tshawytscha pop. 12*) and critical habitat
- Fin whale (*Balaenoptera physalus*)
- Gray whale (*Eschrichtius robustus*)
- Humpback whale (*Megaptera novaeangliae*)
- Soutern resident killer whale (*Orcinus orca*) and critical habitat
- Leatherback sea turtle (*Dermochelys coriacea*)
- Logerhead sea turtle (*Caretta caretta*)
- North Pacific right whale (*Eubalaena japonica*)
- Sei whale (*Balaenoptera borealis*)
- Short-tailed albatross (*Phoebastria albatrus*)
- Sockeye salmon (Snake River ESU; *Oncorhynchus nerka pop. 1*)
- Sperm whale (*Physeter macrocephalus*)

Threatened

- Bull trout (*Salvelinus confluentus*) and critical habitat, including the Coastal Recovery Unit (*pop. 2*) and Mid-Columbia Recovery Unit (*pop. 3*)
- Chinook salmon (*Oncorhynchus tshawytscha*), including the Lower Columbia River ESU (*pop. 1*), Puget Sound ESU (*pop. 15*), Snake River Fall ESU (*pop. 2*), and Snake River Spring/Summer ESU (*pop. 8*)
- Chum salmon (*Oncorhynchus keta*), including the Columbia River ESU (*pop. 3*) and Hood Canal Summer ESU (*pop. 2*)
- Coho Salmon (Lower Columbia River ESU; *Oncorhynchus kisutch pop. 1*)
- Eulachon smelt (Southern DPS; *Thaleichthys pacificus*)
- Green sea turtle (*Chelonia mydas*)
- Green sturgeon (Southern DPS; *Acipenser medirostris*)
- Marbled murrelet (*Brachyramphus marmoratus*)
- Oregon spotted frog (*Rana pretiosa*)
- Sockeye salmon (Ozette Lake ESU; *Oncorhynchus nerka pop. 2*)
- Steelhead (*Oncorhynchus mykiss*), including Lower Columbia River DPS (*pop. 14*), Middle Columbia River DPS (*pop. 17*), Puget Sound DPS (*pop. 37*), Snake River DPS (*pop. 13*), and Upper Columbia River DPS (*pop. 12*)
- Western snowy plover (*Charadrius nivosus*)
- Yelloweye rockfish (Puget Sound / Georgia Basin DPS; *Sebastes ruberrimus*)

Water quality standards regulations in Washington

Water pollution control in the State of Washington is regulated under Chapter 90.48 Revised Code of Washington (RCW). These regulations declare that:

> "…it is the public policy of the state of Washington to maintain the highest possible standards to insure the purity of all waters of the state consistent with public health and public enjoyment thereof, the propagation and protection of wild life, birds, game, fish and other aquatic life, and the industrial development of the state, and to that end require the use of all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the state of Washington" (Chapter 90.48.010 RCW).

Chapter 90.48.035 authorizes Ecology to promulgate rules and regulations it deems necessary to carry out the provisions of Chapter 90.48, including regulations related to WQS. These regulations maintain the highest possible standards of all waters within the state in accordance with the public policy. To implement Chapter 90.48, Ecology promulgates new and updated WQS in Chapter 173-201A Washington Administrative Code (WAC), which are the Water Quality Standards for Surface Waters of the State of Washington. WAC 173-201A establishes standards for public health and public enjoyment of waters in the state and for propagation and protection of fish, shellfish, and wildlife.

Litigation

EPA Actions on previously approved revisions to Washington's water quality standards

In February 2014, the Northwest Environmental Advocates (NWEA) filed a complaint with the United States District Court for the Western District of Washington (Case No. 2:14-cv-0196-RSM) challenging, in part, EPA's 2008 CWA Section 303(c) approval of the following natural conditions provisions:

- WAC 173-201A-200(1)(c)(i) and WAC 173-201A-210(1)(c)(i): Allowable human contribution to natural conditions provisions for aquatic life temperature (fresh water and marine water, respectively)
- WAC 173-201A-200(1)(d)(i) and WAC 173-201A-210(1)(d)(i): Allowable human contribution to natural conditions provisions for aquatic life dissolved oxygen (fresh water and marine water, respectively)
- WAC 173-201A-200(1)(c)(v) and WAC 173-201A-200(1)(d)(ii): Natural condition narrative aquatic life temperature and dissolved oxygen, respectively, for lakes
- WAC 173-201A-260(1): Natural conditions and other water quality criteria and applications

In October 2018, the Court issued an Order Granting a Stay (Dkt. 95) pending EPA's reconsideration of its prior determinations and subsequently granted an extension (Dkt. 118) for EPA to complete its reconsideration of these natural condition provisions by November 19, 2021.

EPA sent notice of its reconsiderations in November 2021 (Opalski, 2021) and made the following decisions:

- No change to the prior approval of WAC 173-201A-200(1)(c)(v) and -200(1)(d)(ii).
- Disapproved WAC 173-201A-200(1)(c)(i), -200(1)(d)(i), -210(1)(c)(i), -210(1)(d)(i), and -260(1)(a).

Reconsideration for aquatic life temperature and dissolved oxygen criteria for lakes

EPA took no action with respect to its prior 2008 approval for the lake temperature and dissolved oxygen natural conditions criteria, meaning these criteria remained in effect for CWA purposes. EPA reiterated its 2008 approval justification: that the 0.3°C increase in temperature above natural and 0.2 mg/L DO decrease below natural were insignificant and within monitoring measurement error for recording instruments typically used to monitor these parameters. In addition, EPA noted that, for lakes, not allowing some insignificant decreases from natural would be unnecessarily restrictive for the protection of designated uses.

Reconsideration for the natural and irreversible human conditions general provision

EPA disapproved this provision at WAC 173-201A-260(1)(a). EPA stated in its justification that the provision is broadly drafted and does not specify the types of criteria or pollutants to which it applies. Therefore, such a provision could apply to a wide range of naturally occurring pollutants, including toxic pollutants, and even allow an exception from otherwise applicable numeric human health criteria. This is not consistent with EPA's interpretation of the relationship between natural conditions and protection of designated human health uses. Washington's provision did not limit in scope the natural conditions provision to aquatic life uses or specific pollutants.

EPA noted that there are no changes necessary to address the disapproval. Washington's WQS currently include applicable numeric criteria that EPA has determined to be protective of designated uses. EPA did, however, provide discretionary recommendations. EPA noted that it continues to believe an "appropriately drafted natural condition provision can serve an important role in state WQS by reflecting a naturally occurring spatial and temporal variability in water quality that is protective of uses" (Opalski, 2021). EPA notes that a new provision for natural conditions narrowly tailored to aquatic life uses could be adopted. Alternatively, the adoption of a performance-based approach could be used to establish aquatic life criteria reflecting the natural condition for specific pollutants.

Reconsideration for allowable human contributions

EPA disapproved these human allowance provisions in WAC 173-201A-200 and -210. In their justification, EPA noted that it had disapproved the general provision in WAC 173-201A-260 (as discussed above). Without an approved WQS that allows for natural conditions to constitute the applicable water quality criteria, then the applicable criteria for temperature and dissolved oxygen are the biologically-based numeric criteria. The natural condition provisions for allowable human contribution are not based on these numeric criteria, but on the natural conditions of the waterbody. Further, these provisions do not authorize human actions to cause insignificant exceedances to the applicable numeric criteria. Therefore, EPA disapproved these provisions because such impacts are not tied to approved criteria that are in effect for CWA purposes.

EPA noted there are no changes necessary to address the disapproval. Washington's WQS currently include applicable numeric criteria that EPA has determined to be protective of designated uses for both temperature and dissolved oxygen. EPA did, however, provide discretionary recommendations. EPA noted Washington could adopt new natural conditions criteria specific to temperature or DO. For instance, a performance-based approach for establishing these criteria representative of the natural condition of a waterbody could be adopted into the WQS. Another option would be for Washington to adopt numeric criteria that account for natural conditions using the best available relevant data. This could include site-specific criteria. EPA notes that Washington could also choose to adopt a new WQS provision that allows for human actions to cause insignificant changes in DO or temperature. Such provision would need to be scientifically defensible and tied to approved criteria that are protective of designated uses, such as criteria based on the natural conditions of a waterbody.

Rulemaking strategy

We updated our natural conditions criteria to ensure consistency with CWA recommendations, continue to protect endangered species, and address disapprovals of our prior natural condition criteria that had previously been approved by EPA. In this rulemaking, we used information from previous ESA consultations, prior EPA biological evaluations, EPA memorandums, EPA guidance documents, exploration of how other states address natural conditions, and the latest scientific information to adopt natural conditions criteria that will protect designated and existing uses in Washington while recognizing that some waters in Washington do not meet applicable biologically based numeric criteria due to natural or seasonal factors. The methods section below describes the decision-making process for developing these adopted criteria.

Methods

Overview

In this rulemaking, we considered a variety of approaches to crafting the natural conditions criteria based on the best available science, protection of designated and existing uses, and flexibility to recognize the unique characteristics of waters in Washington. In this section, we discuss these approaches that we used to adopt protective natural conditions criteria.

Applicability of natural conditions in water quality standards

Natural conditions criteria differ from many other aquatic life criteria in a few ways. While many aquatic life criteria are based on protection levels determined through biological evaluation (e.g., lethal concentration tests, growth studies), natural conditions criteria for protection of aquatic life are based on the natural and seasonal variations of a waterbody due only to non-human-caused sources. In addition, EPA publishes aquatic life criteria pursuant to CWA Section 304(a), providing guidance for states and authorized Tribes to use for establishment of WQS. Natural conditions, however, do not have Section 304(a) recommended criteria. Rather, EPA assists states in their ability to set protective, scientifically defensible, criteria for water bodies that do not meet the biologically-based criteria due to natural conditions.

Site-specific criteria

Under the CWA and federal regulations at 40 CFR § 131.11, states and authorized Tribes must adopt water quality criteria that protect designated uses. In adopting these criteria, states and authorized Tribes establish numerical criteria values based on: (1) CWA Section 304(a) guidance; (2) modified CWA Section 304(a) guidance that reflect site-specific considerations; or (3) other scientifically defensible methods. If states and authorized Tribes adopt criteria based on other scientifically defensible methods, the criteria must:

- Be based on sound scientific rationale,
- Contain sufficient parameters or constituents to protect the designated use or uses of the waters, and
- Support the most sensitive designated use of the waterbody.

States and authorized Tribes can also establish narrative criteria or criteria based on biomonitoring methods, either where numerical criteria cannot be established or to supplement numeric criteria.

1997 Memorandum on natural conditions

In 1997, the Director of EPA's Office of Science and Technology released a public memo regarding states establishing site-specific aquatic life criteria that were equal to the natural background of the water (Davies, 1997). At the time, EPA identified several issues by states and authorized Tribes regarding the adoption of site-specific numeric criteria based on natural

conditions. This memo reflected EPA's policy on natural conditions and their use in establishing site-specific criteria.

EPA noted that the use of site-specific criteria is allowed by regulation and subject to EPA review and approval. When states and authorized tribes submit such criteria to EPA, pursuant to 40 CFR § 131.5(a)(2), EPA reviews these WQS to determine whether the criteria protect designated uses. EPA's existing guidance and practice are such that EPA will approve site-specific criteria that are developed based on sound scientific rationales. When the memo was released in 1997, EPA's guidance had three recommendations for states and Tribes to follow in deriving protective site-specific criteria: the Recalculation Procedure; the Water-Effect Ratio Procedure; and the Resident Species Procedures (USEPA, 1994). EPA recognized, though, that there may be naturally occurring concentrations of pollutants which exceed the national criteria published under Section 304(a).

EPA's natural conditions policy applied only to site-specific numeric aquatic life criteria based on natural background. EPA said that states may establish these criteria by setting the criteria value equal to "natural background" (i.e., natural conditions). EPA defined natural background as the "background concentration due *only* to non-anthropogenic sources, i.e., non-manmade sources" (Davies, 1997). EPA further recommended elements that states and Tribes should include in their WQS when setting aquatic life criteria equal to natural conditions:

- States and authorized Tribes should include a definition of natural conditions consistent with EPA's policy in their WQS.
- The WQS should have a provision that allows site-specific criteria to be set equal to natural conditions.
- There should be a procedure for determining natural conditions within the WQS. Alternatively, there should be a reference in the WQS to another document that describes the binding procedure that will be used.

Additional elements can be added to the WQS by states and authorized Tribes to support natural conditions criteria development and calculated values.

In the discussion of this policy, EPA noted that any procedure for determining the natural condition of a waterbody should be specific enough to establish those conditions or concentrations accurately and reproducibly. EPA affirmed that where natural conditions are documented, those natural parameter concentrations, by definition, are sufficient to support aquatic life that occur naturally in those waters absent any human interference. Finally, EPA reiterated that natural conditions apply only to aquatic life, not human health uses. If there are naturally occurring exceedances of the human health criteria, then states and authorized Tribes should re-evaluate the human health use designation. If the natural conditions will not support the designated human health use, then the use should be changed to one the natural background concentration will support (such as through a Use Attainability Analysis).

2015 Natural conditions framework

In 2015, EPA provided a framework for states and authorized Tribes to define, document, and develop site-specific natural condition aquatic life criteria (USEPA, 2015). This document expanded on EPA's 1997 recommendations (Davies, 1997), but specifically focused on development of natural conditions criteria for three aquatic life parameters: temperature, dissolved oxygen, and pH.

The document intends to assist states and authorized tribes to develop "consistent, transparent, and scientifically defensible approach[es] for identifying and characterizing natural conditions, which will specifically inform the development of site-specific criteria…for temperature, dissolved oxygen (DO), and pH for the protection of aquatic life designated uses" (USEPA, 2015). EPA notes that so long as these site-specific criteria have firm scientific basis and protect designated uses, the resulting criteria could be more or less stringent compared to adopted numeric criteria and still meet CWA requirements.

This framework document reiterated the three recommendations set forth in the 1997 policy memo, noting that states and regions have taken different approaches to characterize natural conditions. EPA recognized that human disturbances of water bodies are widespread and pervasive in some areas. Combined with temporal and spatial variability of environmental data, separating natural from anthropogenic and characterizing natural sources can be challenging. EPA created this framework document to assist in overcoming these challenges and help those states and Tribes interested in considering the use of natural conditions to develop site-specific aquatic life criteria for temperature, DO, and pH.

When using the framework, the result will typically be natural conditions criteria (consisting of magnitude, duration, and frequency) for one or more water quality parameters applicable to a site. The developed site-specific criteria must be adopted by states or Tribes into their WQS, reviewed by EPA, and receive federal approval prior to becoming effective for CWA actions. EPA identified two approaches that states and Tribes could use to adopt these criteria:

Option 1. Determine a specific outcome (i.e., concentration limit for a pollutant) through development of an individual numeric criterion and adopt this value into the WQS.

Option 2. Adopt a criteria derivation process through the performance-based approach.

EPA notes that Option 1 has been the more common way to adopt natural conditions criteria, noting that it affords flexibility to develop criteria on a case-by-case basis at the expense of resources. Ecology previously had procedures for adopting site-specific criteria at WAC 173-201A-430, but the prior regulations did not permit natural conditions to be the scientific justification for any developed site-specific criteria when following this process.

Option 2 is a performance-based approach that relies on the adoption of a process (derivation methodology) rather than a specific outcome. Washington's WQS previously did not have procedures for developing site-specific criteria using a performance-based approach.

Additional information

In this 2015 guidance document, EPA provided a flowchart for identifying and documenting natural conditions for temperature, DO, and pH (Figure 1). This five-part process is useful for developing site-specific natural conditions criteria and could be modified to fit a performance-based approach, or methodology, to develop site-specific natural conditions criteria for these specific parameters. This framework document is not applicable to other aquatic life water quality parameters (e.g., aluminum), nor can it be used for human health criteria.

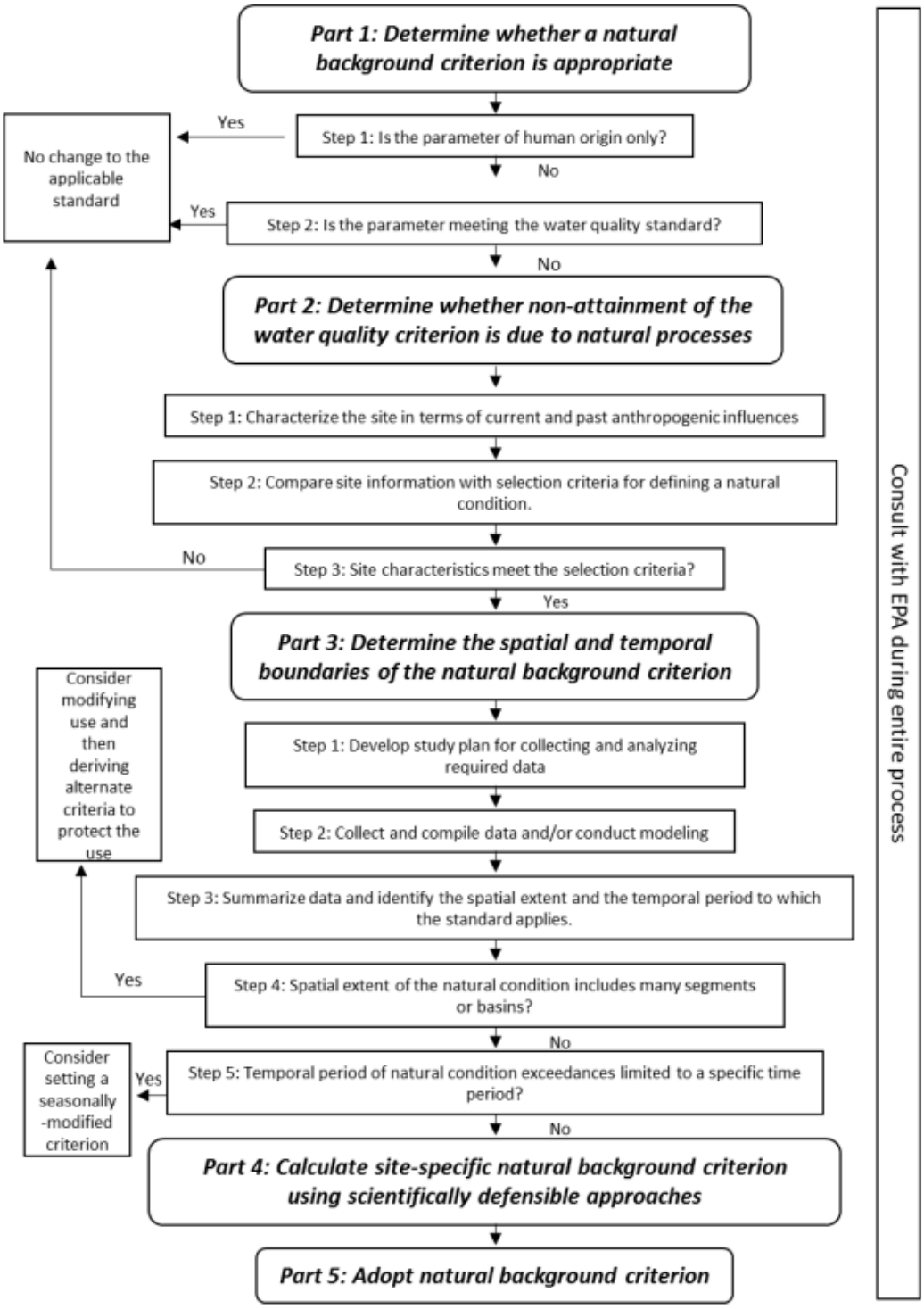

Figure 1. Flowchart for identifying and documenting natural conditions (USEPA, 2015).

EPA recognized that designated uses assigned to water bodies may not fully capture the unique or complex physical, chemical, and biological characteristics of the water. In some cases, this is due to natural processes or seasonal variations that prevent attainment of applicable numeric water quality criteria developed from a biologically based process. States and Tribes, therefore, either can develop and adopt site-specific criteria that are alternates to otherwise applicable statewide criteria or refine the designated uses for those waters. The framework document provides information on the former, and appropriate site-specific criteria set to natural conditions means there is no need to modify the designated use of the system or pursue a use attainability analysis.[4]

EPA outlined a defensible, transparent, and consistent procedure for developing natural conditions criteria in five parts:

1. Determine if a natural conditions criterion value is appropriate.
2. Determine whether nonattainment of the applicable water quality criterion is due to natural processes or seasonal variations.
3. Determine the spatial and temporal boundaries of the natural background criterion.
4. Calculate site-specific natural background criterion values using scientifically defensible approaches.
5. Adopt the natural background criterion (e.g., through adoption of a methodology like the performance-based approach).

In Part 1, states and Tribes must first determine whether natural conditions criteria are appropriate for the site. Parameters that are of human origin only (and therefore, clearly not natural) would not be eligible for a natural background criterion value. Further, EPA recommends determining whether the parameter is meeting the applicable aquatic life WQS. Waters meeting applicable aquatic life criteria wouldn't necessarily need site-specific criteria development; however, states and Tribes may have data that a more representative site-specific value is needed based on the natural condition regardless of whether the numeric WQS are currently being met. In some cases, this could result in a natural conditions criterion that is more stringent than the statewide numeric criteria.

In Part 2, states and Tribes determine whether the nonattainment of the water quality criteria is due to natural processes. This involves three steps:

1. Site characterization – Include past and current anthropogenic influences.
2. Compare site information with selection criteria for defining the natural condition.
3. Determine whether the site characteristics meet the selection criteria for natural conditions.

[4] Specifically, a Use Attainability Analysis (UAA) would only be used in this scenario if natural conditions preclude attainment of a designated use for a waterbody. If waters *can* meet designated uses, but needs a criterion value that reflects the natural condition of the site instead of the biologically-based numeric criteria, then a site-specific approach would be used to develop protective aquatic life criteria based on those natural conditions.

When determining whether a site's conditions represent natural conditions, EPA provides multiple factors for consideration. For example, waters surrounded by undisturbed vegetation, no historic or current land use indicating anthropogenic impacts, insignificant groundwater withdrawal, no point-source discharges, and high-quality biological integrity all provide confidence that a given condition of a site has minimal human disturbances, especially at the local and regional level.

EPA recommends that it may be useful to also define what would not be considered natural conditions (e.g., atmospheric deposition resulting from human-caused conditions). Further, EPA recommends sources of information to provide when characterizing a site, such as GIS maps or imagery, water quality monitoring data, and all available records from relevant agencies (local, state, and federal) identifying mining, forest, and other human activities surrounding the waterbody of interest.

If all available information indicates that there are no known anthropogenic influences on the parameter of interest, then Part 3 provides the foundation for determining the spatial and temporal boundaries of the natural conditions criteria. EPA recommends that at this point a study plan should be developed (e.g., a project Quality Assurance Project Plan, or QAPP) to describe the temporal and spatial characteristics of the water quality parameter. EPA provides possible pathways that could be taken to determine the site extent, such as conceptual models or computational modeling approaches. Data should be collected and analyzed according to the project QAPP, and it might be necessary to collect data that reflect variability during critical periods (e.g., summer low flow conditions).

After data are compiled and summarized, it may be necessary to group similar sites; EPA notes this is appropriate so long as the process for doing so is defensible and transparent. EPA further states that states and Tribes should determine whether any newly developed site-specific criterion applies only to certain seasons or time periods. These considerations for developing the project QAPP and approaches for characterizing spatial and temporal boundaries are in Figure 2.

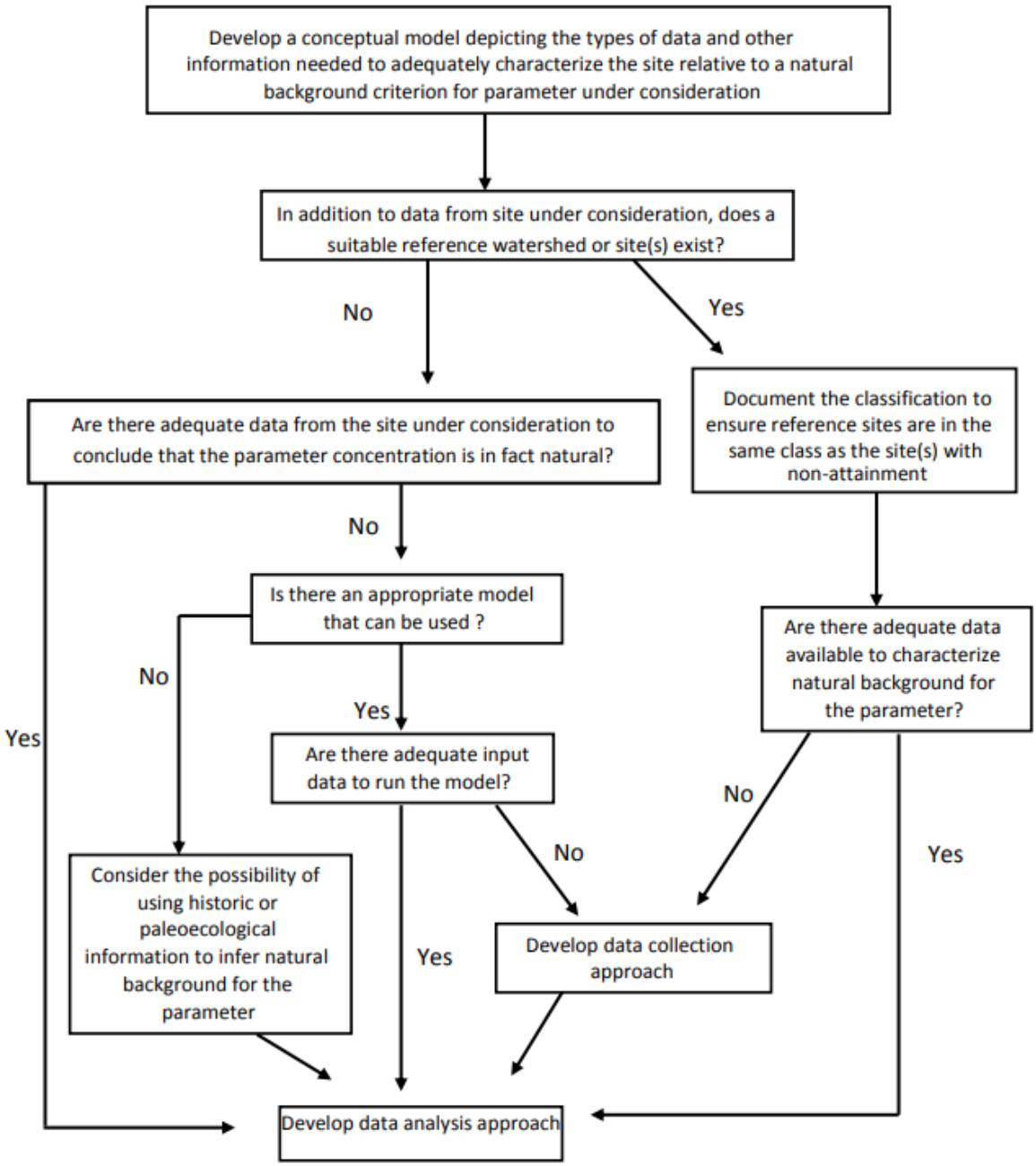

Figure 2. Considerations for project QAPP development and the approach for characterizing spatial and temporal boundaries for natural conditions criteria.

Part 4 of this process is to calculate the natural conditions criteria values for the water quality parameters. EPA states that criteria include magnitude, duration, and frequency elements. EPA provides two general approaches for calculating criteria values: an empirical statistical approach and a mechanistic modeling approach. These approaches could be used independently or in conjunction when developing criteria. Empirical statistical models relay on use of a statistical model or approach to derive an estimate of the natural condition. For instance, a state or Tribe could use a long-term percentile of annual means associated with the natural conditions as the magnitude for the criterion. Mechanistic modeling approaches rely on measurements and equations that represent key relationships among ecosystem components. These water quality models can simulate the water quality parameter of interest under natural conditions, which is then used to investigate whether the result is similar to current or observed conditions. EPA notes that there are many existing models available, and states and Tribes may choose appropriate models to use for developing site-specific criteria. However, EPA states a process should be followed that guarantees the model output can be confidently used to simulate existing or natural conditions. Data quality and measurement quality objectives need to be established within a project QAA to ensure proper model calibration and validation.

Use of these models must follow any applicable and approved state WQS. For instance, if a state has an EPA-approved performance-based approach that only describes the use of mechanistic models to calculate natural conditions criteria, the state could not deviate and use statistical models while still claiming to be following the performance-based approach. An alternative site-specific criteria process would need to be used (e.g., site-specific rulemaking, such as found in Washington's WQS at WAC 173-201A-430).

Part 5 involves adopting a natural conditions criterion value into a state or Tribe WQS. The performance-based approach is one option available to states and Tribes. In this approach, states or Tribes would adopt a criteria derivation process rather than a specific outcome (e.g., criterion value). In a performance-based approach, states or Tribes would specify the procedures it uses to derive site-specific criteria (including methods, minimum data requirements, and decision thresholds) into its WQS regulation or other binding procedure document. EPA states that when "such a performance-based approach is sufficiently detailed and has suitable safeguards to ensure predictable, repeatable outcomes, EPA approval of such an approach serves as approval of the outcomes as well" (USEPA, 2015).

Natural conditions in neighboring states and authorized Tribes in Washington

During the rule development, Ecology considered how other neighboring states and authorized Tribes in Washington incorporated natural conditions criteria into their WQS.

Oregon

Oregon's WQS are developed by Oregon Department of Environmental Quality and are available at Oregon Administrative Rules (OAR) 340, Division 41 *Water Quality Standards: Beneficial Uses, Policies, and Criteria for Oregon*.

Oregon has a definition of natural conditions in their WQS at OAR 340-041-00002(40):

> "Natural Conditions" means conditions or circumstances affecting the physical, chemical, or biological integrity of a water of the state that are not influenced by past or present anthropogenic activities. Disturbances from wildfire, floods, earthquakes, volcanic or geothermal activity, wind, insect infestation and diseased vegetation are considered natural conditions.

Statewide narrative criteria at OAR 340-041-0007 state that when natural conditions exceed the applicable numeric criteria for a water, the natural conditions criteria supersede the numeric criteria and becomes the standard for the waterbody (with restrictions that may apply to discharges that affect DO). However, this provision was disapproved on August 8, 2013, by EPA. Therefore, while it remains in Oregon's WQS for state purposes, it is no longer in effect for CWA actions.

Oregon has criteria specific for "natural lakes" at OAR 340-041-0028(6), stating that:

> Natural lakes may not be warmed by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life. Absent a discharge or human modification that would reasonably be expected to increase temperature, DEQ will presume that the ambient temperature of a natural lake is the same as its natural thermal condition.

This criterion is similar to Washington's criteria for lakes at WAC 173-201A-200(1)(c)(v). Oregon provides similar language for ocean and bays (except for the Columbia River above river mile 7) at OAR 340-041-0028(7). Further, in the temperature criteria section of Oregon's WQS, OAR 340-041-0028(8) reiterates the fact that when natural potential of a portion or all of a waterbody exceeds the biologically based numeric criteria, the natural condition temperature supersedes the biologically based criteria. Like the statewide narrative criterion at OAR 340-041-0007, this provision was disapproved by EPA in August 2013.

In Oregon's dissolved oxygen criteria section at OAR 340-041-0016, marine waters have narrative criteria (rather than a numeric concentration) such that DO concentrations must have no measurable reduction.

In Oregon's antidegradation policy, the WQS define insignificant temperature increases as those values not causing exceeding criteria values defined at OAR 340-041-0028(11) and -0028(12). In these sections, for the human use allowance, no single NPDES point source discharge may cause temperature to increase more than 0.3°C above the applicable criteria after mixing with either 25% of the stream flow or temperature mixing zone, whichever is more restrictive. Following temperature TMDLs or other cumulative effect analyses, wasteload allocations restrict all NPDES point source and nonpoint source discharges to a cumulative increase of no more than 0.3°C above the applicable criteria.

Insignificant dissolved oxygen decreases are defined as 0.1 mg/L when measured from the upstream end of a stream reach to the downstream end of the reach. Further, for dissolved oxygen, where waters are designated "water-quality limited for dissolved oxygen", Oregon's WQS state that when establishing wasteload allocations under a TMDL, an allowance may be provided for these allocations that result in no measurable reduction of dissolved oxygen. Oregon defines this term as no more than 0.1 mg/L from a single source and no more than 0.2 mg/L for all anthropogenic activities. This allowance applies both to surface water quality DO criteria and intergravel dissolved oxygen criteria, so long as a determination is made that conditions are naturally caused.

In addition to WQS, Oregon also has regulations for TMDLs at OAR 340-042. This includes a definition of "background sources" at OAR 340-042-0030(1):

> "Background Sources" include all sources of pollution or pollutants not originating from human activities. In the context of a TMDL, background sources may also include anthropogenic sources of a pollutant that DEQ or another Oregon state agency does not have authority to regulate, such as pollutants emanating from another state, tribal lands or sources otherwise beyond the jurisdiction of the state.

Washington does not have state regulations for TMDLs; however, this definition provides context between how Oregon adopts natural conditions WQS (prior to disapproval of Oregon's natural conditions criteria) and how these criteria are implemented in CWA actions like TMDLs.

Idaho

Idaho's WQS are developed by Idaho's Department of Environmental Quality and are available at Idaho Administrative Procedures Act (IDAPA) 58.01.02 *Water Quality Standards*.

Idaho has a definition for natural background conditions at IDAPA 58.01.02.10.63:

> **Natural Background Conditions.** The physical, chemical, biological, or radiological conditions existing in a water body without human sources of pollution within the watershed. Natural disturbances including, but not limited to, wildfire, geologic disturbance, diseased vegetation, or flow extremes that affect the physical, chemical, and biological integrity of the water are part of natural background conditions. Natural background conditions should be described and evaluated taking into account this inherent variability with time and place.

Idaho's policy for natural conditions is found at IDAPA 58.01.02.054.04, stating that "there is no impairment of beneficial uses or violation of [WQS] where natural [conditions] exceed any applicable water quality criteria…and such…conditions shall not…be the basis for placing a water body on the list of water quality limited water bodies…" Further, IDAPA 58.01.02.210.09 establishes the natural conditions general provision:

> **Natural Background Conditions as Criteria.** When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, there shall be no lowering of water quality from natural background conditions. Provided, however, that

temperature may be increased above natural background conditions when allowed under Section 401.

Temperature criteria for lakes in Idaho are set such that there is no measurable change from natural background conditions. In Section 401, Idaho regulations state that if temperature criteria for a designated use are exceeded due to natural conditions, then wastewater must not raise the receiving water temperatures by more than 0.3°C. Idaho notes that this was submitted to EPA as a temporary rule in 2011 and finale rule in 2012; however, EPA has not yet approved this revision.

Finally, Idaho's site-specific criteria procedures at IDAPA 58.01.02.275.01 state that acceptable conditions for developing site-specific criteria include situations where natural background levels of a pollutant exceed the applicable water quality criterion.

Authorized Tribes in Washington

We reviewed the WQS, if available, for all authorized Tribes in the state. For the table below, columns provide the following information:

- **Tribe** – Name of Tribe
- **WQS** – Does the Tribe have Water Quality Standards (WQS)?
- **Definition** – Does the Tribe have a definition of natural conditions in their WQS?
- **Provision** – Does the Tribe have a natural conditions general provision in their WQS?
- **SSC for NC** – Does the WQS contain information about setting site-specific criteria (SSC) to the natural conditions (NC) of the waterbody?
- **HUA for Temperature** – Is there an applicable human-use allowance (HUA) for temperature criteria, and if so, what is the value?
- **HUA for DO** – Is there an applicable human-use allowance (HUA) for dissolved oxygen (DO), and if so, what is the value?
- **Lake Criteria** – Do the tribal WQS contain criteria for lakes, and if so, what are those criteria? NCC = natural conditions criteria.
- **Other Notes** – Contains any other relevant information in the Tribe's WQS related to natural conditions.

Table 1 provides a summary of natural conditions criteria in these WQS. In general, for Tribes that have WQS, the majority have definitions for natural conditions and a general provision authorizing the use of natural conditions for aquatic life criteria. Some Tribes have information in their site-specific criteria procedures allowing the use of natural conditions as the required scientific justification. Most Tribes have human action allowances for dissolved oxygen (0.2 mg/L) and temperature (range 0.25°C to 0.3°C). Over half of the Tribal WQS contain separate natural conditions criteria for lakes. Finally, a few extend natural conditions criteria specifically to wetlands, and the Makah Indian Tribe has a specific appendix for determining natural conditions for implementing the WQS.

For the table below, columns provide the following information:

- **Tribe** – Name of Tribe
- **WQS** – Does the Tribe have Water Quality Standards (WQS)?
- **Definition** – Does the Tribe have a definition of natural conditions in their WQS?
- **Provision** – Does the Tribe have a natural conditions general provision in their WQS?
- **SSC for NC** – Does the WQS contain information about setting site-specific criteria (SSC) to the natural conditions (NC) of the waterbody?
- **HUA for Temperature** – Is there an applicable human-use allowance (HUA) for temperature criteria, and if so, what is the value?
- **HUA for DO** – Is there an applicable human-use allowance (HUA) for dissolved oxygen (DO), and if so, what is the value?
- **Lake Criteria** – Do the tribal WQS contain criteria for lakes, and if so, what are those criteria? NCC = natural conditions criteria.
- **Other Notes** – Contains any other relevant information in the Tribe's WQS related to natural conditions.

Table 1. Natural Conditions Criteria in WQS for Authorized Tribes.

Tribe	WQS?	Definition?	Provision?	SSC for NC?	HUA for Temperature?	HUA for DO?	Lake Criteria	Other Notes
Chehalis Reservation	Yes	Yes	Yes	Yes	0.3°C	No	-	-
Colville Reservation	Yes (Federally Promulgated)	No	No	No	0.3°C	No	NCC	Waters designated Special Resource Water Class have NCC for DO and temperature.
Jamestown S'Klallam Tribe	No	-	-	-	-	-	-	-
Kalispel Tribe of Indians	Yes	Yes	Yes	No	0.25°C	0.2 mg/L	No	-

Tribe	WQS?	Definition?	Provision?	SSC for NC?	HUA for Temperature?	HUA for DO?	Lake Criteria	Other Notes
Lummi Nation	Yes	Yes[1]	Yes	No	0.3°C	0.2 mg/L	NCC	-
Makah Indian Tribe	Yes	Yes	Yes[2]	Yes	0.25°C	0.2 mg/L	NCC	There are NCC for wetlands. Appendix C provides implementation procedures for NC.
Port Gamble S'Klallam Tribe	Yes	Yes	Yes[3]	Yes	No	0.2 mg/L[6]	No	-
Puyallup Tribe	Yes	Yes	Yes	No	0.3°C	0.2 mg/L	NCC	-
Quinault Indian Nation	No	-	-	-	-	-	-	-
Spokane Tribe	Yes	Yes	Yes	Yes[4]	No	No	NCC	There are NCC for wetlands. Disapproved by EPA in 2017 for not meeting 1997 memo requirements plus issues with human health criteria.
Squaxin Island Tribe	No	-	-	-	-	-	-	-

Tribe	WQS?	Definition?	Provision?	SSC for NC?	HUA for Temperature?	HUA for DO?	Lake Criteria	Other Notes
Swinomish Indian Tribal Community	Yes	Yes	Yes	Yes[5]	No	No	No	-
Tulalip Tribes of Washington	No	-	-	-	-	-	-	-

[1] Further defines natural conditions as those conditions "prevalent in the pre-contact era circa 1820."
[2] Requires firm scientific basis and is subject to site-specific criteria.
[3] Directs to the site-specific criteria section of the WQS.
[4] Disapproved by EPA.
[5] Points to EPA's 1985 Guidelines for developing criteria using a biologically based approach.
[6] Certain classes of waters only.

Sources for Tribal Water Quality Standards:

- Chehalis Reservation[5]
- Colville Reservation[6]
- Kalispel Tribe of Indians[7]
- Lummi Nation[8]
- Makah Indian Tribe[9]
- Port Gamble S'Klallam Tribe[10]
- Puyallup Tribe[11]
- Spokane Tribe[12]
- Swinomish Indian Tribal Community[13]

[5] https://www.epa.gov/sites/default/files/2014-12/documents/confederated-tribes-chehalis.pdf
[6] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-131/subpart-D/section-131.35
[7] https://www.epa.gov/system/files/documents/2023-03/kalispel-tribe-wqs-2022.pdf
[8] https://www.epa.gov/sites/default/files/2014-12/documents/lummi-nation-wqs.pdf
[9] https://www.epa.gov/sites/default/files/2014-12/documents/makah-tribe-wqs.pdf
[10] https://www.epa.gov/sites/default/files/2014-12/documents/port-gamble-tribe-wqs.pdf
[11] https://www.epa.gov/sites/default/files/2014-12/documents/puyallup-tribe-wqs.pdf
[12] https://www.epa.gov/sites/default/files/2014-12/documents/spokane-tribe-wqs.pdf
[13] https://www.epa.gov/sites/default/files/2017-09/documents/swinomish-wqs-title19-chapter6.pdf

Makah Indian Tribe implementation procedures for determining natural conditions for applying the water quality standards

Appendix C in the Makah Indian Tribe's WQS[14] sets forth the procedures for determining natural conditions using a site-specific criteria approach. The procedures note that EPA will be notified of any final decision to carry out Section 303(c) review and approval or disapproval of the adopted site-specific criteria (thus, this is not a performance-based approach).

The procedures include:

- A definition of natural conditions for water quality present before human-caused pollution.
- Possible potential pollutants that may have natural conditions criteria, including nutrients, metals, and bacteria.
- General methodology that outlines the scientific steps using best available data. This may include reference streams, historical data, and other studies.
    - For temperature, possible methods include using statistical or computational models, reference systems, historical data, and distribution of salmonids.
- Past and present human activities, and estimates of impact are subtracted from current water quality to calculate natural conditions.
- A public process with supporting documentation made available prior to formal adoption of any site-specific natural conditions criteria.
- A commitment to work with EPA on refining natural conditions methodologies in other CWA actions, such as TMDLs, NPDES discharge permits, and the CWA Section 303(d) listing.
    - The Makah Indian Tribes notes that natural conditions will most commonly be identified through the TMDL process.
- A list of water bodies where natural condition findings have been made to ensure the public is aware and notified.
- The evaluation of designated uses to determine whether use changes are necessary, and if so, carry out these changes through a Use Attainability Analysis.
- A list of documentation provided to EPA as part of its site-specific criteria rule package, including information that shows natural conditions support designated uses and that exceedances of the numeric criteria are attributed to natural or seasonal processes.

[14] https://www.epa.gov/sites/default/files/2014-12/documents/makah-tribe-wqs.pdf

Human allowance when natural conditions constitute the water quality criteria

There are currently no EPA recommended Section 304(a) criteria for human allowances of degradation for water quality parameters, such as temperature or dissolved oxygen. However, EPA, NMFS, and USFWS have previously provided support for such *de minimis* allowances, and EPA Region 10 also released a temperature guidance document for the Pacific Northwest that discussed temperature in water quality standards, including *de minimis* human allowances.

EPA Region 10 temperature guidance

EPA recognized that many salmonid species in the Pacific Northwest are listed as threatened or endangered. The ESA requires that EPA must ensure approval of state or Tribal WQS is not likely to jeopardize the continued existence of any endangered or threatened species or result in modification or destruction of their critical habitat. As temperature is a critical aspect of the freshwater habitat for these species and human actions have caused increases in river water temperatures (identified as a factor in decline of salmonids in the Pacific Northwest), EPA (with collaboration) developed temperature guidance to describe best approaches for appropriate water quality temperature criteria for protection of salmonids. This EPA Region 10 guidance document was released in April 2003 (USEPA, 2003).

The document discusses the importance of temperature for salmonids, identifies human activities that can cause temperature impacts and therefore salmonid declines, and general life histories of salmonids if elevated temperatures may be a problem. The document provides criteria recommendations to protect these salmonids, include the protection of waters that are colder than numeric criteria and provisions to protect species from thermal plume impacts from permitted discharges. Further, the document discusses approaches states and Tribes can take when numeric criteria are unattainable or inappropriate, including the use of natural condition provisions.

The document also discusses the incorporation of a *de minimis* temperature increase above the numeric criteria or natural background temperature. EPA notes that this provision would allow a way for accounting for monitoring measurement error and allowing negligible human impacts. EPA notes that the data and information currently available suggest that an increase of temperature of 0.25°C cumulatively from all sources above protective numeric or natural conditions criteria would not impair designated uses.

Past Biological Evaluations and Biological Opinions

As discussed previously, the EPA prepared a BE in 2007 for Washington's 2003 and 2006 WQS adoptions, which included human use allowances for temperature and dissolved oxygen. EPA consulted with the Services on this action, and both NMFS and USFWS released BiOps in 2008. See the "Introduction" section for discussion of these documents.

Performance-based approach and framework to develop site-specific criteria

There are a limited number of guidance documents and recommendations for use of a performance-based approach to develop site-specific criteria. These documents are discussed below.

2015 Natural conditions framework

In 2015, EPA provided a framework for states and authorized Tribes to define, document, and develop site-specific natural condition aquatic life criteria (USEPA, 2015). This included information regarding development of a performance-based approach to develop site-specific criteria. See the prior discussion above ("Applicability of Natural Conditions in Water Quality Standards") for additional details.

2023 EPA draft recommendations

As part of this rulemaking process, we worked with EPA Region 10 and EPA Headquarters staff to discuss EPA's natural condition recommendations and requirements for this rulemaking. This included discussion of previously released EPA documents, such as the 2003 Region 10 temperature guidance and 2015 framework for developing site-specific criteria (USEPA, 2003; USEPA, 2015). In 2023, EPA provided recommendations to Washington for a performance-based approach for natural conditions for temperature, DO, and freshwater pH, which also included required elements for this approach (USEPA, 2023). The recommendations received by Ecology are found in Appendix A.

We preface discussion of this document with the following caveats and considerations:

- This document is an EPA staff-level, draft, and deliberative work product that provides recommendations for this performance-based approach for consideration by Ecology only.
- EPA has not provided any information on when this document will be finalized or whether a final document will be specifically for Washington or more generally applicable to other states and Tribes.
- EPA has not provided any updates or changes to this document since receiving the first version of the document.
- Information in the document is being offered as an "initial scoping concept template" to assist Ecology in developing the performance-based approach.
- The components provided are generic to all waterbodies.
- EPA recommends that these elements be included in rulemaking, while additional procedures for implementing these criteria can be included in state guidance documents.

- These components are required to be included when Ecology estimates natural conditions through modeling, either through process-based or statistical models.
- EPA recommends that if human allowance provisions for DO and temperature are included in the proposed rulemaking, then Ecology should provide whether and how these provisions will be applied, including any interaction with the performance-based approach.
- The spatial and temporal scope of the approach for developing site-specific criteria must ensure designated and existing use protections. If there are timeframes and locations where the performance-based approach does not apply, then the applicable biologically based numeric criteria apply (unless there is a rationale for extending the time period that protects the designated uses).
- If the performance-based approach cannot be followed for a waterbody, then Ecology must either apply CWA-effective biologically based numeric criteria or go through site-specific criteria development with procedures at WAC 173-201A-430. This includes the requirement that these criteria must be submitted to EPA for review and action under CWA Section 303(c).
- Any update to the performance-based approach, regardless of whether it is incorporated into the WQS directly or through a binding reference, must follow federal requirements for revising water quality standards, which requires EPA's review and action before applicable for CWA actions.
- Finally, as these are preliminary staff-level recommendations for Washington's WQS program, they are provided as consideration only. Nothing in the document should be interpreted as binding requirements or as establishing EPA guidance for Washington or any other state or tribe.

EPA's recommendations for essential components in a performance-based approach are split into three sections: (1) definitions and scope; (2) general data considerations; and (3) model elements and development.

In the first section, EPA provides a list of definitions that should be included in the WQS and general elements and requirements for WQS application. This includes a natural condition general provision, the derivation of appropriate criteria including why the criteria are protective of designated uses, the type of data that will be used, and how data gaps will be addressed. EPA notes that the performance-based approach only applies to aquatic life criteria and protection. In the performance-based approach, Ecology should identify sources, data, and approaches relevant to each water body, the temporal period and constrains, and spatial application and constraints. EPA states that when using the performance-based approach to develop site-specific natural conditions, the estimated natural condition will be applicable to those waters even if water quality is better than or more stringent than the applicable biologically based numeric criteria. EPA does note that the state can use the biologically based numeric criteria instead, but Ecology must provide a rationale as to why those criteria are protective of the most sensitive designated use rather than the determined natural conditions criteria.

For general data considerations, EPA notes that the approach must specify the requirements for what are considered quality data, and data quality assurance and control must adhere to Ecology's programmatic QAPP for impaired waters assessment (or equivalent). The approach should specify requirements for data selection and incorporate all relevant and readily available data pertinent to estimation of natural conditions. These data must also reflect pre-climate change conditions when high quality data are available, and data selected for assessment of anthropogenic sources and impacts may be from a more recent timeframe than data used to estimate natural conditions. The methodology for combining these different time frame data sets must be documented alongside all other rationale for data used. This must be made available for public comment with each application of the performance-based approach (e.g., draft TMDL, draft NPDES permit).

The last section deals with model elements and development of water quality models that can be used to estimate natural conditions. Overall, EPA recommends that Ecology develop a project QAPP for each application of the performance-based approach that includes all relevant information and analysis plans, and to make these QAPPs and related documentation available to the public (e.g., alongside submittal of draft and final TMDL actions).

EPA provides a list of requirements for model selection, including that such natural condition estimates be based on the best available models that can simulate key processes and sources affecting the water quality parameter of interest. The model chosen should be able to recreate the existing conditions and natural conditions within documented precision and accuracy in the project QAPP. Models should be open source, with code that has undergone peer review. When setting boundary conditions for natural condition predictions in the model, all methods and assumptions made must be documented.

For resolution of the model, EPA states that the model grid should have sufficient resolution to capture horizontal and vertical variations in water quality. The model should be able to generate temperature, DO, and pH predictions on at least an hourly basis. Finally, the resolution of the model must be high enough to identify criteria outcomes that are protective of designated uses (e.g., values that protect benthic and pelagic species in lakes).

EPA provides a list of possible sources of anthropogenic influence on waterbodies. This includes possible impacts to temperature, DO, and pH in fresh, marine, and lake systems. When determining the natural conditions of a waterbody, all anthropogenic sources must be removed from the model setup. This includes impacts both within and outside Washington's jurisdiction where applicable (e.g., upstream Canadian water inputs). EPA states that the methodology for filling data gaps must be described alongside key assumptions of the model. For the model calibration, reasonable adjustments of model parameters to achieve a reasonable fit are required when calibrating. The quality of the calibration must be documented, as does all model parameter values. Sensitivity testing must be conducted for means and ranges for the most influential parameters, and Ecology must describe the effects on criteria outcomes.

Finally, sources of uncertainty in the model must be summarized and peer review of each model application (internal or external) must be completed prior to public notice or review. During public review and comment, the model documentation must be available for review (such as during the draft TMDL public process), and all peer review and public comments on

model quality must be considered and addressed. When the model output is interpreted to the natural condition scenario, the statistical metric simulated must be specified and ensure protection of designated and existing uses.

Results

Summary of adopted criteria

Ecology adopted new and updated natural condition provisions into Washington's WQS that provide protection of designated and existing uses in the state's waters while allowing us to recognize the unique attributes of waterbodies that may prevent attainment of the applicable biologically-based numeric criteria.

The sections below identify the updates we adopted for this rulemaking with a brief description of any changes from previous natural conditions criteria rules. We also identify where no changes were adopted for natural conditions provisions, and these criteria remain in effect for state and federal CWA actions. The remainder of the Results section provides justification on our adopted changes to Washington's WQS.

WAC 173-201A-020 Definitions

We adopted two new definitions to this section.

We adopted a definition for local and regional sources of human-caused pollution:

> **"Local and regional sources of human-caused pollution"** means sources of pollution caused by human actions, and the pollution originates from: (1) within the boundaries of the state; or (2) within the boundaries of a U.S. jurisdiction abutting to the state that impacts surface waters of the state."

This definition defines how Ecology determines whether a source of human-caused pollution is considered local or regional when considering cumulative impacts to waters.

We adopted a definition for a performance-based approach:

> **"Performance-based Approach"** means a water quality standard that is a transparent process (i.e., methodology) which is sufficiently detailed and has suitable safeguards that ensures predictable and repeatable outcomes, rather than a specific outcome. The outcomes from the performance-based approach are site-specific criteria.

This definition defines the performance-based approach as a process to establish criteria rather than determining a specific outcome.

Washington's WQS already contains an EPA-approved definition for natural conditions:

> **"Natural conditions" or "natural background levels"** means surface water quality that was present before any human-caused pollution. When estimating natural conditions in the headwaters of a disturbed watershed it may be necessary to use the less disturbed conditions of a neighboring or similar watershed as a reference condition. (See also WAC 173-201A-260(1).)

We neither proposed nor adopted any changes to this definition.

WAC 173-201A-200(1)(c) Freshwater temperature

> (i) When a water body's temperature is warmer than the criteria in Table 200 (1)(c) (or within 0.3°C (0.54°F) of the criteria) and that condition is due to natural conditions, then local and regional sources of human-caused pollution considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C (0.54°F) above natural conditions.
>
> (v) For lakes, human actions considered cumulatively may not increase the 7-DADMax temperature more than 0.3°C (0.54°F) above natural conditions.

We adopted updates to the human allowance for natural condition temperature criteria. We adopted a human action cumulative value of no more than 0.3°C increase above the natural conditions. We also adopted adjusted language regarding what actions are considered in the cumulative allowance. Human actions not meeting this "local and regional sources of human-caused pollution" definition would not be provided any allowance (as per WAC 173-201A-310(3)).

We neither proposed nor adopted any changes to the lake temperature criteria. These criteria were previously approved by EPA and remain in effect for CWA actions.

WAC 173-201A-200(1)(d) Freshwater dissolved oxygen

> (i) When a water body's D.O. concentration is lower than the numeric criteria in Table 200 (1)(d) (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then local and regional sources of human-caused pollution considered cumulatively may not cause the D.O. concentration of that water body to decrease more than 10 percent or 0.2 mg/L below natural conditions, whichever decrease is smaller.
>
> (ii) For lakes, human actions considered cumulatively may not decrease the dissolved oxygen concentration more than 0.2 mg/L below natural conditions.

We adopted updates to the human allowance for natural condition dissolved oxygen criteria, including revisions to the human action cumulative value. Specifically, we adopted language that local and regional sources of human-caused pollution may not cause the DO concentration of a water body to decrease more than 10% of the natural conditions criteria or 0.2 mg/L, whichever decrease value is smaller. Therefore, when the natural conditions criteria of a water body have been determined (and are in effect) to be 2.0 mg/L or greater, the allowance would be 0.2 mg/L.[15] Waters that have been determined to have site-specific, effective natural conditions criteria less than 2.0 mg/L would have an allowance equal to 10% of those conditions.[16]

[15] As 10% of 2.0 mg/L would be equal to 0.2 mg/L, and any value greater than 2.0 mg/L would be equal to a value greater than 0.2 mg/L, which would not be smaller than 0.2 mg/L.

[16] For instance, if the site-specific natural conditions D.O. criterion for a site has been determined to be equal to 1.2 mg/L, then local and regional sources of human-caused pollution, considered cumulatively, may not cause the D.O. of the water body to decrease by more than 10% of that value, which is equal to 0.12 mg/L.

We also adjusted the language regarding what actions are considered in the cumulative allowance. Human actions not meeting this "local and regional sources of human-caused pollution" definition would not be provided any allowance (as per WAC 173-201A-310(3)).

We neither proposed nor adopted any changes to the lake dissolved oxygen criteria. These criteria were previously approved by EPA and remain in effect for CWA actions.

WAC 173-201A-210(1)(c) Marine water temperature

> (i) When a water body's temperature is warmer than the criteria in Table 210 (1)(c) (or within 0.3°C (0.54°F) of the criteria) and that condition is due to natural conditions, then local and regional sources of human-caused pollution considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C (0.54°F) above natural conditions.

We adopted revisions to the human allowance for natural condition temperature criteria. We adopted a human action cumulative value of no more than 0.3°C increase. We also adjusted the language regarding what actions are considered in the cumulative allowance. Human actions not meeting this "local and regional sources of human-caused pollution" definition would not be provided any allowance (as per WAC 173-201A-310(3)).

WAC 173-201A-210(1)(d) Marine water dissolved oxygen

> (i) When a water body's D.O. concentration is lower than the numeric criteria in Table 210 (1)(d) (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then local and regional sources of human-caused pollution considered cumulatively may not cause the D.O. concentration of that water body to decrease more than 10% or 0.2 mg/L below natural conditions, whichever decrease is smaller.

We adopted revisions to the human allowance for natural condition dissolved oxygen criteria, including revisions to the human action cumulative value. Specifically, we adopted language that local and regional sources of human-caused pollution may not cause the DO concentration of a water body to decrease more than 10% of the natural conditions criteria or 0.2 mg/L, whichever decrease value is smaller. Therefore, when the natural conditions criteria of a water body have been determined (and are in effect) to be 2.0 mg/L or greater, the allowance would be 0.2 mg/L.[17] Waters that have been determined to have site-specific, effective natural conditions criteria less than 2.0 mg/L would have an allowance equal to 10% of those conditions.[18]

[17] As 10% of 2.0 mg/L would be equal to 0.2 mg/L, and any value greater than 2.0 mg/L would be equal to a value greater than 0.2 mg/L, which would not be smaller than 0.2 mg/L.

[18] For instance, if the site-specific natural conditions D.O. criterion for a site has been determined to be equal to 1.2 mg/L, then local and regional sources of human-caused pollution, considered cumulatively, may not cause the D.O. of the water body to decrease by more than 10% of that value, which is equal to 0.12 mg/L.

We also adjusted the language regarding what actions are considered in the cumulative allowance. Human actions not meeting this "local and regional sources of human-caused pollution" definition would not be provided any allowance (as per WAC 173-201A-310(3)).

WAC 173-201A-260(1) Natural conditions and other water quality criteria and applications – Natural and irreversible human conditions

> (a) It is recognized that portions of many water bodies cannot meet the assigned aquatic life criteria due to the natural conditions of the water body. When a water body does not meet its assigned aquatic life criteria due to natural climatic or landscape attributes, the following will be used to determine site-specific numeric aquatic life criteria representing conditions unique to a water body:
>
> (i) Aquatic life criteria based on natural conditions for temperature or dissolved oxygen for fresh or marine waters, or pH for fresh waters, will be derived by following either the site-specific criteria approach pursuant to WAC 173-201A-430 or the performance-based approach pursuant to WAC 173-201A-470.
>
> (ii) For all aquatic life parameters other than those listed in WAC 173-201A-260(1)(a)(i), aquatic life criteria based on natural conditions will be derived by following the site-specific criteria approach pursuant to WAC 173-201A-430.

We reintroduced during our adoption of this rule our natural conditions general provision. There are a few notable changes from the previously approved general provision. First, the natural conditions provision has been updated to reflect EPA recommendations and requirements that it only apply to either specific parameters or aquatic life criteria. We have chosen to update the provision to apply to aquatic life criteria only.

Second, we have provided information regarding options available to determine natural conditions criteria values, which reflects EPA's minimum element recommendations that there be some binding procedure in a state's WQS to determine natural background (Davies, 1997). Specifically, we split this into two sub-sections: one where the performance-based approach is applicable for those listed parameters, and one for all other aquatic life water quality parameters.

WAC 173-201A-430 Site-specific criteria

> (1) Where the existing and designated uses for the water body would be fully protected using an alternative criterion, site-specific criteria may be adopted.
>
> (a) The site-specific criterion must be consistent with the federal regulations on protecting uses (currently 40 C.F.R. 131.11); and
>
> (b) The decision to approve a site-specific criterion must be subject to a public involvement and intergovernmental coordination process.
>
> (2) The site-specific analyses for the development of a new water quality criterion must be conducted in a manner that is scientifically justifiable and consistent with 40 C.F.R.

131.11; and conducted in accordance with the procedures established in the "Water Quality Standards Handbook," EPA 2023, as revised.

(3) The decision to approve the site-specific criterion must be based on a demonstration that it will protect the existing and designated uses of the water body.

We updated the language in our site-specific criteria application to allow for the use of additional scientifically-justifiable approaches to site-specific criteria development. Previously, our WQS stated that site-specific analyses must be conducted using EPA's 1985 "Guidelines for Derving National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses". These guidelines provide a method for developing biologically-based aquatic life criteria; however, it does not provide a method for developing natural conditions criteria. We adopted language that site-specific analyses must be conducted using procedures based on forms of criteria at 40 CFR § 131.11. This allows for criteria development based on "other scientifically defensible methods", which includes site-specific criteria based on the natural conditions of a water body.

In addition, we adopted minor updates to recognize that the current version of the WQS Handbook that describes the procedures for establishing site-specific criteria was last updated in 2023. We also clarified language that site-specific criteria protect existing and designated uses, that site-specific criteria are consistent with regulations for protecting uses, and that such criteria are not based on attainable conditions but rather for protection of existing and designated uses.

WAC 173-201A-470 Performance-based approach

The performance-based approach may be used by the Department to establish numeric criteria based on natural conditions that are protective of existing and designated aquatic life uses.

(1) Aquatic life water quality criteria must be derived using the procedures referenced in Ecology publication 25-10-001, "A Performance-Based Approach for Developing Site-Specific Natural Conditions Criteria for Aquatic Life in Washington".

(2) Application of the performance-based approach for establishing aquatic life water quality criteria is limited to the following listed water quality constituents:

(a) Aquatic life temperature criteria in fresh water;

(b) Aquatic life dissolved oxygen criteria in fresh water;

(c) Aquatic life pH criteria in fresh water;

(d) Aquatic life temperature criteria in marine water;

(e) Aquatic life dissolved oxygen criteria in marine water.

(3) Aquatic life water quality criteria developed using this approach are applicable to the water body upon derivation.

(4) If the requirements set forth in the performance-based approach cannot be met, then site-specific criteria can be established by following the alternatives listed at WAC 173-201A-260(1)(a)(i).

We adopted a new section in Washington's WQS that allows for the use of a performance-based approach when developing site-specific natural conditions criteria for certain aquatic life water quality parameters. The use of such an approach would differ from site-specific criteria development at WAC 173-201A-430 in that criteria values developed using this approach are applicable to the waterbody following derivation. Criteria values developed using this approach would not need to be incorporated directly into chapter 173-201A WAC, and EPA approval of such an approach would mean approval of the outcomes as well; in other words, no separate approval of the criteria values (i.e., outputs of the approach) would be needed before use in CWA actions.

A Performance-Based Approach for Developing Site-Specific Natural Conditions Criteria for Aquatic Life in Washington

We have developed a draft performance-based approach for determining site-specific natural conditions criteria for aquatic life protection in Washington (Ecology Publication 24-10-017).

Due to the information required for the performance-based approach, we proposed having a separate, rule-referenced document that provides the details and requirements of the performance-based approach as noted in the adopted section WAC 173-201A-470(1). This document provides approaches to developing protective site-specific criteria based on the natural conditions of a waterbody. We are proposing that this performance-based approach be limited to dissolved oxygen criteria (fresh water and marine water), temperature (fresh water and marine water), and pH (fresh water only).

Finalization of the Performance-Based Approach Document

During the public comment period for this rulemaking, Ecology received numerous comments regarding our draft performance-based approach document. These comments allowed us to recognize that additional work is needed to the document.

Ecology plans to make edits to this publication based on feedback received and provide another opportunity for public involvement and review on the revised draft of the performance-based approach document. Following the public comment period, we will carefully consider the comments received and aim to publish the final version of this publication alongside our response to comments by Summer 2025.

Because the performance-based approach document is only referenced, and not part of the Water Quality Standards regulations at WAC 173-201A-470, and revisions to the document would not change the adopted regulatory language, we are not required nor will be conducting a separate formal rulemaking to revise this document. However, we feel it is important to provide another opportunity for public and Tribal input on a revised draft. Further, this document, which governs how Ecology will use the performance-based approach for site-specific criteria development, must meet federal CWA requirements, which includes a public review process and EPA review and approval before use in federal CWA actions.

Therefore, until we publish a final version of this document and receive EPA approval following their review, we will not be able to use the performance-based approach document for site-specific criteria under the Clean Water Act.

General provision updates

In this rulemaking, we reintroduced our natural conditions general provision into Washington's WQS. Compared with the previously adopted general provision[19], there are a few notable changes. First, we updated the provision to reflect EPA recommendations and requirements. Second, we have provided information regarding the paths available to determine natural conditions criteria values.

The revisions for WAC 173-201A-260(1) Natural conditions and other water quality criteria and applications – Natural and irreversible human conditions are:

> (a) It is recognized that portions of many water bodies cannot meet the assigned aquatic life criteria due to the natural conditions of the water body. When a water body does not meet its assigned aquatic life criteria due to natural climatic or landscape attributes, the following will be used to determine site-specific numeric aquatic life criteria representing conditions unique to a water body:
>
> (i) Aquatic life criteria based on natural conditions for temperature or dissolved oxygen for fresh or marine waters waters, or pH for fresh waters, will be derived by following either the site-specific criteria approach pursuant to WAC 173-201A-430 or the performance-based approach pursuant to WAC 173-201A-470.
>
> (ii) For all aquatic life parameters other than those listed in WAC 173-201A-260(1)(a)(i), aquatic life criteria based on natural conditions will be derived by following the site-specific criteria approach pursuant to WAC 173-201A-430.

2021 Disapproval of previously approved natural conditions

EPA disapproved our prior natural conditions provision in 2021 (Opalski, 2021). In the disapproval, EPA noted that that provision was "broadly drafted" as it does not specify the types of criteria or pollutants to which it applies. EPA concluded that the provision could be applied to a range of naturally occurring pollutants, including toxic pollutants, and could be allowed to replace human health criteria as the applicable criteria. Therefore, the provision is not consistent with EPA's interpretation of the relationship between natural conditions and human health protections.

Ecology's adopted general provision addresses these previous issues by stating these natural conditions criteria apply only to aquatic life criteria.

[19] Disapproved for CWA purposes in 2021 (Opalski, 2021).

EPA 1997 memorandum and 2015 framework guidance

EPA's 1997 Policy memorandum on natural conditions states that states or Tribes should include in WQS a provision that says site-specific criteria may be set equal to natural background (Davies, 1997). States and Tribes should also include a procedure for determining natural conditions criteria, whether as incorporated directly into the WQS or as a reference to another document describing the binding procedure. Further, EPA is clear (and thus, is EPA's policy) that natural conditions apply only to site-specific numeric aquatic life criteria that are based on natural background.

In EPA's 2015 natural conditions guidance document, EPA reiterates their current national policy that reflects the 1997 memo: natural conditions are for site-specific numeric aquatic life criteria, WQS should have a provision that allows setting site-specific criteria equal to natural conditions, and the WQS should include a procedure or reference to procedure for determining natural background (USEPA, 2015).

Ecology's adopted general provision addresses these requirements by stating these natural conditions criteria apply only to aquatic life criteria and reference binding procedures (i.e., site-specific criteria at WAC 173-201A-430 and performance-based approach at -470 for applicable parameters) to determine natural conditions.

Exclusion of human health

Natural conditions do not apply to human health criteria. Our adopted general provision makes it clear that these natural conditions criteria apply only to aquatic life criteria.

The reason for this exclusion is that naturally occurrent levels of pollutants do not necessarily protect human health designated uses. It is assumed that aquatic life species have adapted over time to naturally occurring pollutant levels in a waterbody; that same assumption cannot be made to humans. Therefore, the assumptions of designated use protections offered to aquatic life do not carry over to human health designated uses. This applies to all human health designated uses, from consumption of fish or shellfish to recreational activities (Opalski, 2021). EPA's 1997 policy states that should pollutants be naturally higher than applicable human health criteria, then states and Tribes should re-evaluate the designated human health use (Davies, 1997).

Ecology's adopted general provision aligns with these exclusions of human health designated uses by making it clear that natural conditions apply only to aquatic life criteria.

Human use allowances

We reintroduced the human allowance for natural condition temperature and DO criteria. We adopted a human action cumulative value of temperature as no more than 0.3°C increase above natural conditions. For DO, we changed the prior human action cumulative value to no more than 10% or 0.2 mg/L of natural conditions, whichever decrease is smaller. We also adjusted the language regarding what actions are considered in the cumulative allowance.

Human actions not meeting these definitions would not be provided any allowances. To do this, we adopted a new definition at WAC 173-201A-020 Definitions:

> **"Local and regional sources of human-caused pollution"** means sources of pollution caused by human actions, and the pollution originates from: (1) within the boundaries of the state; or (2) within the boundaries of a U.S. jurisdiction abutting to the state that impacts surface waters of the state."

We adopted no changes to the lake temperature or lake nutrient criteria.

EPA workgroup report on principles to consider when using natural conditions provisions

For both temperature and DO updates to the human use allowances, we considered EPA's informal discussion and workgroup report. In April 2005, EPA Region 10 released an informal, clarifying workgroup report on principles to consider when reviewing and using natural conditions provision (USEPA, 2005). This document does not represent a formally-issued EPA guidance. In this document, EPA suggested that during development of WQS and the implementation plan, states and Tribes could consider measurable change and cumulative impacts.

EPA describes these as:

> "Measurable change", when equated with analytical detection limits[,] becomes an allowance for a certain negligible increase over or change from the actual natural condition. Similarly, Oregon has adopted a human use allowance that allows a negligible increase above the natural condition due to human sources…
>
> The term "measurable change" is often used to describe two distinct concepts – analytical laboratory measurement sensitivity and negligible pollutant increases that are deemed ecologically insignificant. The state or tribe should ensure that clarification is provided when including terms such as "measurable change" or "no measurable change" in the definition of natural condition.

These statements indicate when discussing *de minimis* impacts to a system, there are generally two approaches used to defend those *de minimis* values: biological and analytical. Biological support would be demonstrating that the proposed decrease in temperature or DO does not harm aquatic life, either on an acute or chronic level – that their designated uses are still protected. Analytical support would demonstrate that a proposed change cannot be detected or fully realized within the accuracy range of the analytical instrument.

The EPA workgroup report suggests that both pathways would be possible for support of *de minimis* values in WQS. That said, it is important to note that species protection isn't reliant on our ability to detect changes in their environment, but only if such a change in their habitat impacts their propagation and survival. It is possible that the accuracy range of analytical instruments could be at a value that impacts aquatic life. Therefore, to ensure that analytical instrument limitations are protective of aquatic life from a biological perspective, so long as we see no impact to species at these changes (i.e., at the limits of instrument precision), then

support for such a *de minimis* value is appropriate. However, if impacts are seen within the accuracy limitations of instruments, then a smaller *de minimis* value would be necessary. EPA states as such in this document: “define the basis for the definition of ‘measurable’ and for the conclusion that potential changes are below that level” (USEPA, 2005).

Temperature

We adopted the following at WAC 173-201A-200(1)(c) for fresh water temperature:

> (i) When a water body's temperature is warmer than the criteria in Table 200 (1)(c) (or within 0.3°C (0.54°F) of the criteria) and that condition is due to natural conditions, then local and regional sources of human-caused pollution considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C (0.54°F) above natural conditions.

We adopted the following at WAC 173-201A-210(1)(c) for marine water temperature:

> (i) When a water body's temperature is warmer than the criteria in Table 210 (1)(c) (or within 0.3°C (0.54°F) of the criteria) and that condition is due to natural conditions, then local and regional sources of human-caused pollution considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C (0.54°F) above natural conditions.

Below we discuss the justifications for these changes.

2003 EPA Region 10 temperature guidance

The EPA Region 10 guidance document discusses the importance of temperature for salmonids, identifies human activities that can cause temperature impacts and therefore salmonid declines, and general life histories of salmonids if elevated temperatures may be a problem. This document also discusses how states and Tribes could incorporate a *de minimis,* or insignificant, temperature increase allowance into their WQS. This provision would allow for an insignificant increase in temperature, is a way for accounting for monitoring measurement error, and allows for negligible human impacts. EPA states that the data and information available to EPA indicates an increase of 0.25°C cumulatively from all sources above protective numeric or natural conditions criteria would not impair designated uses (USEPA, 2003).

Other EPA documents

EPA discussed insignificant impacts to temperature in their approval of Washington’s 2003 and 2006 WQS. EPA noted that Washington’s proposed 0.3°C increase above natural conditions was insignificant and well within the range of uncertainty of thermal requirements for salmon (approximately +/- 0.5°C). Further, this value is within the error band associated with typical temperature monitors (USEPA, 2007; Opalski, 2021).

In addition, EPA noted in Section 3.B. *Species Assessed for Effects* of EPA's 2007 BE that evaluation of these criteria is limited to those species that could be affected by this action, directly or indirectly. EPA determined the following regarding Washington's 2003 and 2006 proposed temperature criteria which included the *de minimis* temperature value:

- Vegetation will not be affected. All nine plant species listed in Washington State are not affected by alterations of temperature.
    - Further, the proposed freshwater temperature criteria are intended to restore thermal refuges to protect sensitive native salmonids.
- Terrestrial animal species will not be exposed to altered temperature effects.
- Similar to terrestrial mammals, impacts to bird species only occur through reduction in prey base. Two species, the bald eagle and marbled murrelet, are significant piscivores that could be affected by a reduction in prey base (mainly salmonids).
    - Three marine mammals (Stellar sea lions, humpback whales, and killer whales) also had the same route of exposure regarding reduction in prey base.
    - All five of these species were found to be NOT LIKELY TO BE ADVERSELY AFFECTED for all water quality provisions being approved by EPA.
- The one listed butterfly species does not use aquatic habitats during its life, so there is no effect.
- The southern sea otter was given a NO EFFECT determination as it does not consume prey species most affected by changes to the WQS (salmonids). It's prey mostly consists of invertebrates like sea urchins, clams, crabs, and mussels.
- The Eskimo curlew does not occur in the state at any point; thus, it received a NO EFFECT determination.
- Two turtle species prey on invertebrates, algae, seaweed, seagrass, and fish. Similar to the otter, these species were given a NO EFFECT determination due to not feeding on salmonids.

Section 5.H.9 *Allowable 0.3°C increase in temperature in waters warmer than the criteria* of the 2007 BE discusses EPA's evaluation of the 0.3°C value for human actions considered cumulatively when water bodies are identified as having naturally higher temperatures. EPA determined that this value is insignificant and would not adversely affect listed salmonids. However, EPA also recognized that temperatures within the mixing zone of some NPDES discharges may result in temperatures near the vicinity of the discharge that may adversely affect salmonids; therefore, EPA concluded approval of this provision is likely to adversely affect listed species.

Specifically, EPA discussed the 0.3°C human allowance stating that:

> The above provision is consistent with the recommendations in EPA's Temperature Guidance which discusses allowing the temperature in a waterbody to be insignificantly higher than the applicable criteria…

> Absent such a provision, no heat would be allowed from human activities when the natural condition criteria [are] the applicable criteria. EPA has concluded that this result is unnecessarily restrictive for protection of salmonid uses, and would lead to unnecessary costly expenditures, therefore the EPA recommended such a provision in its Temperature Guidance…
>
> EPA believes that a 0.3°C or less temperature increase above the natural condition temperature is insignificant because monitoring measurement error for recording instruments typically used in field studies is approximately 0.2°C to 0.3°C. In other words, this level of a temperature increase is considered within the error range associated with typical temperature monitoring equipment. (USEPA, 2007)

USFWS Biological Opinion

In the 2008 BiOp for Washington's proposed 2003 and 2006 criteria adoption, the USFWS acknowledged EPA's assertion that a 0.3°C or less temperature increase is insignificant based on monitoring measurement error and within the range of uncertainty of our understanding of thermal requirements of salmonids. USFWS determined, however, that allowable increases in point sources contribute to the cumulative warming of the waterbodies and maintains degraded baseline conditions in areas where temperatures are already above optimal levels for bull trout. When discussing the allowable temperature increases for lakes (also 0.3°C), USFWS reiterated what EPA wrote in the 2007 BE, but did not provide any additional information on support (or lack thereof) for the action (USFWS, 2008).

NMFS Biological Opinion

NMFS released their BiOp on Washington's adopted 2003 and 2006 WQS in 2008. When discussing the 0.3°C allowance, NMFS concurred with EPA's recognition that temperatures within the mixing zone of some NPDES discharges may adversely affect salmonids. There was also concern that Ecology proposed 2003 and 2006 adoptions did not have temperature thermal plume limitations specific to protect salmonid and steelhead spawning from point source discharges if the spawning is not protected by that designated use criteria.

NMFS wrote, however, that the 0.3°C allowance above natural conditions for lakes provision does not undermine the protection of uses, stating:

> The 0.3°C or less temperature increase is insignificant for two reasons. First, monitoring measurement error for recording instruments typically used in field studies is about 0.2 to 0.3°C. In other words, this level of a temperature increase is considered undetectable with typical temperature monitors. Second, a 0.3°C temperature difference is well within the range of uncertainty of our understanding of the thermal requirements of salmonids, which are in the range of ±0.5°C. (NMFS, 2008)

Scientific literature

We reviewed published literature to ensure that the 0.3°C allowance would not harm aquatic life or their designated uses. We note that when developing aquatic life criteria, we must ensure criteria are protective. If insufficient data were available to derive protective criteria when just focusing on site- or state-specific studies, we expanded our scope in our review of science to ensure confidence that adopted criteria were sufficiently protective.

Prior studies have analyzed impacts to aquatic life, including fish, resulting from changes in environmental temperature conditions. Temperature shifts can impact reproduction, growth, and survival of aquatic life (Mugwanya et al., 2022). It can also modify invertebrate emergence timing by altering development rates (Fuller et al., 2021). One 12-month study observed that fathead minnows' exposure to elevated water temperatures between 26 and 34°C demonstrated reproduction (e.g., number of eggs produced per female, number of eggs per spawning) were more sensitive to temperature increases compared with survival, growth, or egg hatchability (Dowling and Wiley, 1986).

Behavior changes, such as feeding rates, are impacted by increasing temperatures. For example, channel catfish experienced higher growth rates at optimal feeding temperatures (30°C) compared with higher (34°C) or lower (26°C) temperature conditions, and the highest rate of digestion occurred between 26.6 and 29.4°C (Dowling and Wiley, 1986). In Atlantic salmon (*Salmo salar*), a four-month study indicated feeding remained high over 0.2°C increments from 12°C up to 22°C (prior studies showed feeding rates decreasing starting around 16 to 18°C) (Ignatz et al., 2021). In redside dace, small increases of temperature (2°C) decreased appetite (Turko et al., 2020). Rainbow trout (*Oncorhynchus mykiss*) fed at optimal temperatures (15°C); at higher temperatures (19°C), there were negative effects to feed efficiency, even if given higher feed intake. The study also reported negative impacts on fatty acid bioconversion capacity in the higher temperature scenario (Mellery et al., 2016).

Impacts to the surrounding aquatic environment occur, as well. Ecosystem processes (e.g., respiration, organic matter decomposition) are sensitive to temperature changes in aquatic environments. Increases in river temperatures can harm coldwater habitat and disproportionally impact ectothermic organisms like fish or amphibians. For instance, salmonids (e.g., Pacific salmon, char) require continuous or patchy distributions of cold waters during migration to survive and reach their spawning habitat. These species are impacted by changes in thermal regimes resulting from hydrologic modifications and climate change (Fuller et al., 2022).

Scientists have observed impacts from large-scale changes in water temperature. In the UK, sea temperature increases rose 1°C over a period of two decades and had significant changes in the distribution of intertidal organisms. For instance, between the 1930s and 1950s, coldwater species declined in response to mean sea temperature increases as small as 0.5°C. Warming waters also saw the occurrence and spread of kelp (*Laminaria ochroleua*) and brown alga (*Zanardinia prototypus*). Further, changes in barnacle abundance were observed. In Monterey, California, summer temperature increases of 0.75°C over a period of 60 years saw significant increases of southern intertidal species and decreases in northern intertidal species abundance (Hiscock et al., 2004).

Global increases in water quality temperature are expected to impact aquatic life this century. Air temperatures are expected to increase between 2 – 5°C until 2100 (Brodersen et al., 2011). Sea temperatures, meanwhile, could increase up to 2.5°C higher in 2050 compared to 2000 (Hiscock et al., 2004). This can have impact on fish life histories. Investigations into juvenile roach (*Rutilus rutilus*) demonstrated that small increases in water temperatures of 2°C caused loss in fish biomass (Brodersen et al., 2011). Generally, rising temperatures will have higher impacts on marine species compared to freshwater species due to lower concentrations of DO. Increased precipitation in warming regions can negatively affect reproduction, growth, stock distribution, and survival of marine species. However, freshwater aquatic life will be more vulnerable to increasing environmental pollution. Metabolic rates in fish can increase 2-3 times for every 10°C increase in water temperature. Coldwater species (e.g., coho salmon) see increased immune responses and osmoregulatory impairment at temperatures as cold as 15°C. Even changes in warmer waters can be impactful: Nile tilapia had impacted immunoglobulins when waters were 33°C compared to 28°C (Mugwanya et al., 2022).

Fish have adapted to past temperature increases and employ techniques to avoid temperatures higher than their acclimation temperature (Dowling and Wiley, 1986). Thermal tolerance studies in redside dace showed considerable thermal tolerance. Body condition was also observed to a play a role in tolerance; however, the mechanism linking these attributes is unknown (Turko et al., 2020). A journal review explored intraspecific variation in warming tolerances of fish. In general, thermal tolerance varies across life stages and as fish mature. Phenotypic plasticity (the ability of individual genotypes to produce different phenotypes when exposed to different environmental conditions) may buffer species' sensitivity to negative impacts of temperature increases in their life span. Variations based on heritable genetic differences were explored, as well. These genetic variations underline local adaption and may help define long-term adaptability. There is clear evidence of local adaption of fish to increased temperatures, and there is limited evidence supporting hereditability (McKenzie et al., 2020).[20]

Based on the available literature exploring the change in temperature needed to observe impacts to aquatic life, we adopted 0.3°C as our allowance. We find there are no observed impacts when temperature increased by this amount or less, and therefore, such a change in value would still support aquatic life.

Sensor accuracy for temperature measurements

In addition to published literature, we also reviewed precision and accuracy of instruments used to record temperature in waters.

Modern water quality sondes have improved temperature sensor accuracy and precision such that current equipment are extraordinarily accurate. Field sondes accuracy varies, including from +/- 0.1°C (e.g., Hydrolab HL4) down to +/- 0.01°C between -5 and 35°C (e.g., YSI EXO2). This means that, as an example, a water quality sonde reporting 16°C temperature would

[20] For instance, the southern Atlantic killfish species have greater thermal tolerance than their northern populations in long-term thermal exposure tests. Further, differences exist in morphology, physiology, behavior, and life histories of sockeye salmons, which are attributed to local adaption.

indicate the true temperature of the water could be as accurate as 15.99°C to 16.01°C, or a range of 0.02°C.

The USGS investigates and studies instruments used to collect water quality data. In the latest revision of Techniques and Methods 9-A6.1, USGS explored the various options for measuring temperature, including liquid-in-glass field thermometers[21] and thermistor thermometers.[22] USGS notes that only calibration thermometers having current National Institute of Standards and Technology certification or traceability can be used to check accuracy of calibrating field thermometers. USGS recommends that liquid-in-glass thermometers have calibrated accuracy within 1% of full scale or 0.5°C, whichever is less. For thermistor thermometers, accuracy should be within 0.1 and 0.2°C (USGS, 2006).

USGS also evaluates specific field equipment. The agency previously evaluated the Xylem EXO Water Quality Sonde in 2015 to measure accuracy of these sondes (Snazelle, 2015), specifically exploring the accuracy of the EXO1 and EXO2 devices. The temperature and conductivity are on a single sensor, so calibration was for specific conductance at 22°C. Temperature readings were verified against a certified YSI 4500 digital thermometer calibrated to a +/- 0.015°C tolerance. Comparisons to EXO sondes were made with YSI 6920 equivalent sensors. Calibration criteria were set at +/- 0.2°C, with test acceptance criteria at +/- 0.4°C. Laboratory tests were conducted at 5, 15, 25, and 40°C. The maximum difference between EXO and YSI sondes was 0.11°C, with mean difference of 0.04°C. Additional field testing demonstrated that measurements between EXO sondes and a Hydrolab DataSonde 5X were well within the +/- 0.4°C testing criteria. Average temperature differences ranged between 0.04 and 0.05°C. Between the EXO and YSI sondes, average temperature differences ranged from 0.03 and 0.04°C (Snazelle, 2015).

The accuracy of these equipment provides confidence in studies exploring small changes in temperature, as discussed previously. Impacts to aquatic organisms were only seen outside of the error bands associated with common water quality instruments for temperature. If we had seen impacts to aquatic organisms within the error bands, then we would not have the required confidence to determine what temperature allowance would still be protective of aquatic life. However, as this is not the case, we adopted 0.3°C as our allowance.

Dissolved oxygen

We adopted the following at WAC 173-201A-200(1)(d) for fresh water dissolved oxygen:

> (i) When a water body's D.O. concentration is lower than the numeric criteria in Table 200 (1)(d) (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then local and regional sources of human-caused pollution considered cumulatively may not cause the D.O. concentration of that water body to decrease more than 10% or 0.2 mg/L below natural conditions, whichever decrease is smaller.

[21] Total immersion thermometers filled with a stable liquid (not mercury).
[22] Electrical device made of solid semiconductor with large temperature coefficient of resistivity.

We adopted the following at WAC 173-201A-210(1)(d) for marine water dissolved oxygen:

> (i) When a water body's D.O. concentration is lower than the numeric criteria in Table 210 (1)(d) (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then local and regional sources of human-caused pollution considered cumulatively may not cause the D.O. concentration of that water body to decrease more than 10% or 0.2 mg/L below natural conditions, whichever decrease is smaller.

Below we discuss the justifications for these changes.

EPA documents

EPA discussed insignificant impacts to DO in their approval of Washington's 2003 and 2006 WQS. EPA determined that 0.2 mg/L is within the error band associated with typical DO monitoring equipment. EPA stated that numerous factors impact oxygen levels in waters like lakes, and that without some allowance of insignificant decreases, the natural conditions criterion for DO would be "unnecessarily restrictive for the protection of designated uses". EPA concluded that 0.2 mg/L decrease from protective natural conditions criteria was insignificant (USEPA, 2007; Opalski, 2021).

Further, EPA noted in Section 3.B. *Species Assessed for Effects* of EPA's 2007 BE that evaluation of these criteria is limited to those species that could be affected by this action, directly or indirectly. EPA determined the following regarding Washington's 2003 and 2006 proposed DO criteria which included the *de minimis* DO value:

- Vegetation will not be affected. All nine plant species listed in Washington State are not affected by alterations of DO.
- Terrestrial animal species will not be exposed to altered DO effects.
- Similar to terrestrial mammals, impacts to bird species only occur through reduction in prey base. Two species, the bald eagle and marbled murrelet, are significant piscivores that could be affected by a reduction in prey base (mainly salmonids).
    - Three marine mammals (Stellar sea lions, humpback whales, and killer whales) also had the same route of exposure regarding reduction in prey base.
    - All five of these species were found to be NOT LIKELY TO BE ADVERSELY AFFECTED for all water quality provisions being approved by EPA.
- The one listed butterfly species does not use aquatic habitats during its life, so there is no effect.
- The southern sea otter was given a NO EFFECT determination as it does not consume prey species most affected by changes to the WQS (salmonids). It's prey mostly consists of invertebrates like sea urchins, clams, crabs, and mussels.
    - While this species was not considered in the BE, we recognize that the sea otter could be considered as its prey items are benthic invertebrates and the human action value applies to marine systems. Generally, areas near the sea floor and freshwater beds have lower DO compared to surface marine or freshwaters.

- The Eskimo curlew does not occur in the state at any point; thus, it received a NO EFFECT determination.
- Two turtle species prey on invertebrates, algae, seaweed, seagrass, and fish. Similar to the otter, these species were given a NO EFFECT determination due to not feeding on salmonids.
    - As with the otters, Washington recognizes that these species may need to be considered in any updates to the human action value.

Section 5.H.13 *Dissolved Oxygen Narrative Provisions – Allowable Decreases* of the 2007 BE discusses EPA's evaluation of the 0.2 mg/L value for human actions considered cumulatively when water bodies are identified as having naturally low DO. EPA determined that the approval of this provision is not likely to adversely affect the salmonid ESUs (and therefore, would not impact the listed species that feed on these species), stating:

> These provisions allow an insignificant decrease in the D.O. level from human activities when the natural condition criterion is the applicable criterion. Dissolved oxygen is a characteristic of a waterbody that can be affected by several different parameters such as temperature, physical characteristics (stream velocities, percent sediments, etc.), nutrients, sunlight, ammonia, etc. Because any oxygen demanding material or nutrient will negatively affect dissolved oxygen, meeting the "natural condition criterion" without allowing some insignificant decrease in dissolved oxygen would require dis-allowing any discharge of any pollutant that would affect dissolved oxygen. Absent such a provision as proposed by Washington, no oxygen demanding material would be allowed from human activities when the natural condition criteria are the applicable criterion. EPA believes that this is unnecessarily restrictive for the protection of designated uses, and would lead to unnecessary and costly expenditures. Additionally, 0.2 mg/L is within the monitoring measurement error for recording instruments typically used to monitor dissolved oxygen. In other words, this level of dissolved oxygen decrease is considered within the error band associated with typical dissolved oxygen monitors, therefore, EPA considers it insignificant. (USEPA, 2007)

EPA also briefly discussed natural conditions in their water quality release for 1986, known as the "Gold Book" (USEPA, 1986). For freshwater DO criteria, EPA noted that:

> Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable criteria means or minima or both, the minimum acceptable concentration is 90 percent of the natural concentration. These values are similar to those presented graphically by Doudoroff and Shumway (1970) and those calculated from Water Quality Criteria 1972 (NAS/NAE, 1973). Absolutely no anthropogenic dissolved oxygen depression in the potentially lethal area below the 1-day minima should be allowed unless special care is taken to ascertain the tolerance of resident species to low dissolved oxygen. (USEPA, 1986).

The one day minimum dissolved oxygen criteria values listed in this document (as instantaneous concentrations to be achieved at all times) were 8.0 mg/L for early life stages of coldwater species (and 4.0 mg/L for other life stages), and 5.0 mg/L for early life stages of warmwater species (and 3.0 mg/L for other life stages).

While this percentile criterion is for the biologically-based numeric dissolved oxygen criteria (and not designed for a human-use allowance value), it indicates that in natural waters, EPA recommended that for protection of aquatic life, there should be no more than a 10% decrease in dissolved oxygen from the applicable criteria.

USFWS Biological Opinion

In the 2008 BiOp for Washington's proposed 2003 and 2006 criteria adoption, the USFWS wrote that:

> Although the FWS agrees that the allowable decrease is insignificant, we do not have any reasonable assurances that the existing DO standard will provide adequate protection for bull trout. Therefore, we are unable to make a determination on the overall effect of approving this provision. If it is determined that the current DO standards are not providing adequate protection for native fish (i.e., adverse effects are occurring), the DO criterion may need to be increased to 11 mg/L for all water bodies that are used by native fish for spawning and rearing. (USFWS, 2008)

USFWS agreed that the 0.2 mg/L was insignificant; however, it does not provide any additional support regarding this determination. Most of discussion focused on the proposed freshwater biologically-based numeric criteria – that the 9.5 mg/L proposed may not be protective for bull trout – rather than the measurable change component (USFWS, 2008).

NMFS Biological Opinion

NMFS released their BiOp on Washington's adopted 2003 and 2006 WQS in 2008. This biological opinion does not discuss the measurable change component for DO or offer any support or issues with such an adoption by Washington. The BiOp did conclude that the "approval of the DO criteria in specific areas will not result in a measurable change in the baseline condition." They also noted that freshwater DO biological numeric criteria may need to be revised based on upcoming studies to determine whether 9.5 mg/L provide adequate protection for egg incubation and embryo development (NMFS, 2008).

Scientific literature

We reviewed published literature to ensure that the 10% or 0.2 mg/L, whichever decrease is smaller, allowance would not harm aquatic life or their designated uses. If insufficient data were available to derive protective criteria when just focusing on site- or state-specific studies, we expanded our scope in our review of science to ensure confidence that adopted criteria were sufficiently protective.

Changes in the DO levels of waters are common. Aquatic species are exposed to fluctuations in DO via biotic and abiotic factors, such as respiration, photosynthesis, decomposition, aeration, temperature, salinity, and atmospheric factors. Organisms that inhabit these waters have a diverse range of adaptions for resilience to these changes, including times when fish experience too little or too much DO (Ali, 2022).

Scientific studies exploring DO impacts to organisms typically focus on acute and chronic impacts to survival and growth (Ali, 2022). These studies report characteristics of interactions between aquatic life and their environment (e.g., median lethal concentration or LC50), and these factors are important when developing biologically based numeric criteria to ensure protection of aquatic life. However, determining an appropriate *de minimis* or insignificant human action value focuses less on what is the minimum DO requirement for species survival and growth, but rather in these natural condition scenarios how much can DO change (i.e., decrease) such that species are still protected. Protection of the species may be met because the change in DO is insignificant to the species or that the DO shift is significant (and potentially would have impact), but the species have adaptations that allow it to mitigate any possible DO impacts, retaining optical growth, reproduction, and survival rates.

These adaptions include tolerance variations in aquatic life to hypoxia, or low DO. Previous hypoxia tolerance studies suggest that fish with large genomes or body mass in marine systems would be the least tolerant to these conditions, and in general marine fishes are more susceptible to hypoxia than freshwater fishes (consistent with the greater fluctuations in oxygen and temperature in fresh waters; Verberk et al., 2022). In general, aquatic life success rates for avoidance of hypoxic and lethal concentrations of DO increase when higher oxygenated water is accessible (Dowling and Wiley, 1986). This can be due to adjustments in ventilation rates, cardiac activity, hemoglobin content, and oxygen binding to increase lamellar surface area (Breitburg et al., 2018).

Past research studies have explored DO impacts on aquatic life. One such study in New Zealand explored past work on native fish to determine protective aquatic life criteria in New Zealand waters. A review of previous acute studies showed that holding native fish in Zealand in 1 mg/L and 3 mg/L DO waters for 48 hours at 15°C saw 50% mortality after just over half an hour in both cases, while 50% mortality at 5 mg/L was observed at one hour. Other species, such as juvenile banded kokopu (*Galaxias fasciatus*), were more resilient, with 50% mortality in 1 mg/L DO concentrated waters not occurring until 8 hours. Some species can withstand these hypoxic waters for longer, but eventually need higher oxygenated waters for survival: juvenile torrentfish (*Cheimarrichthys fosteri*) showed no mortality at 24 hours, but 100% mortality at 48 hours.

Chronic studies, meanwhile, indicate that some species exhibit behavioral changes at much higher concentrations. Rainbow trout were observed to have reduced swimming speeds in waters at 5.7 mg/L DO compared to normoxic (i.e., 9.5 mg/L DO) conditions. Large mouth bass experienced similar reductions in swimming speeds with significant changes in small (<1 mg/L) decreases in DO (Dowling and Wiley, 1986). In brown trout species, alevins subjected to embryonic hypoxia (3 mg/L DO) during development had delayed gravel emergence, reduced swimming activity, and greater predation mortality compared to those developed under higher

DO conditions (Franklin, 2013). Egg reduction impacts were also observed in fathead minnow species when waters were 2.0 mg/L for DO, and no spawning occurred at 1.0 mg/L (Dowling and Wiley, 1986).

In EPA's CWA Section 304(a) recommendations for DO in marine waters from Cape Cod to Cape Hatteras, the document identified sensitivity of certain species in low DO conditions. Spot (*Leiostomus xanthurus*) had a lethal concentration 5% (LC5) at 0.81 mg/L, but LC50 occurred at 0.7 mg/L – a difference of just 0.11 mg/L. Even chronic effects were observed in relatively small decreases in DO. Atlantic silverside, for example, saw no mortality or growth reductions at 4.8 mg/L. When DO was reduced 0.9 mg/L, mortality of these species reached 40%, and a 24% reduction in growth was observed. Further, the mysid (during 10-day duration studies) saw no observed effects at 2.4 mg/L, but effects at 1.6 mg/L (USEPA, 2000).

Globally, climate change impacts aquatic life despite relatively small percentage drops in global dissolved oxygen concentrations. Global DO levels have decreased by around 2% within the past five decades with impacts on local and basin scale habitats. In Washington, the highest marine DO criterion is 7.0 mg/L (WAC 173-201A-210(1)(d)); a 2% decrease would be equivalent to 0.14 mg/L at this concentration. There are regional trends, with most deoxygenation occurring in the north Pacific and Southern Oceans. In coastal systems, DO changes occur through regional physical, biogeochemical, and anthropogenic changes (e.g., run off from nutrients, deposits of organic matter). Increases in global temperatures reduces oxygen solubility in surface waters, which in turn reducing the initial amount of subducted and convected oxygen (Garcia-Soto et al., 2021). There are also increases in chlorophyll *a* in surface waters and increased detritus, both which lead to a decline in available DO (Kim et al., 2022). A 50% oxygen loss due to climate change impacts the upper 1000 meters of oceans due to solubility changes, with reported decreases ranging between 0.07 mg/L to 0.13 mg/L (Garcia-Soto et al., 2021).

Additional studies have measured global decline of DO from the 1970s to 1990s of around 0.03 mg/L for water depths between 100 to 1000 meters. The highest decreases were seen in bottom waters (greater than 2000 meters) in the East / Japan Sea, which experienced a 0.15 mg/L decrease per decade from 1961 to 2001 (Kim et al., 2022). In the central California current region of the Pacific Ocean, DO decreased on average 0.06 mg/L per year between 1998 and 2013, which translates to a 40% decline from initial concentrations. Observations were taken from cores between 100 – 400 meters deep at locations 130 and 240 kilometers offshore (Ren et al., 2017).

Future projections suggest that the end of the 21st century could see declines between 4-7%, suggesting a potential for global warming to drive the deep ocean to anoxic conditions. Long-term modeling predicts a decline of DO in most of the subsurface ocean, with the lowest concentrations generally found in the thermocline due to high consumption of oxygen that occurs between the base of the euphotic zone and about 2000 meters due to remineralization of sinking particulate organic matter. For comparison, a 4-7% decrease in DO represents a 0.16–0.28 mg/L shift at 4.0 mg/L DO concentration and a 0.28-0.49 mg/L shift at 7.0 mg/L DO concentration, which represent the range of Washington's numeric DO criteria values (Matear and Hirst, 2003). Additional studies using Chesapeake Bay indicated hypoxic and anoxic

volumes in marine waters would increase by 10-30% between the late 20th and mid-21st century. Decreased solubility due to warming accounts for around 50% of the reduction in benthic DO concentrations, and these decreases in estuarine systems are occurring faster compared to open ocean environments (Ni et al., 2019).

Shifts in DO concentration affect marine ecosystems. In Hood Canal, scientists observed negative (strong) associations between bacterial richness and DO, with significant changes in the bacterial community occurring between 5.18 mg/L and 7.12 mg/L DO. Sublethal effects occurred generally below 2.61 +/- 0.17 mg/L. This suggests that changes in bacterial community may precede effects on ecologically and economically important macrofauna (Spietz et al., 2015). Further, in the eastern tropical North Pacific, despite their hypoxia tolerance, many zooplankton species live near their physiological limits and respond to slight (<1%) changes in oxygen. These responses are occurring at low (0.16 mg/L and 0.26 mg/L) oxygen concentrations, where even a small decrease (~0.06 mg/L) in DO sees shifts in zooplankton abundance. Further DO decreases between 100- and 1000-meters depth may cause major changes in midwater ecosystem structure and function (Wishner et al., 2018).

It's important to note that studies observing impacts with small decreases in DO generally occur when DO is already low in concentration, including at concentrations that represent hypoxic conditions and where fish start to exhibit acute mortality. These impacts are more prevalent typically in benthic or deep waters. Studies looking at impacts to aquatic organisms when exposed to small decreases at higher, perhaps natural condition levels, of DO (i.e., not hypoxic or anoxic waters) are limited. At these levels, a 0.2 mg/L decrease seems to be considered insignificant and not causing issues at DO concentrations. Where 0.2 mg/L becomes problematic (and therefore, impactful to aquatic life species) is in mid- to deep-water oceans at hypoxic DO levels (<2 mg/L).

Based on the available literature, we adopted criteria that uses 10% or 0.2 mg/L, whichever decrease is smaller. For waters with DO concentrations at or above 2.0 mg/L, we find no observed impacts when DO decreased by 0.2 mg/L or less, and therefore, such a change in value would still support aquatic life. However, for waters with DO concentrations below 2.0 mg/L, we see that a 0.2 mg/L decrease in DO would possibly cause impact to aquatic life organisms, such as to zooplankton. Therefore, we adopted rule language to set 10% of the natural condition value to be the allowable decrease in order to provide aquatic life protection. For instance, if natural condition criteria for a site was determined to be 1.0 mg/L, then the allowance would be 0.1 mg/L. Based on the available science and EPA's past considerations for freshwater dissolved oxygen criteria, a 10% drop from natural conditions for dissolved oxygen concentrations would still support aquatic life.

Sensor accuracy for dissolved oxygen measurements

In addition to published literature, we also reviewed precision and accuracy of instruments used to record DO in waters.

Modern water quality sondes have improved over time DO sensor accuracy and precision such that current equipment are extraordinarily accurate. For instance, field sondes (e.g., YSI's EXO series) are precise to +/- 0.1 mg/L or 1% of the reading, whichever is greater, between 0 and 20

mg/L. In Washington, generally the +/- 0.1 mg/L would be the greater value when natural conditions criteria are used, and therefore, be the limit for accuracy. This means that, as an example, a water quality sonde reporting 6.5 mg/L DO concentration would indicate the true DO concentration is between 6.4 mg/L and 6.6 mg/L, or a range of 0.2 mg/L. Manufacturers for intelligent DO sensor products also have this level of accuracy for DO measurements. For instance, the Sea-Bird Scientific SBE 63 reports accuracy to 0.1 mg/L and the WTW 700 IQ FDO is accurate to within 0.05 mg/L. Further, WTW's TriOxmatic 702 IQ can resolve DO to 0.01 mg/L or even lower.

The USGS investigates and studies instruments used to collect water quality data. In the latest 2020 revision of *Techniques and Methods 9-A6.2*, USGS explored the various options for measuring DO, including luminescence-based (optical) sensors[23] and spectrophotometric (colorimetric) instrumental methods.[24] USGS notes that the iodometric (Winkler) method, which was previously regarded as an accurate and precise method for calibrating DO sensors and determination of DO concentrations in laboratory conditions, are no longer sanctioned for use by USGS. USGS recommends that the optical DO instruments should have calibrated accuracy of +/- 0.1 mg/L DO (USGS, 2020).

USGS also evaluates specific field equipment. They previously evaluated the Xylem EXO Water Quality Sonde in 2015 to measure accuracy of these sondes (Snazelle, 2015), specifically exploring the accuracy of the EXO1 and EXO2 devices. In this study, DO sensors were calibrated with a single DO concentration at 100% in air-saturated water at 21°C. Comparisons to EXO sondes were made with YSI 6920 equivalent sensors. Calibration criteria were set at +/- 0.3 mg/L DO, with test acceptance criteria at +/- 0.6 mg/L DO. Laboratory bench testing showed that the EXO sondes performed similarly to the YSI 6-series sensors. The max difference between the two sondes was 0.34 mg/L with an average difference of 0.02 mg/L. These sensors were tested at 0, 2.33, 9.17, and 13.18 mg/L DO concentrations. USGS notes that sensor measurements were precise with an average difference of 0.01 mg/L between the replicates. The maximum difference of the three sensors in four different DO concentrations was 0.27 mg/L with an average of 0.1 mg/L. All sensors met the 0.3 mg/L USGS criteria and 1% manufacturing specifications when the titration uncertainty was considered (0.06 mg/L; Snazelle, 2015).

Additional field testing demonstrated that the average difference between EXO1 and YSI 6920 sondes was 0.02 mg/L, and the average difference between the EXO2 and YSI 6920 sondes was 0.12 mg/L. There was also a 0.14 mg/L difference between the EXO1 and Hydrolab DataSonde 5x, and there was a 0.27 mg/L difference between the EXO2 and Hydrolab DataSonde 5x (Snazelle, 2015).

The accuracy of these equipment provides confidence in studies exploring small changes in DO, as discussed previously.

[23] Thes primary field procedure for USGS and applicable to nearly all aqueous environmental conditions.
[24] These methods yield consistent results when applied to oxygen-depleted waters.

Lake criteria

We are adopting no changes to the natural conditions criteria for lake-class systems.

Lake temperature and lake DO criteria were previously adopted by Washington and approved by EPA. In addition, during EPA's 2021 reconsideration of our natural conditions provisions, EPA stated that these narrative criteria are the applicable temperature and DO criteria for lakes in Washington. By leaving these criteria approved for CWA purposes, it ensures aquatic life criteria for these parameters remain in effect. Thus, EPA's reconsideration for these criteria resulted in taking no action with respect to its prior 2008 approval of these criteria (Opalski, 2021).

We agree with EPA's prior approval decision of these criteria, including their justifications that such criteria were protective of designated uses and scientifically defensible (Opalski, 2021). Further, these criteria generally align with human allowance values adopted in this rulemaking for temperature and DO in fresh and marine waters. Therefore, we adopted no changes or updates to these lake criteria.

Updates to site-specific criteria

We adopted updates to the language in our site-specific criteria application at WAC 173-201-430 to allow the use of additional options for scientifically justifiable approaches to site-specific criteria development:

> (1) Where the existing and designated uses for the water body would be fully protected using an alternative criterion, site-specific criteria may be adopted.
>
> (a) The site-specific criterion must be consistent with the federal regulations on protecting uses (currently 40 C.F.R. 131.11); and
>
> (b) The decision to approve a site-specific criterion must be subject to a public involvement and intergovernmental coordination process.
>
> (2) The site-specific analyses for the development of a new water quality criterion must be conducted in a manner that is scientifically justifiable and consistent with 40 C.F.R. 131.11; and conducted in accordance with the procedures established in the "Water Quality Standards Handbook," EPA 2023, as revised.
>
> (3) The decision to approve the site-specific criterion must be based on a demonstration that it will protect the existing and designated designated uses of the water body.

In addition, we adopted minor updates to recognize that the current version of the WQS Handbook that describes the procedures for establishing site-specific criteria was last updated in 2023. We also clarified language that site-specific criteria protect existing and designated uses, that site-specific criteria are consistent with regulations for protecting uses, and that such criteria are not based on attainable conditions but rather for protection of existing and designated uses.

Alignment with federal regulations and comparison to previous criteria

Under the CWA and federal regulations at 40 CFR § 131.11, states and Tribes must adopt water quality criteria that protect designated uses. In adopting these criteria, states and Tribes establish numerical criteria values based on:

- CWA Section 304(a) recommended criteria,
- Modified CWA Section 304(a) recommended criteria that reflect site-specific considerations, or
- Other scientifically defensible methods.

If states and authorized Tribes adopt criteria based on other scientifically defensible methods, the criteria must:

- Be based on sound scientific rationale,
- Contain sufficient parameters or constituents to protect the designated use or uses of the waters, and
- Support the most sensitive designated use of the waterbody.

Previously, we had to conduct site-specific criteria following the assumptions and rationale in EPA's 1985 guidelines (Stephen et al., 1985). This document provides procedures for development of aquatic life criteria through use of information regarding toxicity to and bioaccumulation by aquatic organisms. This typically results in biologically-based aquatic life criteria protective of the designated aquatic life uses in a waterbody. However, this document does not discuss the process for using the natural condition of a waterbody to set site-specific protective aquatic life criteria. EPA's policy asserts states and Tribes can do so if recommendations are met (Davies, 1997). Therefore, if we did not update our site-specific rule language, then we could not develop site-specific natural conditions criteria using WAC 173-201A-430. The adopted updates to our site-specific criteria rule language allows us to consider all possible development options available in the federal regulations for site-specific criteria updates.

Performance-based approach

We adopted a new section in Washington's WQS that allows for the use of a performance-based approach when developing site-specific natural conditions criteria for aquatic life. The use of such an approach would differ from site-specific criteria development (WAC 173-201A-430) in that criteria values developed using this approach are applicable to the waterbody immediately following the process. The adopted rule language at WAC 173-201A-470:

> The performance-based approach may be used to establish numeric criteria based on natural conditions that are fully protective of existing and designated aquatic life uses.

(1) Aquatic life water quality criteria must be derived using the procedures referenced in Ecology publication 25-10-001, "A Performance-Based Approach for Developing Site-Specific Natural Conditions Criteria for Aquatic Life in Washington".

(2) Application of the performance-based approach for establishing aquatic life water quality criteria is limited to the following listed water quality constituents:

(a) Aquatic life temperature criteria in fresh water;

(b) Aquatic life dissolved oxygen criteria in fresh water;

(c) Aquatic life pH criteria in fresh water;

(d) Aquatic life temperature criteria in marine water;

(e) Aquatic life dissolved oxygen criteria in marine water.

(3) Aquatic life water quality criteria developed using this approach are applicable to the water body upon derivation.

(4) If the requirements set forth in the performance-based approach cannot be met, then site-specific criteria can be established by following the alternatives listed at WAC 173-201A-260(1)(a)(i).

To supplement this section, we propose a separate rule document (Performance Based Approach Document - Ecology publication 25-10-001 that provides details and requirements of the performance-based approach. This document provides an approach to developing protective site-specific criteria based on the natural conditions of a waterbody. We are proposing that this performance-based approach be limited to dissolved oxygen criteria (fresh water and marine water), temperature (fresh water and marine water), and pH (fresh water only).

We proposed an approach which characterizes natural conditions through approaches such as a water quality model that simulate the parameter of interest under natural conditions. This is then investigated to determine similarity to observed dynamics in the system. This approach allows quantification of effects to a site of interest from both human sources and natural sources. Recommended use for this approach includes when there are indications that nonattainment of water quality criteria is due, in part, to natural processes.

The performance-based approach must be scientifically defensible and repeatable (USEPA, 2015). However, Ecology recognizes that unique characteristics of waterbodies may result in different, yet still firm scientifically, approaches taken to calculate natural conditions. Our proposed performance-based approach balances these items by providing project requirements (e.g., QAPP, model, elements) while also leaving details of such requirements within the projects themselves (e.g., model precision, amount of undisturbed vegetation of a stream). Every use of the performance-based approach must have a report detailing the evaluation, data usage, and criteria calculations. This report follows alongside the natural conditions criteria for subsequent use in any state or federal CWA action. This includes during public involvement, such as during draft TMDLs.

The performance-based approach document is still in draft form, as we recognize that additional work is needed in the document before it is finalized. We anticipate going back out to the public for review of our next draft in Spring 2025. Please see the earlier section "Finalization of the Performance-Based Approach Document" for further details and information.

Federal Guidance documents and recommendations

Washington is likely one of the first, if not first, states to consider a performance-based approach for natural conditions in the United States. Regarding natural conditions, EPA has only publicly released recommendations in a 1997 natural conditions memo (Davies, 1997) for general inclusion of natural conditions in WQS, and additional recommendations for a performance-based approach framework in 2015 (USEPA, 2015). EPA has also provided Ecology with a draft, deliberative, staff-level guidance document providing recommendations for elements to include in the approach for the performance-based approach (USEPA, 2023). In addition to these documents, we worked closely during this rulemaking with the Environmental Assessment Program (EAP) at Ecology, who are responsible for measuring, assessing, and communicating environmental conditions in Washington. This includes developing and using water quality and environmental models as tools for water quality improvement.

Determining nonattainment is due to natural processes

The performance-based approach requires certain elements that must be evaluated and documented during the development of natural conditions criteria. For this approach, these elements are used to understand and determine the effect of natural conditions. These elements reflect requirements by Ecology staff to produce scientifically sound water quality models, and these elements have been used in past TMDL work at Ecology. Due to inherent differences between the systems, elements are split between fresh water and marine water. Appendix B provides additional information for each element. Specific support for these evaluations is project-specific; however, examples are provided in the performance-based approach document (Ecology publication 25-10-001) that mirror EPA's recommendations. This includes GIS maps, relevant federal and state records, cultural histories, use of reference sites, and water quality data (USEPA, 2015).

Data collection, usage, and site evaluation

The document provides data usage requirements. Per EPA's recommendations, all existing, readily available, and credible water quality data for the site of interest and for waters that affect the site of interest must be considered (USEPA, 2023). Readily available data may be sourced from water quality databases such as the Water Quality Portal or Environmental Information Management System (EIMS) database,[25] other state or federal water quality data portals, or published data from reputable research journals. Credible water quality data are

[25] https://ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database

defined by Washington's Water Quality Data Act in RCW 90.48.585 and discussed in Water Quality Policy 1-11 Chapter 2, Ecology publication 21-10-032.

Waters that affect the site of interest may include upstream waters (e.g., tributaries), oceanic inputs, and waters outside the jurisdiction of the state of Washington (e.g., waters from another state or country). Additional data to characterize the site of interest outside the parameter of interest may need to be considered (e.g., salinity, flow, precipitation, ambient air temperature) to demonstrate that nonattainment of an aquatic life criterion is due to natural causes. Any such data must abide by the credible data requirements. For the approach, any data gaps must be identified, and if these gaps are filled (e.g., through estimation) or any data are estimated for the project, the process must be documented and defended using best professional and scientific judgement.

The extent of the site must be defined and documented. This will be project-specific, ranging from a specific portion of a surface water to an entire watershed. We propose requirements that if grouping sites for a single natural condition criterion value, then such grouping must be appropriate, have a firm scientific basis, and any developed criteria are protective of all designated uses. This reflects recommendations from EPA (USEPA, 2015; USEPA, 2023).

Calculating protective criteria

The document provides detail on determining appropriate and protective natural conditions criteria values. Criteria have three components: magnitude, duration, and frequency. Duration and frequency for natural conditions criteria must be consistent and match the applicable biologically-based aquatic life criterion.[26]

For magnitude calculations, the approach will generally use water quality models to estimate natural conditions, and model requirements are provided in the rule document. These requirements focus on model reproducibility, peer review, and high levels of documentation. These model requirements are based on Ecology staff recommendations from staff that work on water quality models, as well as EPA recommendations (USEPA, 2023). Best practices for environmental model development, evaluation, and application are also found in EPA guidance published by the Council for Regulatory Environmental Modeling (USEPA, 2009).

The approach also requires all human-caused impacts to be accounted when determining natural conditions. It provides allowance for different approaches in calculating these impacts, as frequency or resolution requirements of extra-jurisdictional or climate change data may not meet project requirements. However, inclusion of these data is required as they consist of "all existing, readily available, and credible data", and removal of these sources of pollution is necessary to calculate the natural conditions of a system (USEPA, 2023).

[26] For example, if calculating a freshwater natural conditions value for temperature, the duration should be 7-DADMax and frequency no more than one exceedance in a 10-year period, which reflects numeric temperature freshwater criteria at WAC 173-201A-200(1)(c).

Documentation and use

Once the natural conditions criteria are developed, the determined values are applicable for federal CWA actions (e.g., water quality assessment, TMDLs) without further WQS rulemaking. The evaluation, analyses, and decision points used must be documented in a report and provided alongside the calculated criteria (USEPA, 2023).

For the approach, a project QAPP is required. The QAPP will contain data quality objectives and measurement quality objectives. The QAPP will also contain information regarding model calibration and validation such that the output of the model could be used to inform the selection of appropriate natural conditions criteria. Required project QAPP elements reflect past programmatic QAPPs produced by Ecology and EPA guidance (USEPA, 2023).

Alternatives considered

Ecology explored alternative approaches for natural conditions criteria prior to proposing and adopting the natural conditions criteria in this rulemaking. Below are different options considered by Ecology and reasons why these approaches were not chosen for updating the natural conditions provisions.

Updating natural conditions definitions

We considered if updates were needed to the definition of natural conditions in the WQS at WAC 173-201A-020. This included whether to introduce a separate definition for "background sources", which could be defined to include sources of pollution that Washington does not have the authority to regulate, such as polluting from another state. We determined that such updates were not necessary to have effective natural conditions criteria. Further, the definition of natural conditions in the WQS meet EPA's recommendations for defining natural background (Davies, 1997). In addition, these criteria were previously approved by EPA and remain in effect for CWA purposes.

Updating lake temperature and dissolved oxygen criteria

We considered making updates to the lake temperature and dissolved oxygen criteria. However, we determined that updates were not necessary. The criteria for these parameters in lakes were previously approved in past WQS rule submittals to EPA. Further, EPA's 2021 considerations of our natural conditions criteria reiterated that these criteria are protective of designated uses and scientifically defensible; therefore, these provisions remained in effect for CWA purposes (Opalski, 2021). No changes to these provisions are adopted in this rulemaking.

Human allowance alternatives

We explored various iterations of adopting the human allowance in combination with the presence or absence of the general provision and pH criteria.

Human allowance only – no general provision

The human use allowance absent a general provision would require that we authorize these insignificant exceedances to occur respective to applicable numeric criteria that are already approved for CWA actions (e.g., Table -200(1)(c)). In effect, this approach would tie these human allowance provisions with an approved WQS and therefore, we believe, could receive EPA approval.

However, we chose not to pursue this option as it would not allow developed natural conditions that are in effect for federal CWA actions to be the applicable aquatic life criteria for these parameters: the biologically-based numeric criteria would be the applicable criteria for those waters. Historical use of natural conditions criteria in our state, through actions such as TMDLs and WQA listing decisions, indicate that there are waterbodies in Washington that, at certain times of the year and due to natural causes, cannot meet the biologically based numeric criteria. This is despite the fact that naturally these waters offer protection for all designated and existing uses, including for the most sensitive species. We concluded that updating our general provision allowing natural conditions to be the applicable aquatic life criteria was necessary for us to implement our WQS effectively in our CWA actions, and therefore did not pursue this approach.

Human allowance with general provision

This approach would allow us to authorize insignificant exceedances to occur when developed natural conditions in effect for a waterbody are the applicable criteria. These allowances, combined with a narrowly tailored general provision limiting use to aquatic life criteria, could receive EPA approval.

However, we chose not to pursue this option due to the constraints it could place on the Department. Per EPA's recommendations for setting criteria equal to natural conditions, there should be a binding procedure for determining natural background (Davies, 1997). If we chose to only adopt the human use allowance and natural condition general provision, then one applicable binding procedure would be the site-specific criteria at WAC 173-201A-430. Any natural conditions criteria developed using this process would not go into effect until incorporated into WAC 173-201A and approved by EPA through rulemaking (WAC 173-201A-430(4)). This could require a site-specific criteria rulemaking every time for every new natural condition criterion value for state or federal CWA actions. This process would require further EPA approval and, if endangered species or critical habitat are present in the system, possible consultation with the Services. Only once such site-specific criteria are approved could they be used in additional CWA actions, such as WQA category determination or a TMDL. We estimated that this approach would not be time efficient nor practical to pursue.

Human allowance for pH

Washington's WQS do not provide for human allowances of insignificant degradation outside of the pH criteria ranges for fresh and marine waters. The criteria do allow for human-caused variation, however, within the ranges. For instance, *Excellent quality* marine waters have pH criteria for the range of 7.0 and 8.5 units (expressed as the negative logarithm of the hydrogen

ion concentration), with a human-caused variation within that range of less than 0.5 units (WAC 173-201A-210(1)(f)).

We explored whether insignificant exceedances of the criteria outside of these ranges would be possible when the natural pH of the waterbody is not meeting the applicable pH criteria. We chose not to pursue adopting such criteria into the WQS, however, due to concerns that exceedances of pH, even small, outside of these pH criteria ranges would not offer protection for aquatic life. Many organisms are sensitive to small changes in pH, either directly or indirectly. Processes such as respiration, calcification, photosynthesis, and reproduction can all be impacted by small changes in seawater pH, for instance. Further, the logarithmic scale of pH skews the magnitude of change when small deviations from pH occurs. A decrease of pH by 0.1 units, as an example, represents a 26% increase in the relative acidity of the water. In addition, common water quality sondes used in pH measurements may only be accurate to +/- 0.2 units, which is above Ecology's measurable change definition for pH and represents significant changes to the acidity of the system. Thus, we chose not to adopt new human allowances for pH when natural conditions constitute the criteria.

Natural condition general provision only

We considered whether to adopt only an updated natural condition general provision in this rulemaking. We chose not to pursue this approach for a few reasons.

First, if only this provision were adopted, then the primary applicable binding procedure would be the site-specific criteria at WAC 173-201A-430. Any natural condition site-specific criteria developed through this process would not go into effect until incorporated into chapter 173-201A WAC and approved by EPA through rulemaking (WAC 173-201A-430(4)). This would require us to go through site-specific rulemaking every time we want or need to use a new natural condition criterion value for state or federal CWA actions. That would require further EPA approval and, if endangered species or critical habitat are present in the system, possible consultation with the Services. Only once such site-specific criteria are approved could they be used in additional CWA actions, such as WQA category determination or a TMDL. We estimated that this approach would not be time efficient nor practical to pursue.

Second, absent a human allowance provision, when developed natural conditions in effect for federal CWA actions constitute the applicable aquatic life criteria, then no human actions may cause degradation of water quality, regardless of whether such actions would be considered insignificant. We agree with EPA's conclusion in their 2007 BE that this would be unnecessarily restrictive for protection of salmonid uses and would lead to unnecessary costly expenditures (USEPA, 2007).

Performance-based approach alternatives

We considered a few alternatives regarding our proposal of a performance-based approach in the Standards.

No performance-based approach

This is the same as only pursuing a general provision in that the applicable binding procedure would likely be the site-specific criteria at WAC 173-201A-430. Any natural condition site-specific criteria developed would not go into effect until incorporated into WAC 173-201A and approved by EPA through rulemaking (WAC 173-201A-430(4)). This would require us to go through site-specific rulemaking every time we want or need to use a new natural condition criterion value for state or federal CWA actions. That would require further EPA approval and, if endangered species or critical habitat are present in the system, possible consultation with the Services. Only once such site-specific criteria are approved could they be used in additional CWA actions, such as WQA category determination or a TMDL. We estimated that this approach would not be time efficient nor practical to pursue.

Performance-based approach for marine pH water quality parameter

We considered whether to allow for the performance-based approach to be applied for determining natural conditions for pH in marine water; however, we decided not to propose this in our performance-based approach rulemaking document.

We recognize that EPA's 2015 framework document does not preclude the use of pH in marine waters (USEPA, 2015). We also agree with EPA's statements in the 2007 BE that natural conditions are "fully protective of salmonid uses, even if the natural conditions are higher than the numeric criteria for some waterbodies, because the pollutant level prior to human impacts clearly support healthy salmonid populations" (USEPA, 2007). However, during the development of the rule, there were concerns that such criteria, even if naturally caused, might not support propagation or protection of aquatic life. In *Fair quality* designated waters, for instance, for natural conditions to be the applicable aquatic life criteria, the pH would need to be naturally below 6.5 units or above 9.0 units; these are conditions that would be toxic for many fish species (Fromm, 1980; Morris et al., 1989; Robertson-Bryan, Inc., 2004; Kleinhappel et al., 2019). In addition, we have not developed marine pH TMDLs in the past that have used natural conditions as a basis for the applicable aquatic life criteria. These reasons led us to decide that such inclusion in the performance-based approach would be unnecessary and might not be approvable by EPA, whether due to EPA's determination or opinions from the Services (or both).

This exclusion, however, does not preclude the development of natural conditions pH criteria for marine waters. Such site-specific criteria development would need to follow alternative approaches for criteria development, such as site-specific criteria at WAC 173-201A-430.

No updates to natural conditions criteria

We considered whether to not update our natural conditions criteria and instead remove those disapproved portions from our WQS. We chose not to pursue this option for a few reasons.

First, absent natural condition provisions in our WQS, the biologically-based numeric criteria would be the applicable criteria for waters. Ecology's historical use of natural conditions criteria in our state, through actions such as TMDLs and WQA listing decisions, indicate that there are

waterbodies in Washington that, at certain times of the year and due to natural causes, do not meet the biologically-based numeric criteria. This is despite the fact that naturally these waters offer protection for all designated and existing uses, including for the most sensitive species. Therefore, without natural conditions criteria, there could be waterbodies that naturally are offering protection to aquatic life but would need to be listed as impaired in our CWA Section 303(d) submittals. This would actively contradict RCW 90.48.570, which states that "it is the intent of the legislature that a water body in which pollutant loadings from naturally occurring conditions are the sole cause of a violation of applicable surface water quality standards not be listed as impaired."

Second, if we made no updates to our natural conditions criteria, we would have no human allowance provisions. Absent a human allowance provision, when developed natural conditions in effect for federal CWA actions constitute the applicable aquatic life criteria, no human actions could cause degradation of water quality, regardless of whether such actions would be considered insignificant. We agree with EPA's conclusion in the 2007 BE that this would be unnecessarily restrictive for protection of salmonid uses and would lead to unnecessary costly expenditures (USEPA, 2007).

Thus, we determined that updates to the natural conditions criteria in Washington's WQS were needed to best implement state and federal requirements for the protection of designated and existing uses for aquatic life in state waters.

Conclusions

The work presented in this document represent the updates to natural conditions criteria to be consistent with Clean Water Act recommendations as well as protection levels needed for aquatic life in Washington.

Appendix A provides a copy of draft, deliberative, staff-level recommendations from EPA to Washington Department of Ecology to consider when developing the performance-based approach for dissolved oxygen (fresh and marine waters), temperature (fresh and marine waters), and pH (fresh waters only).

Appendix B is an internal document used to guide development of the performance-based approach document. It lists descriptions of elements to consider (alongside descriptions) when pursuing the site-specific criteria development of natural conditions using the performance-based approach.

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Appendix A: EPA Water Quality Standards Program Recommendations for Performance-Based Approach for Natural Conditions

Introduction

The text below represents an unedited version of staff-level, draft, deliberative recommendations for a performance-based approach for consideration by Ecology from EPA.

EPA Water Quality Standards Program Recommendations for Performance-Based Approach for Natural Conditions (DO, Temperature, Freshwater pH) Required Elements

Disclaimer: This document represents a staff-level draft-deliberative work product highlighting recommendations for consideration by WA Department of Ecology when developing performance-based approaches for deriving temperature and dissolved oxygen (and pH for freshwater, only) site-specific criteria based on natural conditions.

Caveats and Considerations:

- The following "Outline of Essential Components" are offered as an initial scoping concept template to assist WA State in developing a performance-based (P-B) approach for deriving temperature and dissolved oxygen (and freshwater pH if WA State chooses to develop it) site-specific criteria based on natural conditions. EPA anticipates that the development process may identify additional elements or associated details to be included in the approach.
- The components are generic to all waterbody types. It may be necessary to add more detailed requirements specific to different waterbody types.
- EPA recommends that these components be included in rule,[27] while additional implementation procedures may be included in guidance.
- The components are to be included when WA State estimates the natural condition through modeling, either through process-based models or statistical models. For other approaches, please refer to EPA's *A Framework for Defining and Documenting Natural Conditions for Development of Site-Specific Natural Background Aquatic Life Criteria for Temperature, Dissolved Oxygen, and pH: Interim Document* (2015), EPA 820-R-15-001.

[27] "A performance-based approach relies on adoption of a process (i.e., a criterion derivation methodology) rather than a specific outcome (i.e., concentration limit for a pollutant) consistent with 40 CFR § 131.11 & 131.13. When such a "performance-based" approach is sufficiently detailed and has suitable safeguards to ensure predictable, repeatable outcomes, EPA approval of such an approach can also serve as approval of the outcomes as well. If a particular State or Tribe's approach is not sufficiently detailed or lacks appropriate safeguards, then EPA review of a specific outcome is still necessary." EPA 2000. EPA Review and Approval of State and Tribal Water Quality Standards. 65 FR 24641 Page: 24648.

Consistent with EPA 2015, only freshwater and marine DO and temperature, and freshwater pH criteria are covered in this outline.

- If a "Human Use Allowance" de minimis provision for DO and temperature is included in the rule, WA State should provide information in rule detailing whether and how the HUA would be applied. The State should describe how/whether such provisions interact with a P-B approach.
- The spatial and temporal scope of application of the P-B approach must ensure full designated and existing use protection. Outside of the timeframes and locations to which the P-B approach criteria are applicable, the Biologically Based Numeric Criteria (BBNC) must apply, unless there is a rationale for extending the time period that protects the designated uses (DUs).
- If the P-B approach cannot be followed in its entirety for a specific water body, WA State must either apply the Clean Water Act-effective BBNC or establish an individual site-specific criterion (SSC). The SSC must be submitted to EPA for review and action under Clean Water Act section 303(c).
- The derivation procedure should be included in rule text and/or incorporated by reference.
- Any updates to the P-B approach rule language must go through the State's rulemaking process and require EPA 303(c) review and action.
- This document contains preliminary staff-level recommendations for the Washington State Department of Ecology (Ecology) WQS program. These preliminary recommendations are provided for Ecology's consideration and should not be interpreted as binding requirements or as establishing Agency guidance for Washington or any other state or tribe.

Performance-based approach (P-B Approach): Outline of essential components

1.0 Definitions and scope

- Terms to Define
    - Performance-based approach
        - The definition must be consistent with EPA's 2015 Interim Framework (EPA 2015) and *EPA Review and Approval of State and Tribal WQS*.[28]
    - Natural conditions
        - The definition of natural conditions must exclude all anthropogenic sources. This will ensure that the natural conditions criteria will not reflect anthropogenic impacts that contribute to a pollutant

[28] *EPA Review and Approval of State and Tribal Water Quality Standards,* 65 Fed. Reg. 24641 (Apr. 27, 2000).

concentration or load, including but not limited to land use, population, and climate-related anthropogenic impacts.

- General elements and requirements for WQS applications
    - A narrative criterion statement (for each pollutant) that explains the applicable level of protection as either the BBNC or the site-specific outcomes from the referenced P-B approach based on the natural condition that will protect all aquatic life uses, including the most sensitive use.
    - Derive appropriate magnitudes, durations, and frequencies for the natural conditions criteria. Include multiple criteria (e.g., acute and chronic criteria) for each pollutant-waterbody combination, where needed, to protect applicable designated uses. Document why magnitude(s), duration(s), and frequency(ies) are protective of designated uses for the pollutant-waterbody combination.
    - Describe the types of data that will be used and how data gaps will be addressed, such as:
        - All available pertinent data and analyses relevant to the waterbody and pollutant of interest.
        - All data gaps that could influence the level of protection or scientific defensibility of the criterion/criteria will be identified and filled, prior to applying the P-B approach.
    - Describe how different types of data will be used in the criteria derivation process
        - Define how quantitative and qualitative data will be used in the derivation.
        - Identify where and how best professional judgment is used in decision making to derive the natural conditions criteria outcomes.
- Applicability/scope considerations for WQS applications
    - Apply the P-B approach only to aquatic life criteria and aquatic life protection (use(s))
    - Identify the sources, data, and approaches relevant to each water body type (i.e. marine, estuarine, and fresh waters).
    - Identify the time-period of application and interpretation of outcomes (see more in model selection, below).
        - Temporal constraints: Describe how available data and models are used to determine the temporal constraints of the criteria derived, including a requirement that the criteria will not apply to times of year where reliable estimates of the natural conditions cannot be produced.
        - The rationale for the temporal extent must include the relationship to pollutant dynamics, representativeness of the approach, scientific defensibility, and protection of designated uses.
    - Identify the spatial extent of application of the P-B approach and interpretation of outcomes.

        - Describe how available data and models will be used to determine the spatial constraints of the criteria derived, including a requirement that they will not apply criteria to areas where they cannot produce reliable estimates of the natural conditions. The model/tool should be relevant to the spatial extent to which it is applicable.
        - The rationale provided for the spatial extent must include the spatial representativeness of the model to capture pollutant dynamics, representativeness of the approach, scientific defensibility, and protection of designated uses.
        - The spatial extent must consider all contributing waters to provide for the attainment of downstream WQS.
    - The estimated natural condition from the P-B approach will be applicable to all waters even when water quality is better than/more stringent than the BBNC. The State has the option to provide a rationale as to why application of the BBNC to those identified higher quality waters is protective of the most sensitive designated use(s).

2.0 General data considerations

- Data Quality Assurance WQS Considerations:
    - The P-B approach must specify the requirements for what will be considered quality data.
    - Data QA/QC must adhere to the WA Department of Ecology's programmatic QAPP for impaired waters assessment, or equivalent (see Appendix A of Ecology's QAPP for data sources to be incorporated, for example).
- Data Selection WQS Considerations:
    - The P-B approach must specify the requirements for data selection.
    - The P-B approach must incorporate all data pertinent to the estimation of natural conditions at the location and for the pollutant of interest.
    - The P-B approach must specify when data outside the watershed of interest would be used. The rationale for the selection of data must be documented.
    - Data selected for estimating natural conditions must reflect pre-climate change conditions when high quality data are available (e.g., meteorological and hydrologic data selected from a timeframe prior to emergence of climate change).
    - Data selected for assessment of anthropogenic sources and impacts, including climate change effects, may be from a more recent timeframe than the data used to estimate the natural conditions. The methodology used in combining information from different timeframes to estimate natural conditions must be documented.

- All rationales and associated documentation for data use must be included for public comment together with each application of the P-B approach, such as during CWA program implementation (e.g., draft TMDL, draft NPDES permit, or draft 401 certification).

3.0 Model elements and development

- We recommend that the State develops a modeling QAPP that includes all relevant information and analysis plans and make each QAPP and related documentation publicly available.
- Required modeling elements:

Note: This topic list (open bullets) is from R10's modeling QAPP guidance (2016); square bullets are supplemental requirements for natural conditions-based criteria development using models

- Model Selection
  - Requirement that natural conditions estimates are based on best available models.
  - The model selected for natural condition estimation must have the capability to simulate the key processes and sources affecting the parameter of interest and recreate the existing as well as the natural conditions
    - Demonstration/documentation of the above shall be included together with each application of the P-B approach as described above.
  - Models applied will be from a pre-determined list of models that the State will identify as acceptable for the purpose of capturing natural conditions for the waterbody type and pollutant of interest (to be identified in the QAPP), except when a rationale is provided for the use of a non-listed model.
  - Model frameworks including code must have undergone an independent external formal peer review before application if they have not been peer reviewed previously and fully documented. Model peer-review documentation will be identified in the QAPP for each application of the P-B approach (see below).
  - Statistical models must only be applied under conditions for which the range of data available to populate the model is suitable. The dataset must be first determined sufficient to populate the model in order to generate reasonable accuracy of results. For example, if data are only available for one stream order type in one ecoregion, the model should only be applied to that stream order, and that ecoregion. The

biogeochemical and physical relationships used in the models for determining natural conditions must be established based upon known relationships for pristine or pre-anthropogenic conditions. Model resolution must be sufficient to capture the impacts to the most sensitive designated use (include rationale).

- Model Boundaries
  - Flow and water quality of groundwater, tributaries, upstream inflows, and open boundary inflows must be set at estimated natural conditions of those waters, based on the readily available information. Methodologies to be applied in estimating natural conditions at boundaries must be described in the P-B approach.
  - All methods used and assumptions made in setting boundary conditions for the natural condition predictions must be documented.
- Spatial and Temporal Resolution
  - Model grid shall have sufficient resolution to provide predictions that capture horizontal and vertical variations in water quality (e.g., tributary confluences, varied depths in stratified reservoirs, local arms and embayments of estuaries).
  - Model documentation shall include identification of the timeframe of the analysis and the basis for choosing the timeframe over which the natural conditions criterion will apply. Rationale should include designated use protection considerations, as well as applicability of the approach.
  - The model shall be capable of generating temperature/DO/pH predictions on at least an hourly basis to facilitate comparison to existing water quality criteria and other literature in addition to evaluating exposures.
  - The resolution of the model must be high enough to identify criteria outcomes protective of designated uses(s) and this resolution must be documented in the P-B approach. For example, for a lake or coastal application, the resolution with depth should allow for the identification of outcomes needed for protection of both benthic and pelagic species.
- Source Characteristics
  - In any natural conditions simulation, all anthropogenic sources must be removed from the model setup.
  - Anthropogenic sources that impact the waterbody of interest (both within and outside of the State's jurisdiction, where relevant) that must be accounted for and removed in a natural conditions estimation include all known anthropogenic sources of heat, oxygen-demanding pollutants, and/or pH-altering pollutants, including but not limited to:
    - Stream Temperature: Dams, loss of riparian shade; Point-source discharges from wastewater or stormwater outfalls; Tributary

influences; Loss of baseflow/groundwater from water withdrawals; Loss of channel complexity/hyporheic exchange and excess sedimentation; Climate change impacts on air temperature and flow magnitude, duration, timing; Development in the watershed

- Stream Dissolved Oxygen: Increases in water temperatures that lower the ability of water to hold oxygen; Flow changes/stagnant conditions; Groundwater discharges that affect DO levels and nutrient concentrations in streams; Sediment enrichment, which can consume DO in the overlying water and release nutrients into the water column; Discharges from wastewater or stormwater (point sources) or diffuse sources (nonpoint sources) influencing biochemical oxygen demand (BOD); Increased algal and plant photosynthesis due to cultural eutrophication driven by point- and nonpoint-source loading of nitrogen and phosphorus, which increases the severity of the diurnal DO fluctuation; Dam releases of low DO water; Tributary influences; Loss of benthic submerged aquatic vegetation.
- Stream pH: Discharges from wastewater or stormwater (point sources) or diffuse sources (nonpoint sources) resulting in larger pH ranges/higher and lower extremes; Tributary influences; hydromodifications; anthropogenically driven changes in biological productivity, flow, and/or residence time.
- Marine and Lake/Reservoir Temperature: Flow and temperature modification of inflows/outflows; Hydromodification/impoundments; Sedimentation in shallow areas; shoreline vegetation removal; Increased stratification and water mass warming from climate change impacts to air temperature and flow magnitude duration and timing.
- Marine and Lake/Reservoir dissolved oxygen: Increases in water temperatures that reduce the ability of water to hold oxygen; Increased stratification causing increased hypoxia or anoxia at depth; Flow changes; anthropogenically driven changes in biological productivity or residence time; Groundwater discharges affect DO levels and nutrient concentrations at shorelines, marine basin and lake bottom water/sediment interfaces, and accounting for influence of tributaries that contribute to impacted DO in these downstream waters; Sediment enrichment, which can consume DO in the overlying water and release nutrients into the water column; Discharges from wastewater or stormwater (point

sources) or diffuse sources (nonpoint sources) influencing biochemical oxygen demand (BOD); Increased algal and plant photosynthesis due to cultural eutrophication driven by point- and nonpoint-source loading of nitrogen and phosphorus, which increases the severity of the diurnal DO fluctuation; marine-upwelling dynamics at the boundary that varies with climate change; Loss of benthic submerged aquatic vegetation.

- Lake/Reservoir pH: Discharges from wastewater or stormwater (point sources) or diffuse sources (nonpoint sources); Tributary influences; anthropogenic effects on biological productivity, flow, circulation, and residence time; sediment/bottom interactions; vegetation removal; anthropogenic CO_2 uptake from atmospheric sources.

  - Provide a rationale for those sources/stressors that have not been modeled. Document habitat improvements that are not able to be modeled but that would lead to improved DO and temperature (and pH) conditions that better approximate natural conditions. Such conditions could include but are not limited to fine resolution habitat improvements such as enhanced woody debris emplacement; small scale (<300 m) refugia/habitat protection; finescale hyporheic flows.

- Data Gaps
  - Methodologies to be applied in gap filling for model inputs must be described in the approach.
  - Differentiate between what can be modeled/evaluated, and unknowns and uncertainties.
- Important Assumptions
  - Key assumptions of the model must be documented.
- Model Calibration
  - The model must be calibrated using reasonable adjustments of model parameters to achieve a reasonable fit between model-estimated and measured conditions.
  - Comparison of model-estimated and measured conditions must be documented at all monitoring locations with calibration data
  - Quality of calibration must be documented with both qualitative (e.g., time series plots) and quantitative evaluations (e.g., error statistics)
- Model Parameters and Sensitivity
  - All model parameter values must be documented
  - Parameter values must be within realistic ranges for natural conditions based on model default values and scientific literature.
  - Sensitivity testing must be conducted for means and ranges of the most influential parameters with effects on criterion outcomes

- Model Uncertainty, Peer Review, and Acceptance
  - Model Uncertainty
    - Sources of uncertainty must be summarized
  - Peer Review
    - Internal and/or external peer review of each model application must be completed prior to public notice/review of the design application.
  - Public Review and Comment
    - Model documentation must be available for public review and comment prior to finalization of the derivation of the site-specific criteria using the P-B approach. Public review and comment would be typically done during CWA program implementation, such as application within a draft TMDL, draft NPDES permit, or draft 401 certification.
    - All peer review and public comments on the model quality must be considered and addressed.
  - Model Acceptance
    - All technically feasible steps to improve the representativeness of the model based on available information must be taken prior to model acceptance and application to estimate natural conditions.
- Natural condition scenario: interpreting model output
  - The statistical metric (e.g., 7DADM, Daily Maximum, Daily Minimum) simulated must be specified and enable calculation of the outcome (acute/chronic criteria values, singularly or in combination) that protects designated use(s) applicable to the waters of interest for the pollutant/condition that is being analyzed (pH, temperature, DO).
  - The modeling analysis and criteria also shall reflect the natural extent over the longer term (multi-week to annual) and range of natural variation in temperature/DO/pH (e.g., low to high percentile temperatures) based on variability in influences such as river flow, channel morphology, weather/seasons, and estimated variation in parameterizations and boundary inputs.
  - Describe how model output will be used to establish criteria and identify criteria outcomes applicable for each site-specific determination.
- Documentation in Model Reports
  - All model development elements described above must be documented.

Appendix B: Model Consideration Elements for Developing Natural Conditions and Examples

Introduction

In previous TMDL work at Ecology, elements relevant to determining natural water quality conditions have been examined when using a model to predict natural conditions. These elements were compiled by Ecology staff and informed our adopted rule (specifically, the required elements in the draft performance-based approach document). The elements listed in the tables below provide a description of each element.

Table B1. Modeling consideration elements for developing natural conditions for fresh waters

Element 1: Boundary or Initial Conditions	Description of Element
1. Boundary or Initial Conditions • Temperature • Phytoplankton • Nutrients (P, N, OC, others) • Sediment Fluxes • Alkalinity • pH • DO • Other WQ parameters (sediments, turbidity) 1.1 Headwaters 1.2 Tributaries 1.3 Groundwater	Boundary conditions define the flow, water quality concentrations, and other biochemical or physical parameters at the upstream spatial end points of a mechanistic/ process-based model domain. Initial conditions define the flow, water quality concentrations, and other biochemical or physical parameters during the first-time step of a mechanistic/process-based model. Approaches used or anticipated: • Reduce parameter concentrations based on a % reduction from existing concentrations • Reduce parameter concentrations to levels measured at reference watersheds/sites • Use observed data and calculate percentiles based on EPA (2000) guidance • Use “inflection point” in distribution of observed concentrations • Improve tributary or boundary levels to meet numeric criteria (e.g. temperature) when appropriate • Compare estimated parameter concentrations to eco-regional levels established by EPA • For DO, used modeled DO under the reference model run • Compare multiple lines of evidence

Element 2: Hydrologic or Hydraulic Modifications	Description of Element
2.1 Changes to channel geometry due to dredging, bank erosion and other modifications 2.2 Flow reductions or increases 2.3 Hydromodifications and control such as dams, weirs 2.4 Bottom roughness	Designed modifications to channel shape, width, depth, overall geometry, from processes including channelization, dredging, filling have significantly changed numerous freshwater bodies. Dams can change water velocities, residence times and overall hydrodynamics. Aside from physical modifications, flows in a stream can be modified from in-stream diversions or from groundwater usage. Changes to bottom roughness may be engineered or the result of excessive growth from invasive species. Approaches used or anticipated: • Increase depth and/or decrease width by a small amount to account for possible incremental channel degradation • Use information from historical sources (e.g. GLO surveys), particularly if there have been major mechanical changes such as channel straightening, dikes/levees, etc. • Use channel geometry from unimpacted area to estimate historic geometry in a heavily altered area • Apply estimated natural widths to system potential shade calculations • Remove dams and other hydraulic modifications • Explicitly model surface withdrawals as point abstractions in current conditions flow balance, then remove withdrawals for natural conditions • Adjust inflow volumes to account for withdrawals or pumping upstream of the model boundary • Add groundwater inflows equivalent to estimated surface withdrawal volumes • Add groundwater inflows to reflect aquifer pumping (e.g. when there are large numbers of hydraulically connected wells)

Element 3: Riparian Conditions	Description of Element
3. Riparian Conditions 3.1 System Potential Shade 3.2 Other methods to estimate fraction of solar radiation reaching surface of water	Riparian conditions in a natural setting may be very different from existing conditions. Riparian conditions can be significant drivers in modulating the amount of solar radiation reaching the water body. Shade analysis using appropriate wetted width with restoration of the disturbance zone to natural condition, and fully vegetated riparian buffers to system potential height (see channel morphology changes) is done to estimate system potential shade. Other methods could be used in hybrid or statistical models if a firm basis is established in a project specific QAPP. Approaches used or anticipated: • Vegetation height/density/overhang from a reference reach if one exists • Tree heights from soils survey site index data • Tree heights from tribal or other local knowledge, and/or other historical source material • Tree diameters from GLO survey bearing tree records, converted to tree heights using known species-specific relationship between diameter and height. • Riparian forest boundaries and species composition from GLO surveys (mainly for eastern WA, dry climate non-forested regions)

Element 4: Meteorological Conditions	Description of Element
4. Meteorological Conditions 4.1 Air Temperature 4.2 Humidity 4.3 Wind Fields 4.5 Other (e.g. evapotranspiration for hydrological modeling)	Meteorological conditions in the immediate vicinity of the water body may be different from current conditions due to microclimates that may have existed when riparian conditions, channel or surrounding topographical conditions were different. For example, a lake surrounded by an old growth forest has a different humidity, temperature and wind fields than if surrounded by parking lots and buildings. Approaches used or anticipated: • Reduce air temperatures and/or increase dew point temperatures by a small amount (<2°C) to reflect small changes in riparian microclimate if: 1) river is a fairly wide mainstem river; and/or 2) the difference between current and system potential shade is small/incremental. • Reduce air temperatures by a larger amount to reflect radical changes, e.g., small, naturally forested streams flowing through a clearcut or open field • Develop a reference wind field for a specific period if data and tools are available to do so, and project QAPP specifies this. • Develop reference meteorological inputs that may affect hydrology (e.g., evaporation under forested condition) if data are available, to do so and project QAPP specifies this.

Element 5: Point Source Effluent	Description of Element
5. Point source effluent	Point source effluents refer to pollution that discharges at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, hatcheries, industrial waste treatment facilities, and construction sites. Approaches used or anticipated: • Remove point source discharge from model (set discharge concentration to natural ambient background concentration or to zero) • For hatcheries, adjust effluent concentrations but leave flow in • Adjust flow from point sources – this usually means the flows still enters the system

Element 6: Nonpoint source loads	Description of Element
6. Nonpoint source loads include estimation of nutrient, and/or organic carbon loads for DO and pH natural conditions. 6.1 Surface nonpoint source loads 6.2 Groundwater nonpoint source loads	Nonpoint source pollutant loads enter any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface-water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act. Land use is a key driver for non-point source loads. Approaches used or anticipated: • Develop a reference land use condition (e.g. using a watershed model). • Use reference concentrations from reference land uses (e.g. forested condition) to estimates nonpoint impact.
Element 7: Kinetic and physical rates/ratios	**Description of Element**
7. Kinetic and physical rates/ratios • Primary production • Aeration • Organic carbon decomposition rates or fractions • Nutrient limitation rates • Others	Kinetic and physical rates refer to numeric values used to represent the temporal factor or speed at which a chemical or biological or physical reaction or process takes place. Approaches used or anticipated: • Rate parameters are typically determined as part of the model calibration process. The standard approach is to leave the rates unchanged when running model scenarios, including natural conditions, unless there is some clear reason to change one or more rate parameters. • Specify rates or ratios for natural condition scenario when there is a need or a specific basis to do so.

Element 8: Invasive Species	Description of Element
8. Invasive Species	Invasive species are most-often human-introduced into an eco-system. In this context, they are non-native plants or animals that spread and expand their range aggressively taking over the natural habitat within a stream or in its riparian area. Invasive species may affect the biology, chemistry or physics of the system (e.g. plants influencing DO/pH levels or carp influencing turbidity and sediment oxygen demand). Approaches used or anticipated: • Use only native species in natural condition analyses such as shade calculations. • Remove in-stream invasive species if sufficient data is available and project QAPP specifies this. • Assume shading condition under invasive species canopy would be equal to system potential shade under natural conditions.

Table B2. Modeling consideration elements for developing natural conditions for marine waters.

Element 1: Boundary or Initial Conditions	Description of Element
1. Ocean Boundary or Initial Conditions • Phytoplankton • Nutrients (P, N, OC, others) • Sediment Fluxes • Alkalinity • pH • DO • Other WQ parameters (sediments, turbidity) 1.1 Surface watershed loads to marine waters 1.2 Direct groundwater loads to marine waters	Boundary conditions define the flow, water quality concentrations, and other biochemical or physical parameters at the upstream spatial end points of a mechanistic/ process-based model domain. Initial conditions define the flow, water quality concentrations, and other biochemical or physical parameters during the first time step of a mechanistic/ process-based model. Approaches used or anticipated: • Exclude estimated regional anthropogenic nutrient source for parameters in which anthropogenic influence is known. Use natural condition estimation approaches for surface freshwater boundaries consistent with approaches used for freshwater modeling (see table above). • Do a comparative analysis of natural condition concentrations used for the same watersheds in water projects for different model years. • Develop natural condition ocean boundaries as an extrapolation of boundary conditions based on regional observations or from estimates from a larger, regional ocean model. If the domain boundaries are outside of WA waters, natural boundary conditions in areas outside of WA will be the same as those used for existing conditions unless specified otherwise in the QAPP or during pre-modeling planning. • Approximate concentrations at the boundary using established regressions with salinity. If domain boundaries are outside of WA waters, natural boundary conditions in areas outside of WA will be the same as those used for existing conditions unless specified otherwise in the QAPP or during pre-modeling planning. • Run the model for an extended period using natural condition inflows and use the output from the last model run as the initial conditions for all parameters. • If using a sediment diagenesis model, develop natural initial conditions for sediment fluxes that stabilize over a long-term by running the model for multiple years using natural condition inputs, until stability in the labile decomposition of organic carbon is reached. • If not using a sediment diagenesis model, conduct natural condition scenario run to obtain particulate organic carbon bottom concentration estimates to modulate sediment fluxes. • If specified in the QAPP, conduct an analysis to determine whether natural condition groundwater loads need to be explicitly estimated.

Element 2: Hydrologic or Hydraulic Modifications	Description of Element
2. Hydrologic or Hydraulic Modifications 2.1 Changes to channel geometry due to dredging, bank erosion and other modifications 2.2 Flow reductions or increases 2.3 Hydromodifications and control such as dams, weirs 2.4 Bottom roughness	Designed modifications to channel shape, width, depth, overall geometry, from processes including channelization, dredging, filling have significantly changed numerous freshwater bodies. Dams can change water velocities, residence times and overall hydrodynamics. Aside from physical modifications, flows in a stream can be modified from in-stream diversions or from groundwater usage. Changes to bottom roughness may be engineered or the result of excessive growth from invasive species. Approaches used or anticipated: • Remove specific hydraulic modifications (this includes changes to morphology, bottom configuration or levees and dams) in the natural condition scenario as identified in the QAPP or during pre-modeling planning. • No changes to temporal or spatial hydrologic estimates to establish natural condition unless identified in the QAPP or during pre-modeling planning.

Element 3: Temperature Boundary Conditions	Description of Element
3. Boundary Conditions - Temperature	Boundary condition specific to temperature are separated from the other boundary condition elements for marine waters because freshwater temperatures are not generally the main driver of marine waters temperature and stratification. However, for a sheltered inlet of small size, and if significant logging has taken place in the watershed or groundwater baseflow has been greatly diminished, it may be necessary to estimate natural condition temperatures at the mouth of the stream/river. If the estuary being studied is shallow and sheltered, these alternations in temperature might influence estuarine water column temperature or stratification. Salinity differences between freshwater inflows and receiving marine waters are the most significant drivers in estuarine density stratification, so whether this analysis or level of effort is needed for a specific modeling project needs to be specified in the QAPP. Approaches used or anticipated: • The standard approach is to use the same water boundary temperatures for natural condition. • If specified in the QAPP, natural condition water boundary temperatures could be different when there is a firm basis for it.
Element 4: Meteorological Conditions	**Description of Element**
4. Meteorological Conditions 4.1 Air Temperature 4.2 Humidity 4.3 Wind Fields 4.5 Other (e.g., evapotranspiration for hydrological modeling)	Natural conditions for marine modeling need scale- appropriate meteorological inputs (e.g., solar radiation, air temperature, wind fields, cloud cover, etc.) influence algal photosynthesis, primary productivity, mixing and stratification. Approaches used or anticipated: • Use the same meteorological observational or model-based meteorological files for natural conditions as existing conditions. • If specified in the QAPP and the project goals necessitate it, the project may use a different scale-appropriate meteorological estimate of natural conditions.

Element 5: Point Source Effluent	Description of Element
5. Point source effluent	Point source effluents refer to pollution that discharges at a specific location from pipes, outfalls, and conveyance channels directly to marine or brackish waters. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, and industrial waste treatment facilities. Approaches used or anticipated: • Effluent concentrations into marine or brackish waters are set to natural ambient levels.
Element 6: Nonpoint Source Loads	**Description of Element**
6. Nonpoint source loads include estimation of nutrient, and/or organic inorganic carbon loads for DO and pH natural conditions. 6.1 Surface nonpoint source loads 6.2 Groundwater nonpoint source loads 6.3 Atmospheric nonpoint source loads	Nonpoint source pollutant loads enter any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface-water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of “point source” in section 502(14) of the Clean Water Act. Land use is a key driver for non-point source loads. Approaches used or anticipated: • Natural condition is represented by concentrations at river mouths as discussed in 3.1. • Natural condition at river mouths could also be estimated via watershed models run under natural condition scenario.

Element 7: Kinetic and physical rates/ratios	Description of Element
7. Kinetic and physical rates/ratios • Primary production • Aeration • Organic carbon decomposition rates or fractions • Nutrient limitation rates • Others	Kinetic and physical rates refer to numeric values used to represent the temporal factor or speed at which a chemical or biological or physical reaction or process takes place. Approaches used or anticipated: • Rate parameters are typically determined as part of the model calibration process. The standard approach is to leave the rates unchanged when running model scenarios, including natural conditions, unless there is some clear reason to change one or more rate parameters. • Specify rates or ratios for natural condition scenario when there is a need or a specific basis to do so.