Appendix D
Water Quality Environmental Effects Determination Methodology Supplemental Information

D.1 Available Numeric Models for Analysis of the Proposed Action and Alternatives

For the Federal Energy Regulatory Commission relicensing process, PacifiCorp developed the Klamath River Water Quality Model (KRWQM) (Watercourse Engineering, Inc. 2003, PacifiCorp 2004), consisting of linked Resource Management Associates (RMA) RMA-2 and RMA-11-dimensional models for riverine segments, where RMA-2 simulates riverine hydrodynamics and RMA-11 simulates water quality processes, and the 2-dimensional CE-QUAL-W2 model is used for water quality in reservoir segments. The KRWQM does not include a segment for the Klamath River Estuary. The KRWQM possesses the following attributes (Tetra Tech 2009a):

- Uses proven and generally accepted hydrodynamic and water quality models, including historical application to the Klamath River;
- Has been reviewed by a number of stakeholders in the watershed;
- Can be directly compared to many Oregon Department of Environmental Quality (DEQ), North Coast Regional Water Quality Control Board (NCRWQCB) and tribal water quality criteria;
- Has been calibrated for the Klamath River; and,
- Uses the public domain model CE-QUAL-W2 and a version of RMA that can be distributed to the public.

While the KRWQM possesses many beneficial attributes, the computationally intensive nature of the model components and the fine temporal scale of the output means that application of this model to Project alternatives analyzed for the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (EIS/EIR) over the period of analysis (i.e., 50 years) is not practical. Numeric models used to develop water quality effects determinations for the Proposed Action and Alternatives are presented in Table D-1.

KRWQM results for water temperature and dissolved oxygen compare the existing condition (all Project dams in place) to four without-dams scenarios (i.e., without Iron Gate Dam [“WIG”]; without Copco 1, Copco 2, and Iron Gate Dams [“WIGC”]; without

J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams [“WIGCJCB”]; and without Keno, J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams [“WOP” and “WOP2”]). Model runs were calibrated using data from calendar years 2001–2004 (PacifiCorp 2004). General modeling assumptions in comparison to conditions considered for the Klamath Facilities Removal EIS/EIR water quality effects analyses are presented in Table D-2. Limitations, and sources of uncertainty for the KRWQM are presented in Watercourse Engineering, Inc. (2003).

For development of Klamath River Total Maximum Daily Loads (TMDLs) in Oregon and California, Oregon DEQ, NCRWQCB, and the United States Environmental Protection Agency (USEPA) Regions 9 and 10 collaborated to enhance the existing KRWQM (see also Section 3.2.2.4) by revisiting assumptions for several model algorithms and including the 3-dimensional Environmental Fluid Dynamics Code model to represent water quality in the Klamath River Estuary. Algorithm enhancements are described in Tetra Tech (2009a). The Klamath TMDL model was calibrated for water temperature, dissolved oxygen, nutrients (TP, TN, ortho-phosphorus, nitrate, ammonia), and pH using year 2000 data, with the exception of the estuary segment which was calibrated using year 2004 data. Additional model corroboration was conducted for model segments 1 through 5 (within Oregon) using data from year 2002, indicating that the Klamath TMDL model scenarios reproduce general temporal and spatial trends in the observed data (Tetra Tech 2009a). Four simulated scenarios were run for the Klamath TMDL model including the following (Tetra Tech 2009b):

- Natural conditions baseline scenario (T1BSR) – applies to the Upper and Lower Klamath Basin;
- Oregon TMDLs allocation scenario (TOD2RN) – applies to the Upper Klamath Basin to the California-Oregon state line (RM 208.5);
- California TMDLs allocation scenario (TCD2RN) – applies to the Upper Klamath Basin downstream of the California-Oregon state line (RM 208.5) and the Lower Klamath Basin; and,
- With-dams Oregon and California TMDLs scenario (T4BSRN) – applies to the Upper and Lower Klamath Basin.

General modeling assumptions in comparison to conditions considered for the Klamath Facilities Removal EIS/EIR water quality effects analyses are presented in Table D-2. As shown in Table D-2, for T1BSR, TOD2RN, and TCD2RN model runs, only Link River Dam was retained for the analysis. However, for these three model runs, the historically natural Keno Reef was included in place of Keno Dam, such that the Keno Reach is not characterized as a free-flowing river. For T4BSRN, Link River, Keno, J.C. Boyle, Copco 1, Copco 2, and Iron Gate dams were retained for the analysis. Other modeling assumptions, limitations, and sources of uncertainty for the Klamath TMDL model are presented in Tetra Tech (2009a).

Table D-1. Numeric Models Used to Develop Water Quality Effects Determinations for the Proposed Action and Alternatives.

Reach	Water Quality Parameter					
	Water Temperature	Sediment and Turbidity	Dissolved Oxygen		Nutrients	pH
	Long-term[1]	Short-term[2]	Short-term[2]	Long-term[1]	Long-term[1]	Long-term[1]
No Action/No Project Alternative, Fish Passage at Four Dams Alternative						
Downstream of J.C. Boyle Reservoir (RM 224.7)	Klamath TMDL T4BSRN			Klamath TMDL T4BSRN	Klamath TMDL T4BSRN	Klamath TMDL T4BSRN
California-Oregon state line (RM 208.5)						
Downstream of Iron Gate Dam (RM 190.1)						
Shasta River (RM 176.7)	Klamath TMDL T1BSR			Klamath TMDL T1BSR		
Scott River (RM 143)						
Seiad Valley (RM 129.4)	RBM10					
Salmon River (RM 66)						
Trinity River (RM 40)						
Turwar (RM 5.8)						
Klamath River Estuary (RM 0-2)						
Proposed Action, Partial Facilities Removal of Four Dams Alternative						
Downstream of J.C. Boyle Reservoir (RM 224.7)	Klamath TMDL TOD2RN			Klamath TMDL TOD2RN	Klamath TMDL TOD2RN	Klamath TMDL TOD2RN
California-Oregon state line (RM 208.5)						
Downstream of Iron Gate Dam (RM 190.1)	Klamath TMDL TCD2RN	Reclamation SRH-1	Reclamation, USFWS, USGS, Stillwater Sciences BOD/IOD	Klamath TMDL TCD2RN	Klamath TMDL TCD2RN	Klamath TMDL TCD2RN
Shasta River (RM 176.7)						
Scott River (RM 143)						
Seiad Valley (RM 129.4)	KRWQM[3]			KRWQM[3]		
Salmon River (RM 66)	RBM10					
Trinity River (RM 40)						
Turwar (RM 5.8)						
Klamath River Estuary (RM 0-2)						

Table D-1. Numeric Models Used to Develop Water Quality Effects Determinations for the Proposed Action and Alternatives.

Reach	Water Quality Parameter					
	Water Temperature	Sediment and Turbidity	Dissolved Oxygen		Nutrients	pH
	Long-term[1]	Short-term[2]	Short-term[2]	Long-term[1]	Long-term[1]	Long-term[1]
Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative						
Downstream of J.C. Boyle Reservoir (RM 224.7)						
California-Oregon state line (RM 208.5)						
Downstream of Iron Gate Dam (RM 190.1)	KRWQM[3]			KRWQM[3]		
Shasta River (RM 176.7)						
Scott River (RM 143)	RBM10					
Seiad Valley (RM 129.4)						
Salmon River (RM 66)						
Trinity River (RM 40)						
Turwar (RM 5.8)						
Klamath River Estuary (RM 0-2)						

[1]Long-term – greater than 2 years following dam removal.

[2]Short-term – less than 2 years following dam removal.

[3]KRWQM results available for the mainstem immediately downstream of Iron Gate Dam, Scott River confluence, and Salmon River confluence (PacifiCorp 2004).

Key:

Klamath TMDL T4BSRN – with-dams Oregon and California TMDLs allocation scenario (Tetra Tech 2009b).

Klamath TMDL T1BSR – natural conditions baseline scenario for California TMDLs (Tetra Tech 2009b). The T1BSR natural conditions scenario is useful for analyzing those water quality parameters that rely on a comparison to background or natural levels for regulatory water quality standards, such as water temperature and dissolved oxygen.

Klamath TMDL TOD2RN – Oregon TMDLs allocation scenario (Tetra Tech 2009b).

Klamath TMDL TCD2RN – California TMDLs allocation scenario (Tetra Tech 2009b).

KRWQM – Klamath River Water Quality Model (Watercourse Engineering, Inc. 2003, PacifiCorp 2004).

RBM10 – water temperature model including climate change and BO and KBRA flows (Perry et al. 2011).

Reclamation SRH-1 – 1-dimensional sedimentation and river hydraulics model (Huang and Greimann 2010, Greimann et al. 2010).

BOD/IOD – biological oxygen demand (BOD)/immediate oxygen demand (IOD) spreadsheet model developed in collaboration with Reclamation, USGS, and USFWS (Stillwater Sciences 2011).

Table D-2. Comparison of Assumptions and Parameters for Available Numeric Models to Conditions Considered for Water Quality Effects Determinations for the Klamath Facilities Removal EIS/EIR.

	Available Numeric Models for Long-term Conditions		Conditions Considered for Klamath Facilities Removal EIS/EIR		
Assumptions/Model Parameters	**KRWQM**	**Klamath TMDL**	**Proposed Action and Partial Facilities Removal of Four Dams Alt**	**No Action/No Project Alt and Fish Passage at Four Dams Alt**	**Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alt**
Water quality constituents considered	• Water temperature [1] • Dissolved oxygen [1] • Nutrients • Chlorophyll-a	• Water temperature • Dissolved oxygen • Nutrients • pH • Chlorophyll-a	• Water temperature • Suspended material • Dissolved oxygen • Nutrients • pH • Chlorophyll-a • Algal toxins		
Dams remaining in-place	• "WOP" and "WOP2" = Link River • "WIGCJCB" = Link River and Keno • "WIGC" = Link River, Keno, J.C. Boyle • "WIG" = Link River, Keno, J.C. Boyle, Copco 1 and 2 • "EC" = Link River, Keno, J.C. Boyle, Copco 1 and 2, Iron Gate	• "T4BSRN" = Link River, Keno, J.C. Boyle, Copco 1 and 2, Iron Gate • "TOD2RN" and "TCD2RN" = Link River and Keno Reef [2] • "TIBSR" = Link River and Keno Reef [2]	• Link River • Keno	• Link River • Keno • J.C. Boyle • Copco 1 & 2 • Iron Gate	• Link River • Keno • J.C. Boyle
Flows	• Existing conditions for 2000–2004 [3] • NMFS Biological Opinion Mandatory Flows for the Klamath Project	• Existing conditions [4]	• KBRA • NMFS Biological Opinion Mandatory Flows (NMFS 2010)		
Reaches	Link River Dam (RM 253.7) to Turwar (RM 5.8)	Link River Dam (RM 253.7) to the Klamath River Estuary (RM 0–2)	Link River Dam (RM 253.7) to the Klamath River Estuary (RM 0–2)		
Analysis year(s)	2000–2004	2000	2020–2060		
Climate change	Not included	Not included	Considered semi-quantitatively using Bartholow (2005) and other available climate change literature		

Table D-2. Comparison of Assumptions and Parameters for Available Numeric Models to Conditions Considered for Water Quality Effects Determinations for the Klamath Facilities Removal EIS/EIR.

Assumptions/Model Parameters		Available Numeric Models for Long-term Conditions		Conditions Considered for Klamath Facilities Removal EIS/EIR		
		KRWQM	Klamath TMDL	Proposed Action and Partial Facilities Removal of Four Dams Alt	No Action/No Project Alt and Fish Passage at Four Dams Alt	Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alt
Nutrients	Upper Klamath Lake and inputs to Keno Impoundment	Existing conditions [5]	OR and CA full TMDL compliance [6]	Eventual OR and CA full TMDL compliance [6] Timescale assumed to be decades		
	Small tributaries to the lower Klamath River (i.e., Iron Gate Dam to Klamath Estuary)	• TN: 0.275 mg/L • TP: 0.075 mg/L	• TN: 0.077 mg/L [8] • TP: 0.014 mg/L [8]	N/A		
Algae and particulate organic matter (POM)	Upper Klamath Lake and inputs to Keno Impoundment	• Current conditions [4]	OR and CA full TMDL compliance [5]	• Eventual OR and CA full TMDL compliance[5] • Timescale assumed to be decades		
	Settling rates in all reservoirs	• Algal settling rate = 1.0 m/day [6] • POM = 0.5 m/day [7]	• Algal settling rate = 0.3 m/day [9] • POM = 0.8 m/day [9]	N/A		

[1] Published results available for water temperature and dissolved oxygen in PacifiCorp (2005). Additional results available in the FERC record and as an electronic appendix to http://www.riverbendsci.com/reports-and-publications-1/klam_wq_model_eval.pdf

[2] The historically natural Keno Reef was included in place of Keno Dam, such that the Keno Reach is not characterized as a free-flowing river.

[3] The WOP2 scenario has "smoothed flows" from Klamath Irrigation Project, to account for the fact that if Keno Dam were removed, Link releases would have to be smoothed due to instream flow requirements downstream.

[4] Exceptions to current conditions include the TIBSR model (natural conditions) where dramatically increased summer flows (i.e., no diversions) were assumed for tributaries to the mainstem Klamath River. Reclamation 2005 "un-depleted natural flows" were used for flows at Link River Dam and Keno Impoundment. For T4BSRN, TOD2RN, and TCD2RN, Shasta River flows are increased by 45cfs (Tetra Tech 2009a).

[5] Link Dam current conditions based on combination of individual samples and long-term monthly averages (used when individual samples not available) from Freemont Bridge (near outlet of Upper Klamath Lake, Link Dam, and Eastside/Westside powerhouses. Current conditions for other inputs to Keno Impoundment are based on combination of individual samples and averages.

[6] Full implementation assumes 80-90% reductions (relative to current conditions) for total nitrogen (TN), total phosphorus (TP), and biochemical oxygen demand (BOD) for the Lost River and Klamath Straits Drain inputs to Keno Impoundment and 90% TP reduction for wastewater treatment plant point sources (Kirk et al. 2010). The resulting decrease in nutrient loads at the California-Oregon state line is 87% for TP and 62% for TN and BOD (calculated from information in Table 2-8, Kirk et al. [2010]).

[7] PacifiCorp (2005).

[8] NCRWQCB (2010).

[9] Tetra Tech (2009a).

Lastly, the 1-dimensional RBM10 water temperature model was developed as part of the Secretarial Determination studies. The RBM10 model is well suited to the temporal, spatial, and structural requirements for simulating water temperatures in the Klamath Basin because it can 1) predict mean daily water temperature along a longitudinal gradient of a river, 2) accommodate both reservoir and river sections, and 3) simulate long time series (50 years) quickly (Perry et al. 2011). RBM10 was used to simulate water temperatures for 2012-2061 under two management alternatives ("BO" [Biological Opinion], which represents the No Action/No Project Alternative, and "KBRA", which represents the Proposed Action. RBM10 includes and six climate scenarios (i.e., 12 fifty-year simulations). The six future climate scenarios represent hydrology and meteorology using the "Index Sequential Method" and five alternative Global Circulation Models (GCMs; Greimann et al., 2010). The Index Sequential Method generates flows based on historical hydrology and meteorology under future operational conditions (Greimann et al. 2010)

As presented in Table D-2, major differences between the existing numeric models and the conditions considered for the Klamath Facilities Removal EIS/EIR water quality analyses include the following:

- The Klamath TMDL TOD2RN and TCD2RN ("dams out") model runs remove PacifiCorp dams and represent Keno Dam as the historical natural Keno Reef, such that the Keno Reach is not characterized as a free-flowing river. The KRWQM includes a model run retaining Keno. The Klamath Facilities Removal EIS/EIR analysis retains Keno Dam for the Proposed Action and all alternatives, based on the Project description.
- River flows for the Klamath Facilities Removal EIS/EIR analysis are based on Klamath Basin Restoration Agreement (KBRA) flows, which would tend to be greater than those modeled in either the Klamath TMDL model (with the exception of T1BSR) or the KRWQM (see Section 3.6, Flood Hydrology, for a summary of Klamath Basin Restoration Agreement components affecting hydrology on the Klamath River under the Proposed Action).
- Climate change was not considered in either the KRWQM or the Klamath TMDL model.
- The RBM10 water temperature model includes climate change projections and KBRA flows.

To place the Proposed Action analysis in the proper context, the above differences are generally considered as part of the water quality effects determinations whenever numeric model results are utilized.

Additionally, two models have been developed for the Secretarial Determination process to determine potential short-term impacts under the Proposed Action on suspended sediment and dissolved oxygen downstream of the dams. The first, a 1-dimensional sedimentation and river hydraulics model (SRH-1D), was developed to simulate existing conditions for hydraulics and sediment transport downstream of Iron Gate Dam as well as predict suspended sediment concentrations under multiple drawdown scenarios of the

Proposed Action. The SRH-1D model uses three "water year types" defined by the probability that in a given year the river could experience flows exceeding the low-level outlet capacities of the reservoirs (i.e., reservoir storage capacity at the level of the outlet that can evacuate the major portion of the reservoir storage volume by gravity flow)between March and June; a typical "dry year" is defined as having a 10 percent probability of exceedance (i.e., Water Year[1] [WY] 2001), a median year has a 50 percent probability of exceedance (i.e., WY 1976), and a typical wet year has a 90 percent probability of exceedance (i.e., WY 1984) (Greimann et al. 2010). Modeling assumptions, limitations and sources of uncertainty are presented in Huang and Greimann (2010) and Greimann et al. (2010).

The second model developed for the Secretarial Determination process is a simplified spreadsheet model used to investigate the potential influences that re-suspension of reservoir sediments may have on short-term dissolved oxygen levels downstream of Iron Gate Dam. Developed in collaboration with United States Bureau of Reclamation, United States Geological Survey and United States Fish and Wildlife Service, the model uses results from a combination of *in situ* sampling of reservoir sediments and water quality, and laboratory analysis of oxygen demand from the resuspended reservoir sediments, combined with numerical modeling of biochemical oxygen demand, immediate oxygen demand, sediment oxygen demand and oxygen demand as a function of suspended sediment concentrations and other variables. Modeling assumptions, limitations and sources of uncertainty are presented in Stillwater Sciences (2011).

D.2 Environmental Effects Determination Methodology for Short-term Suspended Sediments

NCRWQCB has developed the Desired Conditions Report (2006) as a guidance document describing sediment-related indices of importance to salmonid habitat conditions, including the application of the Newcombe and Jensen (1996) Severity Index and the Suspended Sediment Dose Index. The Severity Index provides a ranking of the effects of suspended sediment on salmonid species, while the Suspended Sediment Dose index relates salmonid exposure time to suspended sediment using a natural log relationship shown below:

Suspended Sediment Dose Index = ln (suspended sediment [mg/L] x exposure time [hrs])

The guidance document suggests that a Severity Index Rank of four or greater represents significant harm to salmonids so as to be detrimental to the beneficial use associated with cold freshwater habitat (NCRWQCB 2006). This ranking would equate to a suspended sediment concentration of 0.15 mg/L and a Suspended Sediment Dose Index of 4.6 (Table D-3 below), assuming 4 weeks exposure as a chronic condition that is likely to occur under a dam removal scenario. However, the general significance criteria adopted

[1] Water year is defined as October 1 to September 30.

for this analysis state that an impact must result in *substantial* adverse affects on beneficial uses of water to be considered significant. Thus, for the Klamath Facilities Removal EIS/EIR water quality analysis, a Severity Index Rank of 8.0 is considered to be a substantial impact, because it corresponds to "major physiological stress, poor condition, and/or long-term reduction in feeding rates" for exposed salmonids (Newcombe and Jensen 1996). This ranking would equate to a suspended sediment concentration of 30 mg/L and a Suspended Sediment Dose Index of 9.9, assuming 4 weeks exposure as a chronic condition (Table D-3). Within the uncertainty of the suspended sediment model developed by Reclamation, for which suspended sediment concentrations are predicted to within a factor of 2 (Greimann et al. 2010), impacts on salmonids could reasonably range from minor (Severity Index Rank of 4–5) to major (Severity Index Rank 8), but would not be expected to cause mortality (Severity Index Rank >10). Therefore, the water quality effects determination uses a predicted suspended sediment value of 30 mg/L over a 4-week exposure period as a general threshold of significance for analyzing the effects of the project alternatives.

Table D-3. Calculated Suspended Sediment Dose Index (SSDI) and Severity Index Rank for a Range of Suspended Sediment Concentrations (SSCs). Based on Newcombe and Jensen (1996).

SSC (mg/L)	SSDI[1]	Severity Index Rank
0.15	4.6	4.0
0.5	5.8	4.9
1	6.5	5.5
4	7.9	6.5
10	8.8	7.2
30	9.9	8.0
60	10.6	8.6
200	11.8	9.5
800	13.2	10.5
3,000	14.5	11.5
7,000	15.4	12.1

[1] Based on 4-week exposure period as a chronic condition.

A more detailed analysis of suspended sediment effects on key fish species, including consideration of specific life history stages, suspended sediment concentrations, and exposure period, is required for a comprehensive assessment of the impacts of the project alternatives on the cold water designated beneficial use. This level of analysis is presented in Section 3.3 Aquatic Resources and appendices to that section, including additional background regarding the applicability of the Newcombe and Jensen (1996) Severity Index Ranks and the Suspended Sediment Dose Index for key fish species in the lower Klamath River. Further discussion of particular effects of suspended sediment on shellfish and estuarine and marine organisms is also presented in Section 3.3.4.3 Aquatic Resources.

D.3 Environmental Effects Determination Methodology for Inorganic and Organic Contaminants

To date, the Secretarial Determination sediment evaluation process has followed screening protocols of the Sediment Evaluation Framework (SEF) for the Pacific Northwest, issued in 2009 by the interagency Regional Sediment Evaluation Team (RSET). The SEF is a regional guidance document that provides a framework for the assessment and characterization of freshwater and marine sediments in Idaho, Oregon, and Washington (RSET 2009). Level 2A of the SEF involves a data screening assessment to compare reservoir sediment data to available and appropriate sediment maximum levels (MLs), screening levels (SLs), and bioaccumulation triggers (BTs); and, Level 2B, including bioassays, bioaccumulation tests and special evaluations such as elutriate chemistry and risk assessments (CDM 2011).

The set of sediment MLs, SLs, and BTs included thus far in the Secretarial Determination process for Level 2A of the SEF represents an array of screening tools for different potential effects scenarios and are (briefly) the following:

- **Pacific Northwest SEF** sediment screening levels for standard chemicals of concern and chemicals of special occurrence in marine and freshwater bulk sediments for Idaho, Oregon, and Washington (RSET 2009)[2];
- **Dredged Material Management Program (DMMP)** screening levels (SL), bioaccumulation thresholds (BT), and maximum levels (MT) for marine sediments[3] in Puget Sound, Washington;
- **Screening Quick Reference Tables (SQuiRTs)** guideline values compiled by NOAA Fisheries, covering organic and inorganic contaminants in a variety of environmental media, including marine and freshwater sediments;
- **Oregon DEQ bioaccumulation screening level values (BSLVs)** for humans and relevant classes of wildlife (e.g., freshwater fish, birds, mammals);
- **California Human Health Screening Levels** are concentrations of hazardous chemicals in soil or soil gas that the California Environmental Protection Agency considers to be below thresholds of concern for risks to human health**;** and,
- **USEPA Regional Screening Levels** (formerly Preliminary Remediation Goals) for assessing human health long-term (i.e., 24-yr) exposure risk for contaminated soils and sediments in various settings (USEPA 1991, 1996, 2002).

Additional information regarding the screening levels is presented in CDM (2011), along with the compilation of screening level values. For the Secretarial Determination process, the sediment screening values have been used in a step-wise manner to

[2] Similar numeric chemical guidelines for the assessment and characterization of freshwater and marine sediments do not exist for California. The SWRCB is in the process of developing and adopting sediment quality objectives (SQOs) for enclosed bays and estuaries. However, the California SQOs are designed to assess in-place, surficial sediments as opposed to deeper sediment deposits or sediment discharges. As such, the California SQOs are not considered particularly relevant to the Secretarial Determination process or the EIS/EIR effects assessment.

[3] The DMMP guidelines do not include numeric values for freshwater sediments.

systematically consider potential impact pathways under each of the Project alternatives (or later, during subsequent permitting actions). The applicability of each of the screening levels to the EIS/EIR effects determination analysis varies depending on the project alternative (Table D-2).

Level 2B testing under the SEF consists of biological testing (bioassays or tissue analyses) or other special evaluations that are completed to provide more empirical evidence regarding the potential for sediment contamination to have adverse effects on receptors (RSET 2009). While tests involving whole sediment identify potential contamination that could affect bottom-dwelling (benthic) organisms, tests using suspension/elutriates of dredged material assess potential water column toxicity. For freshwater ecosystems that contain salmonid species, rainbow trout (*Oncorhynchus mykiss*) is recommended as one of the elutriate test species. A bioaccumulation evaluation is undertaken under SEF Level 2B when bioaccumulative chemicals of concern compared to screening levels either exceed or are inconclusive, and thus need further evaluation to determine if they pose a potential risk to human health or ecological health in the aquatic environment (RSET 2009).

Results from elutriate chemistry, sediment bioassays, and elutriate bioassays carried out for the Secretarial Determination studies are used to provide additional information beyond simple comparisons of sediment contaminant levels to regional or national screening levels (CDM 2011). Elutriate data is evaluated through comparison with a suite of regional, state and federal standards for water quality (Tables D-4 and D-5); the comparison is first carried out without consideration of dilution as a conservative approach. The results of sediment and elutriate bioassays are analyzed for acute toxicity potential for two benthic organisms (*Chironomus dilutus, Hyalella azteca*) and one freshwater fish (*Onchorhynchus mykiss*). *Chironomus dilutus* and *Hyalella azteca* are national "benchmark" toxicity indicator species, as identified in the joint USEPA–USACE Inland Testing Manual for the evaluation of dredged material proposed for discharge into waters of the United States, as follows:

Benchmark species comprise a substantial data base, represent the sensitive range of a variety of ecosystems, and provide comparable data on the relative sensitivity of local test species. Other species may be designated in future as benchmark species by USEPA and the US Army Corps of Engineers when data on their response to contaminants are adequate. Only benthic species should be tested. Although sediment dwellers are preferable, intimate contact with sediment is acceptable. Note that testing with all recommended taxa is not required; however, at least one [benchmark] amphipod taxon should be tested (USEPA and USACE 1998).

Table D-4. Applicable Screening Levels for Determination of Potential Toxicity and Bioaccumulation Effects from Sediment-Associated Contaminants Under the Proposed Action and Alternatives.

Screening Level	No Action/No Project	Full Facilities Removal (Proposed Action)	Partial Facilities Removal	Fish Passage at Four Dams	Fish Passage at Two Dams
Pacific Northwest Sediment Evaluation Framework (SEF)					
Marine (SL1, SL2)		X	X		X
Freshwater (SL2, SL2)	X	X	X	X	X
Puget Sound Dredged Materials Management Program (DMMP)					
Marine (SL, BT, ML)		X	X		X
SQuiRT Values					
Marine (ERL, ERM, T20, TEL, T50, PEL)		X	X		X
Freshwater (TEL, LEL, PEL, SEL, TEC, PEC)	X	X	X	X	X
Oregon DEQ Bioaccumulation Screening Level Values (BSLVs)					
Freshwater (Fish, Bird-Individual, Bird-Population, Mammal-Individual, Human-General, Human-Subsistence)	X	X	X	X	X
USEPA Regional Screening Levels (RSLs)					
Residential Soil Supporting (Total Carcinogenic, Total Non-carcinogenic)	X	X	X	X	X
California Human Health Screening Levels (CHHSLs)					
Residential Soil Supporting (Total Carcinogenic, Total Non-carcinogenic)	X	X	X	X	X

Screening Level Key:

SL1= Sediment Screening Level 1
SL2= Sediment Screening Level 2
SL= Screening Level
BT= Bioaccumulation Trigger
ML= Maximum Level
SQuiRTs= Screening Quick Reference Tables
ERL= Effects Range Low
ERM= Effects Range Median
T20= Chemical concentration representing a 20% probability of observing an effect, calculated using individual chemical logistic regression models based on 10-day survival results from marine amphipod tests (*Ampelisca a.* and *Rhepoxynius a.*).
TEL= Threshold Effect Level
T50= Chemical concentration representing a 50% probability of observing an effect, calculated using individual chemical logistic regression models based on 10-day survival results from marine amphipod tests (*Ampelisca a.* and *Rhepoxynius a.*).
PEL= Probable Effect Level
LEL= Lowest Effect Level
SEL= Severe Effect Level
TEC= Threshold Effect Concentration
PEC= Probable Effect Concentration

Table D-5. Applicable Water Quality Criteria for Determination of Potential Toxicity and Bioaccumulation Effects from Sediment-Associated Contaminants Under the Proposed Action and Alternatives.

Water Quality Criteria	No Action/No Project	Full Facilities Removal (Proposed Action)	Partial Facilities Removal	Fish Passage at Four Dams	Fish Passage at Two Dams
NCRWQCB Basin Plan					
Freshwater (Aquatic Life CTR, Aquatic Life NTR)	X	X	X	X	X
Human Health (Primary MCL, Secondary MCL, Agriculture, Human Health CTR, Human Health NTR)	X	X	X	X	X
California Ocean Plan					
Marine (Aquatic Life Chronic, Aquatic Life Acute, Aquatic Life Instant)		X	X		X
Human Health (CAR, NCAR, Water and Organism)		X	X	X	X
CCR-California Department of Public Health					
Human Health (DLR, MCL)	X	X	X	X	X
Oregon DEQ Water Quality Criteria					
Freshwater (Acute, Chronic)	X	X	X	X	X
Human Health (Water and Organism, Organism only, Drinking Water)	X	X	X	X	X
Oregon DEQ Water Quality Guidance Values X					
Freshwater (Acute, Chronic)					X
National Regional Water Quality Criteria Priority Pollutants					
Freshwater (CMC, CCC)	X	X	X	X	X
Marine (CMC, CCC)		X	X		X
Human Health (Water and Organism, Organism Only)	X	X	X	X	X
National Regional Water Quality Criteria Non-priority Pollutants					
Freshwater (CMC, CCC)	X	X	X	X	X
Marine (CMC, CCC)		X	X		X
Human Health (Water and Organism, Organism Only)	X	X	X	X	X

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