Attachment 15
Sediment Quality Discipline Report

CAPITOL LAKE – DESCHUTES ESTUARY

Long-Term Management Project Environmental Impact Statement

Sediment Quality Discipline Report

Prepared for:

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Final Version

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Executive Summary

This Sediment Quality Discipline Report describes the potential impacts of the Capitol Lake – Deschutes Estuary Long-Term Management Project on sediment quality in the area surrounding the project. The Capitol Lake – Deschutes Estuary includes the 260-acre Capitol Lake Basin, located on the Washington State Capitol Campus, in Olympia, Washington. Long-term management strategies and actions are needed to address issues in the Capitol Lake – Deschutes Estuary project area. An Environmental Impact Statement (EIS) is being prepared to document the potential environmental impacts of various alternatives and determine how these alternatives meet the long-term objectives identified for the watershed. This report was originally prepared to support the Draft EIS and has been revised for the Final EIS. In general, revisions have been made to provide additional information, update and expand analyses and findings, refine measures to mitigate potentially significant impacts, and correct inadvertent errors. Notable substantive revisions in the Sediment Quality Discipline Report are as follows:

- Solid waste handling standards were added as applicable.
- References were changed from MTCA Method A to MTCA Method B.
- A note has been added to Table 4.1 to describe that averages are for comparative purposes only.
- Sediment cleanup information was added for two cleanup sites in Budd Inlet.
- Clarifying text has been added to note that future sediment clean-up site boundaries in Budd Inlet may change.
- The title of Figure 5.1 has been updated to clarify it is without sea level rise for estuary and hybrid alternatives, and other visual changes were made.
- Throughout the document, references to high quality sediment have been removed and instead, the sediment is described as not requiring clean-up relative to applicable standards.

Sediment quality is evaluated by comparing existing and expected future concentrations of chemicals in surface sediments to criteria promulgated by Washington State regulations. These regulations are established for protecting benthic invertebrates and human and ecological health in fresh and marine waters, and for allowing potential disposal of sediments removed from the project site to an open-water disposal site in Puget Sound, placement at an upland location, or upland disposal at an approved landfill. The impacts of construction and operation of each alternative are assessed based on the potential of project alternatives to result in changes in sediment quality within or outside the project area from erosion/deposition or removal of sediment into or out of the project area. Where impacts are identified, the report discusses measures that can be taken to minimize or mitigate potential impacts. The analysis examines the No Action Alternative, as well as three build alternatives: Managed Lake, Estuary, and Hybrid.

Under the No Action Alternative, there would be no construction and therefore no construction- or operation-related impacts. The lake would remain closed to the public for recreational use, and there would be no changes to sediment quality and sediment quality would remain consistent. It is expected that the sediment inputs to the Capitol Lake Basin would remain as they are now, so the risk of sediment quality to deteriorate is expected to be **less than significant**.

Construction-related impacts common to all build alternatives are associated with dredging and placement or export of dredged sediments:

- For the Managed Lake Alternative, dredging would occur in the entire North Basin and all dredged sediments would be used to construct habitat islands in the Middle Basin.
- For the Estuary and Hybrid Alternatives, dredging would occur in portions of the North and Middle Basins and most dredged sediments would be used to construct habitat areas in other portions of those basins, while some excess dredged sediments would be transported to and disposed of at an approved upland landfill or placed at an upland site for reuse.

Sediment dredging and placement of dredged sediments in constructed habitat areas would have **no adverse impacts** to sediment quality because sediment does not require clean-up relative to applicable standards throughout the lake within and below the planned dredge areas. Sediment quality in Budd Inlet would not be impacted by construction because permit-required best management practices would prevent discharge of sediment from the lake during dredging.

A sediment investigation conducted for the project showed that sediment chemical concentrations within and below the proposed dredge depths meet or are lower than the State criteria for protection of the benthic community and human and ecological health, with minor exceptions. High sulfide concentrations from decay of natural organic matter were observed in the sediments that will be dredged as part of the project but not below the dredge layer. Therefore, dredging would have **minor beneficial effect** to sediment quality in Capitol Lake by removing sediments with high sulfide concentrations and exposing sediments with low sulfide concentrations in the dredge areas.

Operation-related impacts of the Estuary and Hybrid Alternatives on sediment quality are associated with removal of the 5th Avenue Dam, which will allow sediment transport from the river and constructed estuary to be deposited throughout most of the West Bay of Budd Inlet at a rate of 8 to 19 centimeters (3 to 7 inches per year), with accumulation trending toward the eastern shoreline of West Bay. Sediment monitoring conducted over the last 10 years indicates that sediment quality is better in the lake than that in Budd Inlet, and the anticipated decrease in sediment chemical concentrations and the amount of organic matter would aid in the natural recovery of most areas within the West Bay of Budd Inlet. Therefore, the natural export of sediment into the West Bay of Budd Inlet would have **minor to moderate beneficial effects** on sediment quality in the West Bay of Budd Inlet depending on the location, deposition rates, and chemical parameter. **Moderate beneficial effects** to sediment quality would be expected particularly where moderate to high deposition rates would result in sediment being deposited or covering high concentrations of dioxins/furans and carcinogenic PAHs that include the southeast, east, and northwest portions of West Bay.

Long-term operations-related impacts common to all build alternatives are also associated with recurring maintenance dredging to maintain target depths. Maintenance dredging would occur in the entire North Basin for the Managed Lake Alternative and in portions of the West Bay of Budd Inlet for the Estuary and Hybrid Alternatives. The risk of sediment quality degradation from maintenance dredging is considered low because dredged sediment quality in the North Basin and West Bay is expected to be similar to sediment quality currently present in Capitol Lake surface sediments. Dredging would target sediment that has been recently deposited by the Deschutes River, since construction. Also, permit-required best management practices would prevent discharge of sediment far outside dredge areas. As a result, maintenance dredging for all build alternatives would have **no adverse impacts** on sediment quality because operations are not anticipated to substantially affect sediment quality within or outside the project area.

Construction and operation impacts of the No Action and Build Alternatives are summarized in Tables E.1 and E.2.

Table E.1. Summary of Construction Impacts and Mitigation Measures.

Impact	Impact Finding	Mitigation (Summarized)	Significant and Unavoidable Adverse Impact?
Managed Lake Alternative			
Dredging and Material Placement	No adverse impacts	Sediment containment BMPs	No
Estuary Alternative			
Dredging and Material Placement	No adverse impacts	Sediment containment BMPs	No

Table E.1 (continued). Summary of Construction Impacts and Mitigation Measures.

Impact	Impact Finding	Mitigation (Summarized)	Significant and Unavoidable Adverse Impact?
Hybrid Alternative			
Dredging and Material Placement	No adverse impacts	Sediment containment BMPs	No

Table E.2. Summary of Operations Impacts (including Benefits) and Mitigation Measures.

Impact	Impact Finding	Mitigation (Summarized)	Significant and Unavoidable Adverse Impact?
Managed Lake Alternative			
Maintenance Dredging	No adverse impacts	Sediment containment BMPs	No
Estuary Alternative			
Sediment Deposition in West Bay	**Minor to Moderate Beneficial Effects** on natural recovery of contaminated sediments in West Bay that varies with level of existing contamination and deposition rate		
Maintenance Dredging	No adverse impacts	Sediment containment BMPs	No
Hybrid Alternative			
Sediment Deposition in West Bay	**Minor to Moderate Beneficial Effects** on natural recovery of contaminated sediments in West Bay that varies with level of existing contamination and deposition rate		
Maintenance Dredging	No adverse impacts	Sediment containment BMPs	No

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List of Acronyms and Abbreviations

Acronyms/ Abbreviations	Definition
µg/kg	micrograms per kilogram (parts per billion)
µg/kg dw	micrograms per kilogram dry weight
AETs	apparent effects thresholds
CLDE	Capitol Lake / Deschutes Estuary
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
CSL	cleanup screening level
COC	chain of custody
COCs	chemicals of concern
DMMP	Dredged Material Management Program
DMMU	Dredged Material Management Unit
dw	dry weight
EIM	Environmental Information Management System
EIS	Environmental Impact Study
GPS	global positioning system
HPAH	high molecular weight polynuclear aromatic hydrocarbon compounds

Acronyms/ Abbreviations	Definition
ID	identification
LPAH	low molecular weight polynuclear aromatic hydrocarbon compounds
mg/kg	milligrams per kilogram (parts per million)
mg/kg dw	milligrams per kilogram dry weight
mg/kg OC	milligrams per kilogram organic carbon
NAD 83	North American Datum of 1983
ng/kg dw	nanograms per kilogram dry weight
NWTPH-Dx	northwest total petroleum hydrocarbons-diesel fraction
OC	organic carbon
PAHs	polycyclic aromatic hydrocarbons
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
R/V	research vessel
SAP	sampling and analysis plan
SCO	sediment cleanup objective
SCUM	Sediment Cleanup User's Manual
SMS	Sediment Management Standards
SVOCs	semivolatile organic compounds
SWAC	spatially weighted average concentration
TCLP	toxicity characteristic leaching procedure
TEQ	toxicity equivalency quotient
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TVS	total volatile solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds
WWTP	wastewater treatment plant

1.0 Introduction and Project Description

1.1 PROJECT DESCRIPTION

The Capitol Lake – Deschutes Estuary includes the 260-acre Capitol Lake Basin, located on the Washington State Capitol Campus, in Olympia, Washington. The waterbody has long been a valued community amenity. Capitol Lake was formed in 1951 following construction of a dam and provided an important recreational resource. Historically, the Deschutes Estuary was used by local tribes for subsistence and ceremonial purposes. Today, the expansive waterbody is closed to active public use. There are a number of environmental issues including the presence of invasive species, exceedances of water quality standards, and inadequate sediment management.

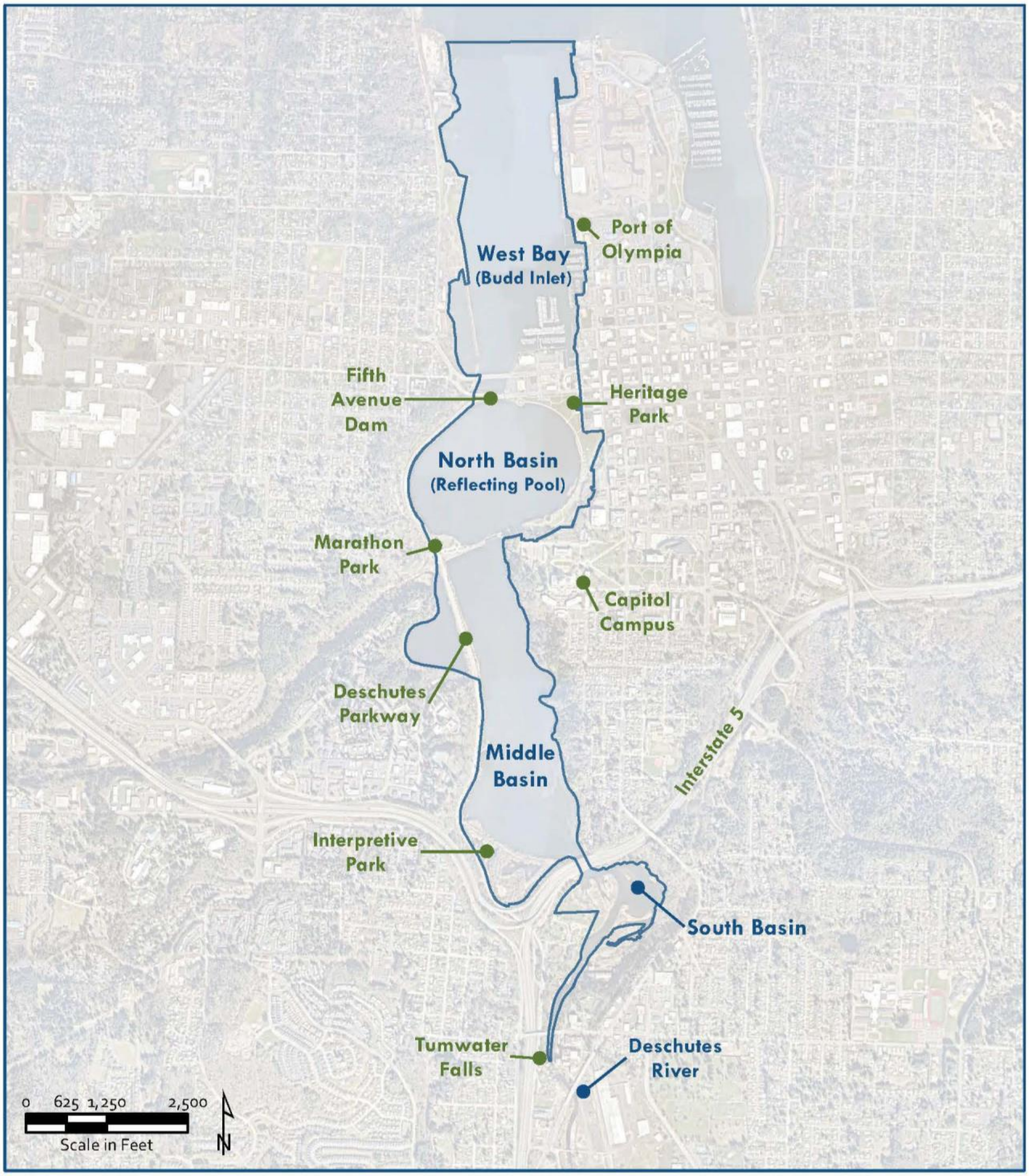
The Washington State Department of Enterprise Services (Enterprise Services) is responsible for the stewardship, preservation, operation, and maintenance of the Capitol Lake Basin. The 260-acre Capitol Lake Basin is maintained by Enterprise Services under long-term lease agreement from the Washington Department of Natural Resources.

In 2016, as part of Phase 1 of long-term planning, a group of stakeholders representing a broad range of interests, in collaboration with the state, identified shared goals for long-term management and agreed an Environmental Impact Statement (EIS) was needed to evaluate a range of alternatives and identify a preferred alternative. In 2018, the state began the EIS process. The Draft EIS was published on June 30, 2021, and evaluated four alternatives: a Managed Lake, Estuary, Hybrid, and a No Action Alternative.

The long-term management alternatives are evaluated against the shared project goals of improving water quality, managing sediment accumulation and future deposition, improving ecological functions, and enhancing community use of the resource. Refer to Figure 1.1 for the project area for long-term management.

Within the Final EIS, Enterprise Services has identified the Estuary Alternative as the preferred environmentally and economically sustainable long-term management alternative for the Capitol Lake – Deschutes Estuary. The EIS process has maintained engagement with the existing Work Groups, which include the local governments, resource agencies, and tribe. It also provides for expanded engagement opportunities for the public, such as a community sounding board.

Figure 1.1 Project Area



1.2 SUMMARY OF PROJECT ALTERNATIVES

1.2.1 Managed Lake Alternative

The Managed Lake Alternative would retain the 5th Avenue Dam and Bridge in its existing configuration. The 5th Avenue Dam would be overhauled to significantly extend the serviceable life of the structure. The reflecting pool within the North Basin would be maintained, and active recreational use would be restored in this area. Sediment would be managed through initial construction dredging and recurring maintenance dredging in the North Basin only. Sediment from construction dredging would be used to create habitat areas in the Middle Basin to support improved ecological function, habitat complexity, and diversity. Sediment would continue to accumulate and over time would promote a transition to freshwater wetlands in the South and Middle Basins. Boardwalks, a dock, and a boat launch would be constructed for community use.

This project would also construct a new, approximately 14-foot-wide bike and pedestrian bridge south of the existing 5th Avenue Bridge to provide a dedicated recreational trail connection.

1.2.2 Estuary Alternative

Under the Estuary Alternative, the existing 5th Avenue Dam and Bridge would be removed, and an approximately 500-footwide (150-meter-wide) opening would be established in its place. This would reintroduce tidal hydrology to the Capitol Lake Basin, returning the area to estuarine conditions where saltwater from Budd Inlet would mix with freshwater from the Deschutes River. Sediment would be managed through initial construction dredging in the Capitol Lake Basin and recurring maintenance dredging within West Bay. Dredged materials from construction dredging would be used to create habitat areas in the Middle and North Basins to promote ecological diversity, though tideflats would be the predominant habitat type. Boardwalks, a dock, and a boat launch would be constructed for community use. This alternative also includes stabilization along the entire length of Deschutes Parkway to avoid undercutting or destabilization from the tidal flow. Existing utilities and other infrastructure would be upgraded and/or protected from reintroduced tidal hydrology and saltwater conditions.

The Estuary Alternative has been updated in the Final EIS to include a new 5th Avenue Bridge that would be constructed south of the existing 5th Avenue Dam and Bridge. The new bridge would include a vehicle lane, bike lane, and sidewalk in each direction, with the sidewalk on the south side providing a dedicated recreational trail connection. This bridge would be constructed and connected to the transportation system before the existing 5th Avenue Dam and Bridge are removed.

Adaptive management plans would be developed to improve ecological functions and manage invasive species during the design and permitting process.

1.2.3 Hybrid Alternative

Under the Hybrid Alternative, the existing 5th Avenue Dam and Bridge would be removed, and an approximately 500-footwide (150-meter-wide) opening would be established in its place. Tidal hydrology would be reintroduced to the western portion of the North Basin and to the Middle and South Basins. Within the North Basin, a curved and approximately 2,600-foot-long (790-meter-long) barrier wall with a walkway would be constructed to create an approximately 45-acre reflecting pool adjacent to Heritage Park. The reflecting pool of the Hybrid Alternative has been updated in the Final EIS to be groundwater-fed, rather than saltwater. Construction and maintenance of this smaller reflecting pool, in addition to restored estuarine conditions in part of the Capitol Lake Basin, gives this alternative its classification as a hybrid.

Sediment would be managed through initial construction dredging in the Capitol Lake Basin and recurring maintenance dredging within West Bay. In the Middle and North Basins, constructed habitat areas would promote ecological diversity, though tideflats would be the predominant habitat type. Boardwalks, a dock, and a boat launch would be constructed for community use. This alternative also includes stabilization along the entire length of Deschutes Parkway to avoid scour or destabilization. Existing utilities and other infrastructure would be upgraded and/or protected from reintroduced tidal hydrology and saltwater conditions.

The Hybrid Alternative would also construct a new 5th Avenue Bridge, as described for the Estuary Alternative, prior to removing the existing 5th Avenue Dam and Bridge.

Adaptive management plans would be needed to improve ecological functions, manage invasive species, and maintain water quality in the freshwater reflecting pool.

1.2.4 No Action Alternative

The No Action Alternative represents the most likely future expected in the absence of implementing a long-term management project. The No Action Alternative would persist if funding is not acquired to implement the Preferred Alternative. A No Action Alternative is a required element in a SEPA EIS and provides a baseline against which the impacts of the action alternatives (Managed Lake, Estuary, Hybrid) can be evaluated and compared.

The No Action Alternative would retain the 5th Avenue Dam in its current configuration, with limited repair and maintenance activities, consistent with the scope and scale of those that have received funding and environmental approvals over the past 30 years. In the last 30 years, the repair and maintenance activities have been limited to emergency or high-priority actions, which occur sporadically as a result of need and funding appropriations.

Although Enterprise Services would not implement a long-term management project, current management activities and ongoing projects in the Capitol Lake Basin would continue. Enterprise Services would continue to implement limited nuisance and invasive species management strategies.

In the absence of a long-term management project, it is unlikely that Enterprise Services would be able to procure funding and approvals to manage sediment, improve water quality, improve ecological functions, or enhance community use. The No Action Alternative does not achieve the project goals.

1.3 CONSTRUCTION METHODS FOR THE ACTION ALTERNATIVES

This impact analysis relies upon the construction method and anticipated duration for the build alternatives, which are described in detail in Chapter 2 of the EIS.

2.0 Regulatory Context

2.1 RESOURCE DESCRIPTION

This report describes sediment quality conditions in the study area and evaluates the potential impact of each project alternative on sediment quality in the Middle Basin and North Basin of Capitol Lake, and the West Bay of Budd Inlet. The study area is the same as the project area shown in Figure 1-1. Portions of Budd Inlet beyond West Bay are not included in the study area because minimal sediment transport is predicted to occur beyond West Bay based on the *Hydrodynamics and Sediment Transport Discipline Report* (Moffat & Nichol 2020), so no project actions would occur in those areas. Therefore, no project alternative is expected to substantially affect sediment quality beyond West Bay. Upstream areas in the South Basin, Deschutes River, and Percival Creek are not part of the study area because these areas would not be affected by project actions.

Sediment quality is evaluated by comparing existing and expected future chemical concentrations in surface sediments to criteria promulgated by Washington State regulations for protecting benthic invertebrates and human health in fresh and marine waters, as well as for allowing potential disposal of sediments removed from the project site to an open-water disposal site in Puget Sound or an upland location.

This report does not evaluate temporary impacts to water quality, fish, and wildlife from sediment suspended or disturbed during project activities. Please refer to the *Water Quality Discipline Report* (Herrera 2020 in press) and other discipline reports for those evaluations.

2.2 RELEVANT LAWS, PLANS, AND POLICIES

Sediment quality within the study area is protected by a variety of federal and state laws, plans and policies (Section 2.2.1) and applicable sediment quality criteria (Section 2.2.2).

2.2.1 Federal and State

Several federal and state government policies and regulations relating to sediment quality apply to this project. Tables 2-1 and 2-2 summarize federal and state regulations and programs for sediment quality.

Table 2.1. Federal Laws, Plans, and Policies.

Regulatory Program or Policies	Lead Agency	Description
Clean Water Act (CWA)	USACE and EPA	USACE and EPA share responsibility for regulating dredged sediments within waters of the United States under Section 404 of the CWA.
Dredged Material Management Program (DMMP)	Seattle District of the U.S. Army Corps of Engineers (USACE)	Interagency program approach to the management of dredged sediments within Puget Sound of Washington State. Seattle District of USACE acts as the lead agency. Cooperating agencies include Region 10 of the U.S. EPA, Washington State Department of Natural Resources, and Washington Department of Ecology.

Table 2.2. State Laws, Plans, and Policies.

Regulatory Program or Policies	Lead Agency	Description
Sediment Management Standards (SMS)	Washington Department of Ecology	The Washington State SMS Chapter 173-204 WAC were developed to reduce and ultimately eliminate adverse effects on biological resources and significant threats to human health from surface sediment contamination. SMS regulations apply to cleanups in freshwater and marine environments.
Model Toxics Control Act (MTCA)	Washington Department of Ecology	MTCA funds and directs the investigation, cleanup, and prevention of sites that are contaminated by hazardous substances. It works to protect people's health and the environment, and to preserve natural resources for the future. MTCA Cleanup Regulations Chapter 173-340 apply to all cleanups, whether they are upland cleanups on land or in groundwater, or sediment cleanups in freshwater or marine environments.
Solid Waste Handling Standards	Washington Department of Ecology	Solid Waste Handling Standards Chapter 173-350 WAC must be followed in consultation with the local jurisdictional health department for proper disposal of all removed debris and dredged materials.

Table 2.2 (continued). State Laws, Plans, and Policies.

Regulatory Program or Policies	Lead Agency	Description
Dangerous Waste Regulations	Washington Department of Ecology	The purpose of Chapter 173-303-070 WAC is to determine whether a solid waste is dangerous waste (DW) and manage these wastes appropriately. This would apply to sediments designated for upland landfill disposal that would undergo additional testing by toxicity characteristic leachate procedure (TCLP) method for disposal designation.

2.2.2 Applicable Criteria

For the purpose of this evaluation, sediment chemistry data are compared to Sediment Management Standards (SMS) chemical criteria for both freshwater and marine sediments, Dredged Material Management Program (DMMP) marine sediment screening levels (SLs), and Model Toxics Control Act (MTCA) Method B direct contact soil cleanup levels. The MTCA Method B soil cleanup levels apply if sediments dredged from the project area were being evaluated for beneficial reuse in the uplands. In addition, all removed debris and dredged material resulting from this project must be disposed of at an approved site and in accordance with Solid Waste Handling Standards (WAC 173-350) and Dangerous Waste Regulations (WAC 173-303) and in consultation with the local jurisdictional health department.

The SMS are used to (1) set standards for sediment quality (both numeric and narrative), (2) apply the standards to reduce pollutant discharges, and (3) provide a decision process for the cleanup of contaminated sediment sites. For this project, SMS sediment quality standards will generally be used for evaluating existing sediment quality and potential impacts to future sediment quality. Freshwater sediment criteria would apply to both existing and future conditions with the Managed Lake Alternative within the Capitol Lake Basin. For the Estuary and Hybrid Alternatives, freshwater sediment criteria would apply to existing conditions within the Capitol Lake Basin during construction, but marine sediment criteria would apply for future conditions within the Capitol Lake Basin during operation.

The DMMP marine sediment SL criteria are applicable for any future dredging project in the West Bay that would dispose of dredged sediments within the waters of the United States. The DMMP SL criteria are used to evaluate potential impacts of project alternatives on open-water disposal options for sediments removed from West Bay in the future because of changes to marine sediment chemistry from the deposition of scoured lake basin sediments. The freshwater DMMP SLs were not evaluated because dredged lake sediments from the project alternatives will be either reused on site or disposed at upland facilities due to the presence of New Zealand mudsnail, which is an aquatic invasive species (AIS). More detail regarding AIS can be found in the *Aquatic Invasive Species Discipline Report* (Herrera 2022).

MTCA Method B direct contact soil cleanup levels are compared to sediment chemistry results to evaluate options for the beneficial reuse of the sediments at a non-landfill upland location dredged under the project alternatives. If chemical concentrations do not exceed these levels, then the sediments are not considered contaminated and may be used or placed at an upland location without restrictions due to contamination. If chemical concentrations exceed MTCA Method B direct contact soil cleanup levels, then additional evaluation would be required to determine what restrictions if any would be required for upland reuse or placement. In either scenario, coordination with Ecology would be required.

If sediment chemical concentrations exceed soil cleanup levels, then the sediment quality is evaluated relative to Dangerous Waste Criteria (see Table 2.2), as part of the upland landfill disposal acceptance process. This includes additional toxicity characteristic leachate procedure (TCLP) testing that simulates leaching through a landfill. Sediment chemical concentrations that do not exceed Dangerous Waste Criteria may be disposed at a municipal solid waste (Subtitle D) landfill, while those designated as dangerous waste must be taken to a hazardous waste (Subtitle C) landfill.

Table 2.3 presents SMS sediment cleanup standards chemical criteria that include the Sediment Cleanup Objective (SCO) and Cleanup Screening Level (CSL) for the protection of the benthic community in freshwater sediment (WAC 173-204-563) and marine sediment (WAC 173-204-562). The SCOs are equivalent to the sediment quality standards (SQSs) for freshwater (WAC 173-204-340) and marine sediments (WAC 204-320), which correspond to the long-term sediment quality goals in Washington State. Sediment chemical concentrations at or below the SCO/SQS are predicted to have no adverse effects on the benthic community. Sediment chemical concentrations between the SCO/SQS and the CSL are expected to have minor adverse effects on the benthic community. Sediment chemical concentrations above the CSL are expected to have significant effects on the benthic community. Table 2.3 also includes marine sediment apparent effects thresholds (AETs) for the benthic community that are based on dry weight and used as an alternative to those marine SMS criteria based on organic carbon (OC) content when the OC content in samples is outside the typical marine habitat range of 0.5 to 3.5 percent, where OC based criteria are recommended.

Table 2.3 also presents SMS sediment cleanup criteria for human and ecological health in marine sediment (WAC 173-204-261). These criteria are simplified from the SMS process described in the Sediment Cleanup User's Manual (SCUM) (Ecology 2019) that rely on an involved risk-based process for obtaining the SCOs and CSLs at a site for bioaccumulative chemicals. Bioaccumulative chemicals can affect humans and trophic levels higher than benthic invertebrates through sediment contact or organism consumption. Bioaccumulative chemicals include dioxins/furans, carcinogenic polycyclic aromatic hydrocarbons (PAHs), dioxin-like polychlorinated biphenyls (PCBs), mercury, and some other metals. In this table, natural background concentrations determined for Puget Sound are used to represent the marine human health SCO, while regional background concentrations determined for Budd Inlet are used to represent the marine human health CSL because chemical concentrations less than regional background concentrations are protective of human health. Regional background concentrations for Budd Inlet have only been established for dioxins/furans and carcinogenic PAHs as the driver chemicals of concern, and because at this time sufficient data are not available for other bioaccumulative chemicals. Natural background concentrations have not been determined for freshwaters and regional background concentrations for freshwaters have only been established for carcinogenic PAHs in Lake Washington. Therefore, as this project does not include sediment clean-up activities, only regional background concentrations for dioxins/furans and carcinogenic PAHs in Budd Inlet are used for evaluating potential impacts of sediment quality to humans and higher trophic levels.

Table 2.3 presents the screening levels (SLs) used to determine if dredged sediments are suitable for disposal at dispersive or non-dispersive open-water disposal sites in Puget Sound in accordance with the Dredge Material Management Program (DMMP) (Ecology 2019). Sediments containing an average concentration greater than the SL for any one chemical would require biological testing to determine if they are suitable for disposal at an open water site. Sediments not suitable for open-water disposal would need to be treated or reused at an upland area, or disposed of at an upland landfill. Sediment quality is the primary consideration for determining suitability for potential in-water disposal; other factors, such as presence of invasive species are also considered.

Table 2.3 presents Model Toxic Control Act (MTCA) Method B cleanup levels for direct contact in soils(WAC 173-340). Sediment meeting MTCA Method B soil cleanup levels could be placed at upland non-landfill locations for beneficial use. Sediments exceeding MTCA Method B soil cleanup levels would require leachate testing to determine if they can be disposed of at a municipal solid waste landfill or require disposal at a hazardous waste landfill.

Table 2.3. Sediment Chemical Criteria for Protection of the Benthic and Human Health, and Marine and Upland Disposal.

Analyte	SMS Freshwater Benthic Health		SMS Marine Benthic Health[a]		SMS Marine Benthic AETs[b]		SMS Marine Human Health[c]		DMMP Marine Disposal	MTCA Upland Placement
	SCO	CSL	SCO	CSL	SCO	CSL	NBkd	RBkd	SL	Method B[d]
Conventional Pollutants	**mg/kg dw**									
Ammonia	230	300	–	–	–	–	–	–	–	–
Total sulfides	39	61	–	–	–	–	–	–	–	–
Metals	**mg/kg dw**		**mg/kg dw**		**mg/kg dw**		**mg/kg dw**		**mg/kg dw**	**mg/kg dw**
Arsenic	14	120	57	93	57	93	11	–	57	24/0.67(ca)
Cadmium	2.1	5.4	5.1	6.7	5.1	6.7	0.8	–	5.1	80
Chromium	72	88	260	270	260	270	62	–	260	120,000
Copper	400	1,200	390	390	390	390	45	–	390	3,200
Lead	360	*>1,300*	450	530	450	530	21	–	450	–
Mercury	0.66	0.8	0.41	0.59	0.41	0.59	0.2	–	0.41	–
Nickel	26	110	–	–	–	–	50	–	–	1,600
Selenium	11	*>20*	–	–	–	–	–	–	–	400
Silver	0.57	1.7	6.1	6.1	6.1	6.1	0.24	–	6.1	400
Zinc	3,200	*>4,200*	410	960	410	960	93	–	410	24,000
Organometallics	**µg/kg dw**									
Monobutyltin	540	*>4,800*	–	–	–	–	–	–	–	–
Dibutyltin	910	130,000	–	–	–	–	–	–	–	–
Tributyltin	47	320	–	–	–	–	–	–	–	–
Tetrabutyltin	97	*>97*	–	–	–	–	–	–	–	–
Miscellaneous Organics	**µg/kg dw**		**µg/kg dw**		**µg/kg dw**				**µg/kg dw**	**µg/kg dw**
2,4-Dimethylphenol	–	–	29	29	29	29	–	–	29	–
2-Methylphenol	–	–	63	63	63	63	–	–	63	4,000,000
4-Methylphenol	260	2,000	670	670	670	670	–	–	670	8,000,000
Benzoic acid	2,900	3,800	650	650	650	650	–	–	650	320,000,000
Benzyl alcohol	–	–	57	73	57	73	–	–	57	8,000,000
Dibenzofuran	200	680	15[e]	58[e]	540	540	–	–	540	80,000
Phenol	120	210	420	1,200	420	1,200	–	–	420	24,000,000

Table 2.3 (continued). Sediment Chemical Criteria for Protection of the Benthic and Human Health, and Marine and Upland Disposal.

Analyte	SMS Freshwater Benthic Health SCO	SMS Freshwater Benthic Health CSL	SMS Marine Benthic Health[a] SCO	SMS Marine Benthic Health[a] CSL	SMS Marine Benthic AETs[b] SCO	SMS Marine Benthic AETs[b] CSL	SMS Marine Human Health[c] NBkd	SMS Marine Human Health[c] RBkd	DMMP Marine Disposal SL	MTCA Upland Placement Method B[d]
Miscellaneous Organics (continued)	**µg/kg dw**		**µg/kg dw**		**µg/kg dw**				**µg/kg dw**	**µg/kg dw**
N-nitrosodiphenylamine	–	–	11[e]	11[e]	28	40	–	–	28	640/3.7(ca)
Phthalates	**µg/kg dw**		**mg/kg OC**		**µg/kg dw**				**µg/kg dw**	**µg/kg dw**
Bis(2-Ethylhexyl)phthalate	500	22,000	47	78	1,300	1,900	–	–	1,300	1,600,000/ 71,000(ca)
Butylbenzyl phthalate	–	–	4.9	64	63	900	–	–	63	16,000,000/ 530(ca)
Diethyl phthalate	–	–	61	110	200	*>1200*	–	–	200	64,000,000
Dimethyl phthalate	–	–	53	53	71	160	–	–	1,400	–
Di-n-butyl phthalate	380	1,000	220	1,700	1,400	1,400	–	–	1,400	–
Di-n-octyl phthalate	39	*>1,100*	58	4,500	6,200	6,200	–	–	6,200	800,000
Pesticides and PCBs	**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**µg/kg dw**		**µg/kg dw**	**µg/kg dw**
beta-Hexachlorocyclohexane	7.2	11	–	–	–	–	–	–	–	560(ca)
Carbazole	900	1,100	–	–	–	–	–	–	–	–
Dieldrin	4.9	9.3	–	–	–	–	–	–	1.9	4,000/6,300(ca)
Endrin ketone	8.5	–	–	–	–	–	–	–	–	–
Total PCB Aroclors[e]	110	2,500	12	65	130	1,000			130	500(ca)
PCB Congeners	–	–	–	–	–	–	3.5	–	–	–
DDDs	310	860	–	–	–	–	–	–	16	2,400/4,200(ca)
DDEs	21	33	–	–	–	–	–	–	9	24,000/2,900 (ca)
DDTs	100	8,100	–	–	–	–	–	–	12	40,000/2,900 (ca)

Table 2.3 (continued). Sediment Chemical Criteria for Protection of the Benthic and Human Health, and Marine and Upland Disposal.

Analyte	SMS Freshwater Benthic Health		SMS Marine Benthic Health[a]		SMS Marine Benthic AETs[b]		SMS Marine Human Health[c]		DMMP Marine Disposal	MTCA Upland Placement
	SCO	CSL	SCO	CSL	SCO	CSL	NBkd	RBkd	SL	Method B[d]
PAHs	µg/kg dw		mg/kg OC		µg/kg dw		µg/kg dw		µg/kg dw	µg/kg dw
Carcinogenic PAHs TEQ	–	–	–	–	–	–	21	78	–	24,000/190(ca)
Total PAHs	17,000	30,000	–	–	–	–	–	–	–	–
Total LPAH	–	–	370	780	5,200	5,200	–	–	5,200	–
Naphthalene	–	–	99	170	2,100	2,100	–	–	2,100	1,600,000
Acenaphthylene	–	–	66	66	1,300	1,300	–	–	560	–
Acenaphthene	–	–	16	57	500	500	–	–	500	4,800,000
Fluorene	–	–	23	79	540	540	–	–	540	3,200,000
Phenanthrene	–	–	100	480	1,500	1,500	–	–	1,500	–
Anthracene	–	–	220	1,200	960	960	–	–	960	24,000,000
2-Methylnaphthalene	–	–	38	64	670	670	–	–	670	320,000
Total HPAH	–	–	960	5,300	12,000	17,000	–	–	12,000	–
Fluoranthene	–	–	160	1,200	1,700	2,500	–	–	1,700	3,200,000
Pyrene	–	–	1,000	1,400	2,600	3,300	–	–	2,600	2,400,000
Benz[a]anthracene	–	–	110	270	1,300	1,600	–	–	1,300	–
Chrysene	–	–	110	460	1,400	2,800	–	–	1,400	–
Total benzofluoranthenes	–	–	230	450	3,200	3,600	–	–	3,200	–
Benzo[a]pyrene	–	–	99	210	1,600	1,600	–	–	1,600	24,000/190(ca)
Indeno[1,2,3-c,d]pyrene	–	–	34	88	600	690	–	–	600	–
Dibenzo[a,h]anthracene	–	–	12	33	230	230	–	–	230	–
Benzo[g,h,i]perylene	–	–	31	78	670	720	–	–	670	–
Petroleum Hydrocarbons	mg/kg dw									mg/kg dw
TPH-Diesel	340	510	–	–	–	–	–	–	–	–
TPH-Residual	3,600	4,400	–	–	–	–	–	–	–	–

Table 2.3 (continued). Sediment Chemical Criteria for Protection of the Benthic and Human Health, and Marine and Upland Disposal.

Analyte	SMS Freshwater Benthic Health SCO	SMS Freshwater Benthic Health CSL	SMS Marine Benthic Health[a] SCO	SMS Marine Benthic Health[a] CSL	SMS Marine Benthic AETs[b] SCO	SMS Marine Benthic AETs[b] CSL	SMS Marine Human Health[c] NBkd	SMS Marine Human Health[c] RBkd	DMMP Marine Disposal SL	MTCA Upland Placement Method B[d]
Chlorinated Organics	µg/kg dw		mg/kg OC		µg/kg dw				µg/kg dw	
1,2,4-Trichlorobenzene	–	–	0.81	1.8	31	51	–	–	–	–
1,2-Dichlorobenzene	–	–	2.3	2.3	35	50	–	–	–	–
1,4-Dichlorobenzene	–	–	3.1	9	110	110	–	–	–	–
Hexachlorobenzene	–	–	0.38	2.3	22	70	–	–	–	–
Hexachlorobutadiene	–	–	3.9	6.2	11	120	–	–	–	–
Pentachlorophenol	1,200	*>1,200*	360[f]	690[f]	360	400	–	–	–	–
Dioxin/Furan Congeners							ng/kg dw		ng/kg dw	ng/kg dw
Dioxins/Furans TEQ	–	–	–	–	–	–	4	19	4/10[g]	93/13(ca)

SMS = Sediment Management Standards (WAC 173-204) Sediment Quality Objective (SCO) and Sediment Cleanup Level (CSL).

NBkd = Natural Background; RBkd = Regional Background for protection of higher trophic levels and human health from bioaccumulative chemicals (Ecology 2019).

DMMP = Dredge Material Management Program (USACE 2018) Screening Level (SL) for open water disposal in Puget Sound.

MTCA= Model Toxics Control Act (WAC 173-340) Method B direct contact soil cleanup level.

mg/kg = milligrams per kilogram, parts per million.

µg/kg = micrograms per kilogram, parts per billion.

ng/kg= nanograms per kilogram, parts per trillion.

dw = dry weight.

OC = organic carbon.

>Italicized blue "greater than" chemical concentration indicates that the toxic level is unknown, but above the concentration shown.

a Chemical concentrations are dry weight normalized for metals and polar organics and normalized to total organic carbon for nonpolar organics. Units in mg/kg organic carbon (OC) represent concentrations in parts per million, normalized to organic carbon. To normalize to TOC, the dry weight concentration for each chemical concentration is divided by the decimal fraction representing the percent TOC content of the sediment.

b Dry weight based AETs should be considered in addition to TOC normalized concentrations when total organic carbon is outside the recommended range of 0.5 – 3.5% for organic carbon normalization. Dry weight apparent effects thresholds (AETs) for phthalates are derived from Barrick et al., 1988. The SCO is established as the lowest AET and the CSL is the 2nd lowest AET, consistent with the dry weight AETs for the other SMS chemicals. These differ from the DMMP concentrations for phthalates which were updated in 2005, based on additional bioassay endpoints and synoptic chemistry/bioassay data. Bioassays may be used in place of these AETs if necessary.

[c] Marine sediment human health criteria are based on natural background in Puget Sound for the SCO and regional background in Budd Inlet for the CSL.

[d] Upland placement of dredged sediments may be evaluated for beneficial use. Method B Direct Contact Noncancer and Method B Direct Contact Cancer (ca) values are provided, if established.

[e] mg/kg OC.

[f] µg/kg dry weight.

[g] For Puget Sound, the Disposal Site Management Objective is 4 ng/kg at dispersive disposal sites. For non-dispersive disposal sites (e.g., Anderson/Ketron), dredged material management units (DMMUs) with concentrations below 10 ng/kg TEQ are allowed for disposal as long as the volume-weighted average concentration in material from the entire dredging project does not exceed the Disposal Site Management Objective of 4 ng/kg TEQ

3.0 Methodology

3.1 SELECTION OF THE STUDY AREA

The study area for sediment quality consists of areas that could be directly or indirectly affected by construction or operation of the project. This includes the North and Middle Basins within the Capitol Lake Basin, and the West Bay of Budd Inlet that could be affected by sediment transport from the Capitol Lake Basin (Figure 1.1). Upstream sediment quality resources, including the South Basin, Deschutes River, and Percival Creek, are not part of the study area for this EIS evaluation because sediment quality in these areas does not have the potential to be affected by construction or operation of a long-term management alternative. Portions of Budd Inlet beyond West Bay are not included in the study area because minimal sediment transport is predicted to occur beyond West Bay (Moffat &Nichol 2020) and, therefore, no project alternatives are expected to substantially affect sediment quality beyond West Bay.

3.2 DATA SOURCES AND COLLECTION

Information about sediment quality was obtained for Capitol Lake and the West Bay of Budd Inlet from historical data available in Ecology's Environmental Information Management (EIM) online database and existing reports, and Capitol Lake sediment sampling conducted in 2020 for this study.

3.2.1 Historical

The following studies were identified in Ecology's EIM database (Ecology 2020a):

- **EIM Study ID LOTT_96**: Ten surface sediment samples from Budd Inlet collected near the LOTT Clean Water Alliance (LOTT) wastewater treatment plant (WWTP) outfalls were analyzed for conventional parameters, metals, semivolatile organic compounds (SVOCs), PCBs, pesticides, and oil and grease.
- **EIM Study ID BUDD07:** Two surface sediment samples from Capitol Lake were analyzed for dioxins/furans and conventional parameters, and one of these samples from the North Basin was also analyzed for metals, SVOCs, and PCB. Existing Reports.

- **EIM Study ID UWI:** A total of 30 surface (0 to 3 cm) sediment stations in Budd Inlet (four were located in West Bay) were sampled in 2011 and 2018 by Ecology as part of the Urban Waters Initiative. All samples were analyzed for SMS chemistry parameters (e.g., conventional parameters, metals, SVOCs, and PCBs), toxicity (bioassay), and benthos. In addition, samples were also analyzed for pharmaceutical and personal care products, stable isotopes, carbon, total nitrogen, biogenic silica, and polybrominated diphenyl ethers (PBDEs).

Information was obtained from Ecology's Spills and Cleanup Website for the Olympia Brewery transformer oil spill that occurred on February 25, 2019. (Ecology 2020b). The spill was containment and cleanup was completed in September 2019 and prevented the PCB-contaminated oil from reaching Budd Inlet.

Relevant studies that have been completed for Capitol Lake include:

- **Herrera 2000 Capitol Lake Adaptive Management Plan Sediment Characterization Report:** Four near-surface (0 to 2.5 feet below sediment surface) sediment cores collected in the Middle Basin and analyzed to determine disposal suitability of sediments (Herrera 2000).
- **Thurston County 2003 Heritage Park Water and Sediment Quality Assessment:** Assessed the quality of the lake sediments adjacent to stormwater outfalls to the eastern shoreline of the North Basin (Thurston County 2008).
- **SAIC 2008 Sediment Characterization Study:** Two sediment samples were collected in 2007 from Capitol Lake and analyzed for dioxins/furans and conventional parameters, and one of the samples from the North Basin was also analyzed for metals, SVOCs, and PCBs. (SAIC 2008).
- **Floyd|Snider 2013 Permitting Recommendation Report:** Comparison of multiple sediment characterization events within Capitol Lake over the past 45 years to current SMS freshwater sediment chemical criteria (Floyd|Snider 2013).

Relevant studies that have been completed for the West Bay of Budd Inlet include:

- **SAIC 2008 Sediment Characterization Study:** Sediment characterization study of existing sediment data was completed for Budd Inlet. All sediment data in EIM for Budd Inlet were evaluated for SMS exceedances (SAIC 2008).
- **Port of Olympia 2016 Investigation Report:** Sediment sampling in 2013 that included surface samples collected in the West Bay of Budd Inlet and analyzed for dioxins/furans, PAHs, mercury, butyl benzyl phthalate, and benzyl alcohol (Anchor QEA 2016).
- **LOTT 2019 NPDES Sediment Monitoring:** Eight surface sediment samples collected and analyzed for SMS parameters from two WWTP outfalls in Budd Inlet as a requirement of their national pollution discharge elimination system (NPDES) permit (Herrera 2020b).

3.2.2 2020 Sediment Study

Lake sediment that would be dredged under the project alternatives was sampled to characterize physical and chemical concentrations. The goals of this sediment sampling were to characterize the physical and chemical quality of sediments within the Capitol Lake Basin to evaluate existing conditions, and therefore, the potential construction and operation impacts to sediment quality for each project alternative. This included an evaluation of surface sediments that would be left undisturbed during and following construction, dredged sediments used to create habitat areas, dredged sediments removed for off-site upland reuse or disposal, deep sediments in dredge areas that would become exposed after dredging (called the z layer or post-dredge surface), and sediments that are expected to become suspended and settle in the West Bay of Budd Inlet. Sediment sampling was conducted in accordance with a separate Sampling and Analysis Plan (SAP) (Herrera 2020a).

Sediment samples were collected for analyses of the following SMS sediment chemicals of concern (COCs) for protection of the freshwater or marine benthic community:

- Conventional analyses including ammonia, total sulfides, total organic carbon (TOC), grain size, total solids, and total volatile solids (TVS)
- Metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc)
- Butyltins (monobutyltin, dibutyltin, tributyltin, and tetrabutyltin)
- SVOCs including PAHs, phthalates, chlorinated organics, and miscellaneous organics
- PCBs as Aroclors
- Organochlorine pesticides
- Total petroleum hydrocarbons (TPH)

Sediment samples were also analyzed for the following parameters that do not have SMS criteria for protection of the benthic community:

- Dioxins/furans

Dioxins/furans were added because they are one of the most widespread bioaccumulative chemicals found in urban areas above background. They are found in Budd Inlet above expected background levels due to historical operations including wood treatment facilities, treated wood storage yards, and hog fuel burners (Ecology 2018). The other widespread bioaccumulative chemicals include carcinogenic PAHs (which are included in the SVOC analysis), PCBs, and mercury and some of the other analyzed metals.

Sediment surface grab samples and subsurface sediment cores were collected on March 25 (Middle Basin) and March 26 (North Basin), 2020 as described in the Sediment Data Report presented in Appendix A. Surface sediment grab samples were collected to a depth of 10 cm at two grab stations in the North Basin and three grab stations in the Middle Basin (shown as G stations in Figure 3.1) using a power grab sampler and processed aboard the boat. No observations of odor or sheen were noted.

Subsurface sediment cores were collected at two core stations in the North Basin and three core stations in the Middle Basin (shown as C stations in Figure 3.1) using a vibracore sampler deployed from the boat and processed on shore the same day they were collected. Both North Basin cores were driven to target depths of 6 and 8 feet; the three Middle Basin cores were driven to target depths ranging from 9.5 to 14 feet.

3.3 ANALYSIS OF IMPACTS

Adverse impacts and beneficial effects related to both construction and long-term operation are evaluated, with a focus on comparatively evaluating the alternatives. In general, construction-related impacts are primarily associated with lake sediment dredging and dam removal because those activities represent the major effects on sediment movement and quality. Future, long-term adverse impacts and beneficial effects associated with sediment quality for each of the four project alternatives are evaluated using a combination of current conditions, predicted sediment transport, and future projections of environmental factors affecting sediment quality.

Qualitative categories such as "less-than-significant" and "significant" are used to assess the relative magnitude of adverse impacts related to sediment quality. Substantial increases in contaminant concentrations expected to exceed CSLs and adversely impact benthic communities or human health by an alternative are considered to be a significant adverse impact, whereas substantial decreases in contaminant concentrations from above to below CSLs are considered a substantial beneficial effect of the alternative. Minor increases in contaminant concentrations that do not exceed CSLs, but are greater than the SCO and have minor impacts on benthic communities or human health are considered to be less-than-significant. Similarly, minor decreases in contaminant concentrations below the CSLs are a minor beneficial effect.

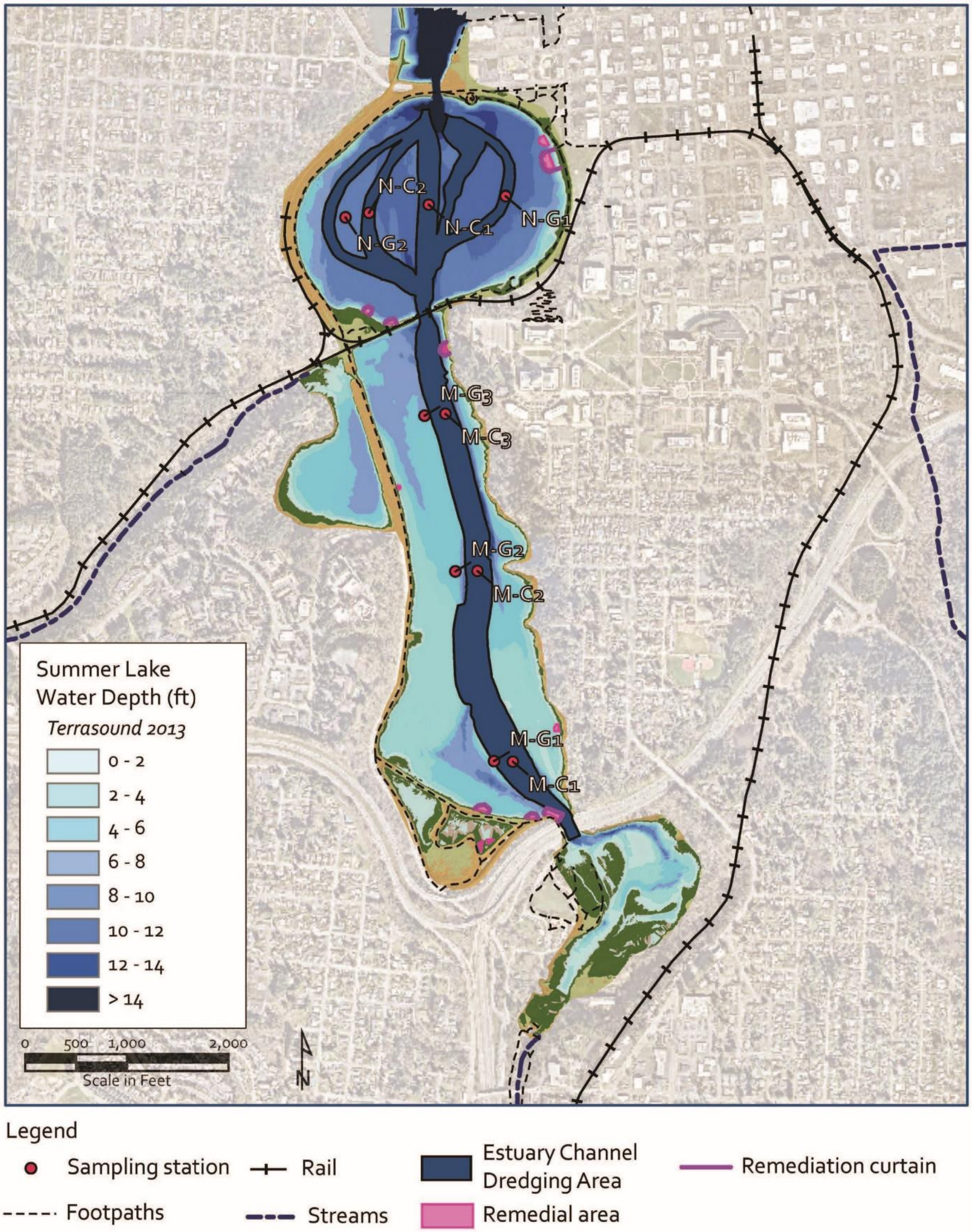
3.3.1 Identification of Construction Impacts

Sediment dredging, dredged sediment placement for constructing habitat areas, and dam removal are the primary construction activities affecting sediment quality. Disposal of dredged sediments at an open-water disposal site or upland landfill or reuse at an upland location is also evaluated for the Estuary and Hybrid Alternatives where a small portion of the sediments dredged during construction cannot be reused onsite and require off-site disposal.

For this analysis, the magnitude of short-term impacts is considered less-than-significant or significant, as follows:

- **Less-than-significant**—Impacts are considered less-than-significant if they would not increase the risk of exceeding sediment cleanup criteria.
- **Significant**—Impacts are considered significant if there would be a substantial increased risk to exceeding sediment cleanup criteria.

Figure 3.1. Sediment Sample Locations, Capitol Lake, Olympia, Washington.



3.3.2 Identification of Operational Impacts

Sediment erosion and transport, deposition of suspended sediment, and maintenance dredging are the primary operations affecting sediment quality. Sediment transport from the lake basin and deposition in West Bay would occur for the Estuary and Hybrid Alternatives. Disposal of dredged sediments from long-term maintenance dredging at an open-water disposal site, or upland reuse site, or an approved landfill is also evaluated for the Managed Lake, Estuary, and Hybrid Alternatives.

Tidal flushing of Budd Inlet sediments into the lake basin is not evaluated for impacts to sediment quality. Numerical modeling of hydrodynamics and sediment transport does show that a small amount of sediment may move upstream during incoming (flood) tides (Moffatt & Nichol 2020). However, sediments moved upstream during flood tides would be a very small amount compared to the downstream movement by river scour and ebb tides, and it would likely be the same sediment that had been transported downstream from the Capitol Lake Basin following dam removal. Therefore, only downstream sediment movement are considered for sediment quality impacts.

For this analysis, the magnitude of long-term (operational) impacts are considered less-than-significant or significant, as follows:

- **Less-than-significant**—Impacts are considered less-than-significant if predicted increases in chemical concentrations would not increase the frequency of sediment cleanup criteria exceedance in the water body.
- **Significant**—Impacts are considered significant if there would be a substantial increased risk, relative to existing conditions, of exceeding sediment cleanup criteria.

4.0 Affected Environment

4.1 CAPITOL LAKE SEDIMENT QUALITY

4.1.1 Historical Studies

A summary of four historical studies conducted in Capitol Lake between 1975 and 2007 is presented below. In general, sediment quality in Capitol Lake has been below sediment quality criteria based on these historical studies. A transformer oil spill that occurred in 2019 and released PCBs to sediment is also summarized below; however, the spill was cleaned up and remaining sediment does not exceed sediment quality criteria. The data presented in this section is intended for historical characterization of sediment in Capitol Lake only. The sediment data collected in 2020 and presented in Section 4.1.2 is the primary basis for impact analysis of this project, as it represents current conditions in the North and Middle Basins of Capitol Lake.

The most extensive sediment characterization event within Capitol Lake occurred in 1975. During this event, 11 sediment samples, collected from six cores from the Middle and North Basins, were analyzed for total metals, PCBs, total chlorinated hydrocarbons, oil and grease, and conventional parameters (CH2M Hill 1976). In one of the 11 samples, mercury exceeded the freshwater sediment chemical criterion. Mercury in this sample was detected at a concentration of 1.03 milligrams per kilogram (mg/kg), exceeding the mercury sediment cleanup objective of 0.66 mg/kg and the mercury cleanup screening level of 0.8 mg/kg by less than a factor of 2. No other analytes tested in these sediments exceeded the freshwater sediment chemical criteria.

In 2000, sediment characterization was performed within the Middle Basin sediment trap area, one of the previous conceptual maintenance dredging areas. Sediment samples covering both the surface and subsurface (0 to 2.5 feet deep) were collected from four sampling locations and analyzed for total metals, toxicity characteristic leaching procedure (TCLP) metals, total petroleum hydrocarbons, SVOCs, volatile organic compounds (VOCs), pesticides, PCBs, and conventional parameters (Herrera 2000). All metals were detected at concentrations less than the SMS freshwater sediment chemical criteria. There were no detections of total petroleum hydrocarbons, VOCs, pesticides, or PCBs in these samples. A few SVOCs were detected in the samples; however, the concentrations were less than the SMS freshwater sediment chemical criteria.

An additional sediment characterization event was conducted in 2002 to assess the quality of the lake sediments adjacent to three stormwater outfalls on the eastern shoreline of the North Basin (Thurston County 2003). Three sediment samples were analyzed for SVOCs and lead, with all detected concentrations less than the SMS freshwater sediment chemical criteria.

The most recent characterization of Capitol Lake sediments, prior to the study conducted by this project, occurred in 2007 as part of a larger study to determine the nature and extent of dioxins/furans in Budd Inlet sediments (EIM study ID BUDD07) (SAIC 2008). Two sediment samples from Capitol Lake were analyzed for dioxins/furans and conventional parameters, and one of these samples, from the North Basin, was also analyzed for metals, SVOCs, and PCBs. There were no exceedances of the SMS freshwater sediment chemical criteria for the metals, SVOCs, and PCBs detected in the North Basin sediment sample. Dioxin/furan toxicity equivalency quotients (TEQs) calculated for the two samples were 2.0 and 3.9 nanograms per kilogram (ng/kg). While there is no SMS freshwater sediment chemical criterion for dioxin/furan TEQ, for comparative purposes, the dioxin/furan TEQs detected in the Capitol Lake sediment samples were less than the DMMP open-water disposal site management objective for Puget Sound of 4 ng/kg TEQ. The dioxin/furan DMMP site management objective is equivalent to the Puget Sound sediment natural background concentration established from the Ocean Survey Vessel Bold Survey (USEPA 2008, DMMP 2009).

In February 2019, a transformer oil spill was discovered at the Olympia Brewery on Boston Street SW near Capitol Lake. The transformer oil was confirmed by Ecology to have spread into Capitol Lake via storm drains and contained PCBs. During the summer and fall of 2019, Ecology was responsible for monitoring and removing PCB contaminated sediments from Capitol Lake. Lake cleanup consisted of removing oiled vegetation and debris, skimming oil from the water surface, and maintaining an oil containment boom. An average of 1 to 1.5 feet of contaminated sediment was dredged by divers in various cleanup locations. All locations of sediment remediation were sampled and analyzed for PCBs and oil, and were confirmed to not have chemical concentrations exceeding SMS freshwater sediment criteria after sediment removal (Ecology 2020b). Remedial areas are located near shore and not in the vicinity of the surface and core sediment stations sampled for the 2020 project study (see Appendix A, Figure 2-1).

4.1.2 2020 Project Study

Data collected as part of this project, during the March 2020 sediment sampling effort (see Figure 3.1), are presented in Appendix A and summarized separately for each parameter group by comparison of surface, dredge layer, and z layer results for the North and Middle Basins to SMS criteria (Table 2.3). Surface layer sediments would be left undisturbed during and following construction. Dredge layer sediments may be used to create habitat areas, or be removed for off-site upland reuse or disposal. Z layer sediments are in dredge areas that would become exposed after dredging. A summary of the Capitol Lake 2020 sediment characterization results is presented for each basin and sediment layer in Table 4.1. The table presents the percent detected and average detected result for selected conventional parameters, and any metal or organic compound detected in one or more samples. Average detected chemical concentrations exceeding criteria presented in Table 2.3 are shown in red.

Table 4.1. Capitol Lake 2020 Sediment Characterization Results for Detected Parameters.

		Middle Basin Samples						North Basin Samples					
		Surface		Dredge Layer		Z Layer		Surface		Dredge Layer		Z Layer	
Parameter	Units	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result
Conventionals													
Total Solids	%	100	39.3	100	59.8	100	72.4	100	29.2	100	50.3	100	62.9
Total Volatile Solids	%	100	9.0	100	6.1	100	3.1	100	12.5	100	6.95	100	5.00
Total Organic Carbon	%	100	3.0	100	2.03	100	1.07	100	4.02	100	2.31	100	1.93
Total Sulfides	mg/kg	66.7	142.4	100	155	100	10.4	100	1646	100	450	100	10.0
Ammonia	mg/kg	100	22.0	100	87.8	100	43.9	100	32.1	100	74.4	100	39.0
Total Fines (<62.5 µm)	%	100	65.13	100	47.58	100	42.95	100	82.28	100	55.95	100	39.64
Total Metals													
Arsenic	mg/kg	100	3.23	100	3.71	100	3.39	100	5.5	100	4.95	100	5.15
Cadmium	mg/kg	100	0.102	100	0.193	100	0.282	100	0.202	100	0.363	100	0.94
Chromium	mg/kg	100	28.6	100	27.4	100	22.8	100	34.9	100	32.1	100	27.0
Copper	mg/kg	100	44.1	100	34.3	100	21.0	100	57.3	100	39.3	100	25.6
Lead	mg/kg	100	5.14	100	6.75	100	3.28	100	7.38	100	11.4	100	6.06
Mercury	mg/kg	100	0.034	100	0.187	100	0.109	100	0.064	100	0.257	100	0.067
Nickel	mg/kg	100	26.1	100	25.9	100	21.5	100	30.8	100	28.1	100	21.6
Selenium	mg/kg	100	0.28	100	0.27	100	0.26	100	0.50	100	0.40	100	0.40
Silver	mg/kg	100	0.046	100	0.052	100	0.092	100	0.087	100	0.211	100	0.091
Zinc	mg/kg	100	58.5	100	51.7	100	36.9	100	77.9	100	67.5	100	44.8
Organometallics													
Monobutyltin	µg/kg	66.7	1.1	33.3	0.61	100	0.40	0	–	0	–	0	–
Miscellaneous Organics													
4-Methylphenol	µg/kg	0	–	33.3	18	0	–	0	–	50	5.8	100	11
Phenol	µg/kg	100	10.2	100	8.0	100	5.9	0	–	0	–	0	–
Phthalates													
bis(2-Ethylhexyl)phthalate	µg/kg	0	–	100	14.3	0	–	50	92	0	–	0	–
Butylbenzylphthalate	µg/kg	0	–	100	7.4	100	6.3	0	–	100	7.1	100	6.3
Diethylphthalate	µg/kg	0	–	0	–	0	–	0	–	0	–	0	–
Dimethylphthalate	µg/kg	0	–	0	–	0	–	0	–	0	–	0	–
Di-n-Butylphthalate	µg/kg	100	16.8	100	10.8	100	8.3	100		100	7.9	100	5.9
Di-n-Octyl phthalate	µg/kg	33.3	6.5	0	–	0	–	50	12	0	–	0	–
Petroleum Hydrocarbons													
Diesel Range Organics	mg/kg	100	12.1	100	10.4	100	4.6	100	23	100	19	100	11
Residual Range Organics	mg/kg	100	59.0	100	49.7	100	20	100	83	100	67	100	35
Pesticides and PCBs													
beta-BHC	µg/kg	0	–	0	–	0	–	0	–	50	2.1	0	–
Carbazole	µg/kg	0	–	33.3	8.4	0	–	0	–	0	–	0	–

Table 4.1 (continued). Capitol Lake 2020 Sediment Characterization Results for Detected Parameters.

		Middle Basin Samples						North Basin Samples					
		Surface		Dredge Layer		Z Layer		Surface		Dredge Layer		Z Layer	
Parameter	Units	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result	Percent Detected	Average Detected Result
Pesticides and PCBs													
Dieldrin	µg/kg	0	–	0	–	0	–	0	–	50	0.60	0	–
Total Aroclors	µg/kg	33.3	4.7	33.3	12	0	–	0	–	50	4.6	0	–
DDDs	µg/kg	0	–	66.7	2.4	0	–	0	–	50	2.0	0	–
DDEs	µg/kg	0	–	66.7	1.4	0	–	0	–	50	1.2	0	–
Polycyclic Aromatic Hydrocarbons													
Total PAHs	µg/kg	0	–	100	157.3	100	4.1	0	–	100	100	100	100
Total cPAHs TEQ (ND=1/2 DL)	µg/kg	100	4.3	100	6.4	100	2.5	100	4.4	100	9.7	100	8.1
Total LPAHS	µg/kg	0	–	100	16.5	0	–	0	–	100	16	100	29
Naphthalene	µg/kg	0	–	0	–	0	–	0	–	100	5.6	100	12
Acenaphthylene	µg/kg	0	–	0	–	0	–	0	–	0	–	100	3.0
Acenaphthene	µg/kg	0	–	0	–	0	–	0	–	0	–	0	–
Fluorene	µg/kg	0	–	0	–	0	–	0	–	0	–	100	3.7
Phenanthrene	µg/kg	0	–	100	14.1	0	–	0	–	100	9.2	100	9.9
Anthracene	µg/kg	0	–	33.3	7.0	0	–	0	–	0	–	100	4.4
2-Methylnaphthalene	µg/kg	0	–	0	–	0	–	0	–	0	–	100	3.5
Total HPAHs	µg/kg	0	–	100	144	100	4.1	0	–	100	82	100	69
Fluoranthene	µg/kg	0	–	100	32	100	4.1	0	–	100	19	100	17
Pyrene	µg/kg	0	–	100	22	0	–	0	–	100	16	100	17
Benzo(a)anthracene	µg/kg	0	–	100	14	0	–	0	–	100	5.7	100	5.7
Chrysene	µg/kg	0	–	100	15	0	–	0	–	100	9.1	100	5.0
Total Benzofluoranthenes	µg/kg	0	–	100	24	0	–	0	–	100	11	100	7.6
Benzo(a)pyrene	µg/kg	0	–	100	13	0	–	0	–	100	7.1	100	6.1
Indeno(1,2,3-cd)pyrene	µg/kg	0	–	100	11	0	–	0	–	100	7.9	100	4.8
Dibenz(a,h)anthracene	µg/kg	0	–	100	4.0	0	–	0	–	0	–	0	–
Benzo(g,h,i)perylene	µg/kg	0	–	100	10	0	–	0	–	100	7.8	100	5.4
Dioxins/Furans													
Total 2,3,7,8-TCDD TEQ (ND=1/2 DL)	ng/kg	100	1.02	100	1.83	100	1.24	100	2.67	100	4.57	100	2.16

Arithmetic average concentrations are presented for comparative purposes only. Individual sample results can be found in Appendix A.

Red chemical concentrations exceed the following criteria referenced in Table 2.3:

- Sulfide concentration exceeds freshwater cleanup screening level of 61 mg/kg
- Mercury concentration exceeds marine human health criterion of 0.2 mg/kg
- Total dioxins 2,3,7,8-TCDD TEQ concentration exceeds marine human health criterion and DMMP screening level of 4 ng/kg

4.1.2.1 Conventional Parameters

SMS criteria are established for total sulfides and ammonia in freshwater sediments. No SMS criteria have been established for marine sediments. All ammonia samples (ranging from 17.5 to 117 mg/kg) were lower than the freshwater SCO criterion of 230 mg/kg. Several total sulfides results exceeded the freshwater SCO criterion of 39 mg/kg or CSL criterion of 61 mg/kg, as follows:

- Total sulfides in the Middle Basin exceeded the SCO criterion in one dredge layer sample (43.2 mg/kg), and exceeded the CSL criterion in one surface sample (277 mg/kg) and two dredge layer samples (360 and 61.7 mg/kg).
- Total sulfides in the North Basin exceeded the CSL criterion in one surface sample (3,270 mg/kg) and both dredge layer samples (130 and 770 mg/kg).

Average sulfide concentrations exceeded the freshwater CSL in the surface and dredge layer in both basins, but not in the z layer of either basin (see Table 4.1).

4.1.2.2 Metals

Metals criteria were exceeded at one or more stations:

- For the Middle Basin, mercury concentrations slightly exceeded the marine SCO and DMMP SL of 0.41 mg/kg in one dredge layer sample (0.43 mg/kg), and nickel slightly exceeded the 26 mg/kg freshwater SCO in two surface grab samples (27 and 28 mg/kg) and one dredge layer sample (29 mg/kg).
- For the North Basin, mercury concentrations slightly exceeded the marine SCO and DMMP SL of 0.41 mg/kg in one dredge layer samples (0.43 mg/kg), and nickel exceeded the 26 mg/kg freshwater SCO in both surface samples (32 and 29 mg/kg).

Average metal concentrations did not exceed any freshwater or marine benthic criteria except nickel exceeded the freshwater SCO in the surface layer of the North Basin and in the surface and dredge layers of the Middle Basin (see Table 4.1). However, none of the nickel concentrations exceeded average nickel concentrations observed in soils in Washington (46 mg/kg) (USGS 1995). Average metal concentrations exceeded marine natural background concentrations for protection of human health except for cadmium in the z layer of the North Basin (see Table 4.1), copper in the surface layer of the North Basin, and mercury in the dredge layer of the North Basin.

4.1.2.3 Semivolatile Organic Compounds

Low concentrations of PAHs were detected in dredge and z layer samples (but not in surface samples) in both basins (see Table 4.1 and Appendix A, Table A-1). No detected SVOCs exceeded freshwater or marine benthic SCO, DMMP, or MTCA method B criteria in either the Middle Basin or North Basin. Average concentrations of total carcinogenic PAHs TEQ in the surface, dredge, or z layer samples did not exceed the Puget Sound natural background (human health SCO) of 21 µg/kg or the Budd Inlet regional background (human health CSL) of 78 µg/kg (see Table 4.1).

4.1.2.4 Petroleum Hydrocarbons

Low concentrations of petroleum hydrocarbons were detected in all samples collected (ranging from 4.6 to 26 mg/kg for diesel range organics, and ranging from 20 to 110 mg/kg for residual range organics), but no results exceeded freshwater SCO (340 mg/kg for diesel range organics and 3,600 mg/kg for residual range organics) or MTCA Method A criteria (2,000 mg/kg for diesel range organics, and 4,000 mg/kg for residual range organics).

4.1.2.5 Pesticides and PCBs

Low concentrations of pesticides were found in the dredge layer of both the Middle Basin and North Basin (see Appendix , Table A-1), but no detected results exceeded freshwater SCO, DMMP, or MTCA Method B criteria. Low concentrations of PCBs were found in the surface and dredge layer of the Middle Basin (4.7 and 12 µg/kg, respectively), and in the dredge layer of the North Basin (4.6 µg/kg). No total PCB results exceeded freshwater (110 µg/kg) or marine (130 µg/kg or 12 mg/kg organic carbon normalized) SCO, DMMP (130 µg/kg), or MTCA Method B (500 mg/kg) criteria.

4.1.2.6 Dioxins/Furans

Dioxins/furans TEQ concentrations, ranging from 0.9 to 7.4 ng/kg, were below the Puget Sound natural background concentration and DMMP SL of 4 ng/kg for dispersive site disposal in Puget Sound, with one exception. The dioxins/furans TEQ result in one dredge layer sample (7.4 ng/kg) in the North Basin exceeded the 4 ng/kg criterion, but did not exceed the regional background criterion CSL of 19 ng/kg for Budd Inlet. The average dioxins/furans TEQ for the two dredge-layer samples from the North Basin was 4.6 ng/kg (see Table 4.1), which slightly exceeds the Puget Sound natural background SCO based on an area-wide average. For disposal of dredged sediments at a non-dispersive disposal site in Puget Sound, which includes the Anderson/Ketron Island site closest to Budd Inlet, the DMMP SL criteria include 4 ng/kg for the site volume-weighted average and 10 ng/kg for the maximum concentration in any one dredge material management unit (DMMU). Thus, none of the dredge layer results exceed the DMMU maximum and it is possible the North Basin dredge layer could exceed volume-weighted average limit depending on the dredge volume proportions.

4.1.3 Summary

Capitol Lake has sediment quality that meets nearly all applicable sediment quality standards. Sediment chemical concentrations were low in all three layers of both lake basins. The only freshwater benthic CSL exceeded was the freshwater CSL for total sulfides; there are no marine benthic criteria for total sulfides. High sulfide concentrations are common in lake sediments due to microbial decay of natural organic matter present in algae and aquatic plants. Average concentrations of total sulfides exceeded the freshwater CSL in the surface and dredge layer in both basins, but not in the z layer of either basin due to the low amount of organic matter in this deep sediment layer. Benthic invertebrates present in the surface layer are likely impacted by the high concentrations of total sulfides (and associated low dissolved oxygen), but not by anthropogenic chemicals.

Average metal concentrations did not exceed any freshwater or marine benthic criteria except nickel exceeded the freshwater SCO in the surface layer of the North Basin and in the surface and dredge layers of the Middle Basin. However, none of the nickel concentrations exceeded average concentrations observed in soils in Washington (46 mg/kg) (USGS 1995). Average metal concentrations exceeded Puget Sound natural background concentrations for protection of human health for cadmium in the z layer of the North Basin, copper in the surface layer of the North Basin, and mercury in the dredge layer of the North Basin. None of the observed metals concentrations would trigger sediment cleanup as the detected concentrations were less than the SMS CSL and are not uncommon in urban areas.

Average concentrations of organic chemicals did not exceed any freshwater or marine benthic criteria and would not trigger sediment cleanup. The average dioxins/furans TEQ for the North Basin dredge layer samples (4.6 ng/kg) slightly exceeded the Puget Sound natural background SCO of 4 ng/kg, but did not exceed the Budd Inlet regional background CSL concentration of 19 ng/kg. For disposal of dredged sediments at a non-dispersive disposal site in Puget Sound, which includes the Anderson/Ketron Island site closest to Budd Inlet, the DMMP SL criteria for dioxins/furans include 4 ng/kg for the site volume-weighted average and 10 ng/kg for the maximum concentration in any one dredge material management unit (DMMU). None of the dredge layer results exceed the DMMU maximum and it is possible the North Basin dredge layer could exceed the volume-weighted average limit depending on the dredge volume proportions. Therefore, concentrations of dioxins/furans would not trigger sediment cleanup in Budd Inlet but may not allow for open-water disposal at a non-dispersive site such as Anderson/Ketron Island depending on the volume-weighted average concentration in all dredged sediments.

No sediment chemical concentrations exceed MTCA Method B direct contact soil cleanup levels. Therefore, there would be no restrictions for reuse or placement of sediments dredged from Capitol Lake at an upland location based on chemical concentrations.

4.2 BUDD INLET SEDIMENT QUALITY

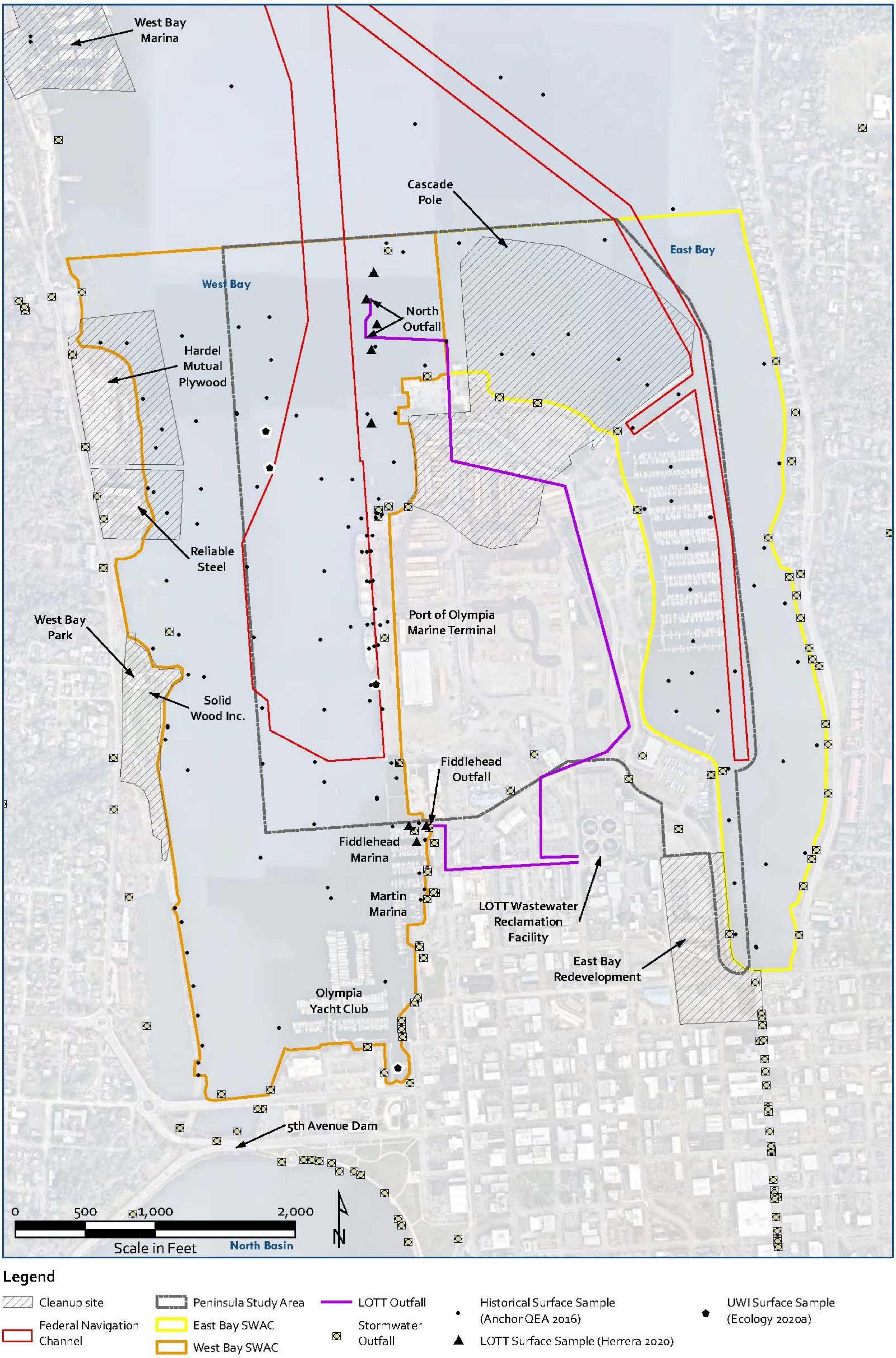
A summary of four historical studies conducted in Budd Inlet between 2008 and 2019 is presented below. In general, sediment quality in Budd Inlet has not met sediment quality criteria based on these historical studies. Contaminants of primary concern include cPAHs and dioxins/furans affecting human and ecological health and located throughout the inlet, while benthic criteria have been exceeded near stormwater outfalls.

There are several cleanup sites around Budd Inlet. Clean up at some sites have been completed but may be reactivated and additional sites may be identified in the future. Currently, Ecology identifies eight cleanup sites around Budd Inlet (see Figure 4.1):

- **West Bay Marina**. Cleanup actions have occurred at the site for copper, petroleum contaminated soil, and dioxins/furans. Ecology has determined that no further cleanup actions are required; however, some dioxins/furans contamination remains in soil at the site. This contamination is being managed by an Environmental Covenant at the site, which limits the type of land use to protect human health and the environment.

- **Hardel Mutual Plywood**. Contaminants of concern at this site included petroleum hydrocarbons and PAHs. The site was determined to be cleaned up by Ecology in 2012. In 2020, additional petroleum-related exceedances in soil and groundwater were found during due diligence investigation activities conducted at the site. In 2020 and 2021 additional supplemental remedial investigation data gap investigation activities were completed. Ecology rescinded its 2012 no further action determination on August 17, 2021. The site is currently in Ecology's Voluntary Cleanup Program.
- **Reliable Steel**. The site was investigated from 2010 – 2013 and a draft cleanup plan was prepared in 2014. Contaminants found above sediment cleanup levels include metals, PAHs, and phthalates.
- **Industrial Petroleum**. Petroleum contamination of soils and groundwater was cleaned up in 2016 and the site is being removed from the Hazardous Sites List.
- **Solid Wood Inc**. Initial investigations found levels of metals, TPH, and PAHs that exceeded MTCA cleanup standards for soil or groundwater. An interim cleanup was conducted in 2009 and a remedial investigation is currently underway.
- **Cascade Pole**. Clean-up actions taken from 1990 to 2008 included dredging approximately 40,000 cubic yards of creosote-contaminated sediments and moving dredged sediment to an upland area and capping them with pavement. Two steel sheet pile walls were installed to stop the flow of contamination into Budd Inlet. In addition, a slurry wall was installed to stop the movement of contamination off-site and a groundwater treatment system was installed to remove some contamination and keep contamination from moving outside the containment area. The Port of Olympia has been required by Ecology to conduct monitoring every 5-years to monitor conditions. The most recent sediment monitoring samples collected in 2017 are below the project clean-up action levels and showed decreasing trends in PAH and dioxin concentrations compared to previous sediment monitoring events (2002, 2007, and 2012) (Landau Associates 2017).
- **East Bay Redevelopment**. Historic timber industry activities caused soil and groundwater contamination with metals TPHs, cPAHs, and dioxins/furans. From 2009-2012, two partial cleanups (interim actions) were done to remove and contain contaminated soil on the southern half of the site. In 2017, Ecology worked with the City of Olympia, the Port of Olympia, and LOTT to complete cleanup of the site by removing soil contamination hot spots covering remaining contaminants with a cap of clean soil, pavement, or buildings.
- **Port of Olympia Peninsula Investigation**. The Port of Olympia has investigated contamination of the peninsula located between and including part of East Bay and West Bay, and is currently evaluating possible cleanup actions for an interim cleanup action plan (see 2013 study described below).

Figure 4.1. Surface Sediment Sample, Outfall and Cleanup Site Locations in Budd Inlet.



4.2.1 Ecology 2008 Sediment Study

A sediment characterization study of existing sediment data was completed for Budd Inlet in 2008 for Ecology (SAIC 2008). As part of this study, all sediment data available in EIM for Budd Inlet were evaluated for SCO and CSL exceedances.

The SQS (SCO) or CSL exceedances were noted on a map at each sample location, but without distinguishing whether it was an SQS or CSL exceedance and data tables were not presented in the report. In West Bay, SMS (SQS or CSL) criteria were most frequently exceeded for miscellaneous organics (see Table 2.3) (at approximately 30 stations) and rarely exceeded for phthalates (6 stations), metals (4 stations), PAHs (2 stations), phenol (2 stations), and chlorinated aromatics (1 station). These study results are not presented or described further because these same historical data were evaluated by the Port of Olympia 2013 sediment study (see below) that included excluding data for sediment that had been dredged and is therefore unrepresentative of current conditions.

4.2.2 Port of Olympia 2013 Sediment Study

In 2013, extensive sediment monitoring was conducted in the vicinity of the Port of Olympia peninsula in Budd Inlet for developing a conceptual site model, sediment cleanup levels, and remedial alternatives for the study area. The results of this study were provided in a 2016 report prepared by Anchor QEA (2016). A total of 65 surface grab samples and 50 subsurface cores were collected. All samples were analyzed for dioxins/furans, the primary parameter of interest, and select samples were analyzed for SMS parameters. A summary of statistics for all data collected in the West and East Bays of Budd Inlet is presented in Table 4.2 for chemicals identified as a potential concern. Surface sediment chemistry results for West Bay are summarized below because those sediments are of primary interest for this sediment discipline report.

Approximately 38 surface sediment samples were collected in the West Bay. Three SVOCs (benzyl alcohol, acenaphthene, and butylbenzyl phthalate) exceeded marine SMS or AET SCOs at the Port of Olympia. Mercury exceeded the marine SCO near the primary LOTT outfall, and five SVOCs (benzoic acid, benzyl alcohol, bis[2-ethylhexyl]phthalate, butylbenzyl phthalate, and di-n-butyl phthalate) exceeded SCO criteria near the Fiddlehead outfall and marina. However, no chemical concentrations exceeded CSL criteria. Therefore, benthic invertebrates are not significantly impacted by sediment quality and no sediment cleanup is required for protection of the benthic community in West Bay. Sample locations with SMS exceedances are shown in Figure 4.2.

Spatially weighted average concentrations (SWAC) of carcinogenic PAH TEQs and dioxins/furans were calculated for comparison to regional background concentrations that are protective of ecological and human health. Historical sediment data for these parameters were also compiled for this study, while excluding data for sediment that had been dredged and is therefore unrepresentative of current conditions. Inverse distance weighting was used to plot interpolated concentrations in Budd Inlet surface sediments of carcinogenic PAHs (Figure 4.2) and dioxins/furans (Figure 4.3). Anchor QEA recently provided digital data for these figures (D. Berlin, Anchor QEA, personal communication).

The average carcinogenic PAHs concentration for the entire West Bay (87 ppb) exceeded regional background (78 ppb). Carcinogenic PAHs were generally found to be between 10 and 100 µg/kg in most of West Bay with low concentrations less than 50 µg/kg near the 5th Avenue Dam and north along the west shore, and high concentrations between 100 and 500 µg/kg along the east shore near the Fiddlehead Marina and north along the Port of Olympia berths. These areas of high sediment cPAH concentrations are likely impacting human and ecological health in Budd Inlet and are a focus of Port of Olympia peninsula cleanup efforts.

The average dioxins/furans concentration for the entire West Bay (15 ng/kg) did not exceed regional background (19 ng/kg), but did exceed the DMMP SL for dispersive disposal sites (4 ng/kg) and non-dispersive disposal sites (10 ng/kg). Dioxins/furans were generally found to be between 5 and 20 ng/kg in most of West Bay with low concentrations less than 5 ng/kg near the 5th Avenue Dam and north along the west shore, and high concentrations between 20 and 40 ng/kg on the east shore from Olympia Yacht Club to Fiddlehead Marina northeast of the dam. These areas of high sediment dioxins/furans concentrations are likely impacting human and ecological health in Budd Inlet and are a focus of Port of Olympia peninsula cleanup efforts.

It should be noted that Budd Inlet is an active cleanup site and remedial actions in Budd Inlet are ongoing. As the remedial process advances and site boundaries or sediment clean-up units (SCUs) are identified, SWACs will be calculated for samples collected only within those defined areas. The SWACs presented in this report may be biased low, as the SWACs may contain samples results from areas outside of future defined site boundaries with little to no contamination (L. Sullivan, Ecology, personal communication).

Table 4.2. Budd Inlet Surface Sediment Quality for Chemicals of Potential Concern.

	Peninsula Study of West and East Bays in 2016[a]					West Bay in 2018[b]	LOTT Outfalls in 2019[c]
	No of Values	Percent Detected	Min. Detected Result	Max. Detected Result	Average Detected Result	Average Detected Result	Average Detected Result
Conventional Parameters (percent)							
Total Fines (silt+clay)	65	100	7.8	98.9	63.4	58.9	40.7
Total organic carbon	106	100	0.57	9.4	3.66	2.48	2.41
Total solids	106	100	18.7	85.6	41.1	40.8	52.2
Metals (mg/kg)							
Arsenic	31	29	1.34	20	10.9	--	6.6
Cadmium	31	100	0.07	4.2	1.80	1.88	1.32
Chromium	31	100	11.6	41	29.1	34.0	22.8
Copper	31	100	10.2	126	59.7	56.3	44.9
Lead	31	100	3	45	18.6	15.3	9.4
Mercury	31	100	0.014	0.51	0.119	0.114	0.171
Silver	31	13	0.03	0.61	0.420	0.291	0.266
Zinc	31	100	42	182	98.2	84.3	78.7
Semivolatile Organics (µg/kg)							
1,2,4-Trichlorobenzene	36	0	–	–	–	–	–
1,2-Dichlorobenzene	36	11	2.6	11	5.15	–	4.9
1,4-Dichlorobenzene	36	44	2.5	17	6.14	–	4.6
2,4-Dimethylphenol	36	50	3.5	18	8.62	–	3.4
2-Methylphenol (o-Cresol)	31	55	2.4	18	8.78	–	–
4-Methylphenol (p-Cresol)	31	100	5	420	125	–	65
Benzoic acid	36	56	110	780	277	–	96.7
Benzyl alcohol	36	36	7	70	28.8	–	–

Table 4.2 (continued). Budd Inlet Surface Sediment Quality for Chemicals of Potential Concern.

	Peninsula Study of West and East Bays in 2016[a]					West Bay in 2018[b]	LOTT Outfalls in 2019[c]
	No of Values	Percent Detected	Min. Detected Result	Max. Detected Result	Average Detected Result	Average Detected Result	Average Detected Result
Semivolatile Organics (continued)							
bis(2-Ethylhexyl)phthalate	36	97	18	2300	226	–	197
Butylbenzyl phthalate	36	72	3.3	86	21.9	–	47.7
Di-n-butyl phthalate	31	16	44	610	160	–	41
Di-n-octyl phthalate	36	6	19	79	49	–	–
Dibenzofuran	70	71	10	140	30.2	16.5	14.2
Diethyl phthalate	36	8	38	130	70	30	–
Dimethyl phthalate	36	36	3	44	15.1	8.8	25.2
Hexachlorobenzene	36	0	–	–	–	–	–
N-Nitrosodiphenylamine	36	8	2.4	17	7.97	–	–
Pentachlorophenol	36	25	16	160	41.4	–	34.7
Phenol	36	77.8	14	520	90.9	–	34.2
Hexachlorobutadiene	5	0	–	–	–	–	–
Polycyclic Aromatic Hydrocarbons (µg/kg)							
2-Methylnaphthalene	70	51	10	150	33.2	10.5	11.6
Acenaphthene	70	69	12	830	59.4	14.7	11.9
Acenaphthylene	70	51	2	110	26.3	22.8	24.3
Anthracene	70	90	3.7	240	49.6	60.8	40.6
Benzo(a)anthracene	70	97	11	1100	103	107	101
Benzo(a)pyrene	70	97	12	2100	127	100	96.8
Benzo(b)fluoranthene	5	100	22	190	119	156	–
Benzo(k)fluoranthene	5	80	7.9	62	42.5	166	–
Benzo(g,h,i)perylene	70	93	11	1700	87	67.8	58.6
Chrysene	70	99	13	1400	173	193	287

Table 4.2 (continued). Budd Inlet Surface Sediment Quality for Chemicals of Potential Concern.

	Peninsula Study of West and East Bays in 2016[a]					West Bay in 2018[b]	LOTT Outfalls in 2019[c]
	No of Values	Percent Detected	Min. Detected Result	Max. Detected Result	Average Detected Result	Average Detected Result	Average Detected Result
Polycyclic Aromatic Hydrocarbons (µg/kg) (continued)							
Dibenzo(a,h)anthracene	70	73	2.9	340	30.4	21.4	20.5
Fluoranthene	70	100	17	1900	315	245	463
Fluorene	70	70	11	330	35.6	23.3	18.7
Indeno(1,2,3-c,d)pyrene	70	96	10	1300	72.6	75.1	56.2
Naphthalene	70	94	12	1200	111	36	35.3
Phenanthrene	70	99	11	650	149	84	157
Pyrene	70	100	23	1900	334	366	418
Total Benzofluoranthenes	70	100	12	3000	259	322	313
Total cPAH TEQ (U=1/2)	70	100	13.6	2690	170	154	148
Total HPAH	70	100	52	14800	1480	1490	1810
Total LPAH	70	100	16.7	2380	376	242	282
Dioxin Furans (ng/kg)							
Total Dioxins/Furans TEQ (U=1/2)	105	100	0.649	98.9	19.5	–	–
PCB Aroclors (µg/kg)							
Total PCB Aroclors	32	50	5.7	222	34.8	24.3	17.5

Value exceeds marine SCO but not CSL.

Value exceeds marine CSL.

[a] Port of Olympia Peninsula Sediment Study in 2016 (Anchor QEA 2016).

[b] Ambient monitoring of four sediment stations in West Bay by Ecology in 2018 (Ecology 2020a).

[c] Monitoring of eight stations in the vicinity of LOTT's main and emergency outfalls in West Bay in 2019 (Herrera 2020).

4.2.3 Urban Waters Initiative Sediment Sampling

The Washington State Department of Ecology's Marine Sediment Monitoring Team has conducted sediment quality monitoring in Puget Sound since 1989, as part of the Puget Sound Sediment Monitoring Program. Sediment chemistry, toxicity, and benthic invertebrates (benthos) have been monitored annually to determine the effects of contaminated sediments on benthos, a key indicator of estuarine sediment condition. A total of 8 regions and six urban bays, which includes Budd Inlet are included in the study. A total of four surface sediment sample stations are in the West Bay of Budd Inlet (see Figure 4.1). In 2019, the data were compiled into one study, Urban Waters Initiative (EIM Study ID UWI), with the purpose to gauge the long-term effectiveness of collective toxics management efforts. The objectives are to assess the current conditions in study areas particularly the overall extent of sediment contamination, and to determine whether there have been changes in sediment quality over time (Ecology 2020a).

Surface sediment samples were collected at the four stations in the West Bay of Budd Inlet in 2011, and most recently in 2018 (Ecology 2020a). Table 4.2 presents the average chemical concentrations for the 2018 sampling event. Average chemical concentrations do not exceed marine SMS or AET SCOs at any of the sample stations.

Figure 4.4 presents data collected for all 8 regions and 6 urban bays throughout the study presented as (top to bottom) (PSP 2020): percentage of chemicals exceeding Sediment Quality Standards (SQS), Sediment Chemistry Index (SCI), and marine Sediment Quality Triad Index (SQTI).

The target of zero percent of chemicals exceeding SQS was met in Budd Inlet in both 2011 and 2018 (see top graph in Figure 4.4). Contaminants measured that contribute to the SQS Index include metals, PCBs, PAHs, and phthalates.

The SCI combines data on the concentrations of selected chemicals for which SMS criteria have been set into an overall index of chemical exposure. The SCI ranges from 1 to 100, with higher index values indicating less exposure to chemical and thus healthier sediments. Budd Inlet met the SCI target value of 93.3 in both 2011 (95.0) and 2018 (95.3) (see middle graph in Figure 4.4).

The SQTI combines sediment chemistry, toxicity, and benthos condition indicators into one number to describe overall sediment quality in Puget Sound. Budd Inlet did not meet the SQTI target value of 81 in 2011 (56.28) (see bottom graph in Figure 4.4) because of low benthos conditions caused by high organic matter content. There is strong relationship between high levels of organic matter in sediments and adversely affected benthic communities, and organic matter accumulates more in terminal inlets such as Budd Inlet than other areas of Puget Sound (PSP 2020). Budd Inlet was sampled in 2018, but toxicity testing was discontinued after 2015, so SQTI values were not calculated for 2018.

4.2.4 LOTT 2019 Study

Historical data review and sediment sampling were recently conducted in compliance with NPDES permit No. WA0037061 for LOTT Clean Water Alliance and the Ecology-approved SAP (Herrera 2020a). A search for sediment chemistry results in Ecology's EIM database for the project vicinity identified the 1996 LOTT NPDES sediment monitoring study (EIM Study ID LOTT_96). A total of 10 locations were sampled in the vicinity of the main north outfall and a total of nine locations were sampled in vicinity of the emergency Fiddlehead outfall (see Figure 4.2) for the following parameters:

- Conventionals (TOC, total solids, total volatile solids, ammonia, and sulfides)
- Metals (arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc)
- SVOCs
- PCBs
- Pesticides
- Oil and grease

No SMS criteria exceedances were found in the samples collected near the main outfall. However, criteria exceedances were found near the Fiddlehead outfall and marina where one sample exceeded the SQS (SCO) for butyl benzyl phthalate and dimethyl phthalate, and exceeded the CSL for 4-methylphenol and bis(2-ethylhexyl) phthalate. No corrective actions were required because of this study.

A total of eight surface sediment samples were collected in September 2019 to characterize current sediment quality in the vicinity of LOTT's primary north outfall and emergency Fiddlehead outfall. Five samples were collected up to 450 feet from the primary north outfall and three samples were collected up to 150 feet from the emergency Fiddlehead outfall. All samples were analyzed for conventional parameters, metals, SVOCs, and PCBs and compared to SMS criteria, yielding the following conclusions:

- Metals – concentrations did not exceed any SMS criteria at any station.
- SVOCs – only the SQS/SCO criterion for butyl benzyl phthalate was exceeded at one station located 150 feet west of the Fiddlehead outfall.
- PCBs – did not exceed any SMS criteria at any station.

In general, low chemical concentrations were found across the site that were well below SMS criteria. One exception is the elevated concentration of butyl benzyl phthalate at one station near the Fiddlehead outfall, which required biological toxicity testing. Sediment collected from this station passed all SQS biological toxicity criteria with a low amphipod mortality, high benthic larval development, and high juvenile polychaete growth relative to a reference sample. Because no biological toxicity was observed, no samples exceeded SQS/SCO criteria. Thus, sediment quality that does not require clean-up relative to applicable standards was observed in the vicinity of the two LOTT outfalls indicating no impacts to benthic invertebrates in either of these areas and including the northern portion of Fiddlehead Marina where SMS criteria had been previously reported in 1996 and by Anchor QEA (2016) (see Figure 4.2). Table 4.2 presents the average chemical concentrations for this study.

4.2.5 Summary

Recent sediment studies have shown that sediment chemical concentrations did not exceed SMS and DMMP criteria in West Bay except for selected chemicals in some samples collected near stormwater outfalls in marinas and the Port of Olympia along the eastern shoreline of the West Bay. Sediment sample average chemical concentrations for the most recent studies were all similar (Table 4.2). Some exceedances of SCOs for SVOCs (acenaphthene, phthalates, benzyl alcohol, and benzoic acid) and mercury were found in recent surface sediment samples collected near stormwater outfalls to West Bay. In general, lower concentrations of SMS parameters were found in the central and southwest areas of West Bay.

Spatially weighted average concentrations of dioxins/furans and carcinogenic PAH TEQs in West Bay were calculated for comparison to regional background concentrations for these bioaccumulative chemicals that are protective of ecological and human health. The average dioxins/furans concentration for West Bay (15 ng/kg) did not exceed regional background (19 ng/kg), but did exceed the DMMP SL for dispersive disposal sites (4 ng/kg) and non-dispersive disposal sites (10 ng/kg). The average carcinogenic PAHs concentration for West Bay (87 ppb) exceeded regional background (78 ppb), indicating potential impacts to ecological and human health. As Budd Inlet is currently an active site with on-going remedial activities, SWACs may be biased low when compared to results once site boundaries and SCUs are developed in the future.

Figure 4.2. Surface Sediment cPAHs and SMS Exceedances in Budd Inlet.

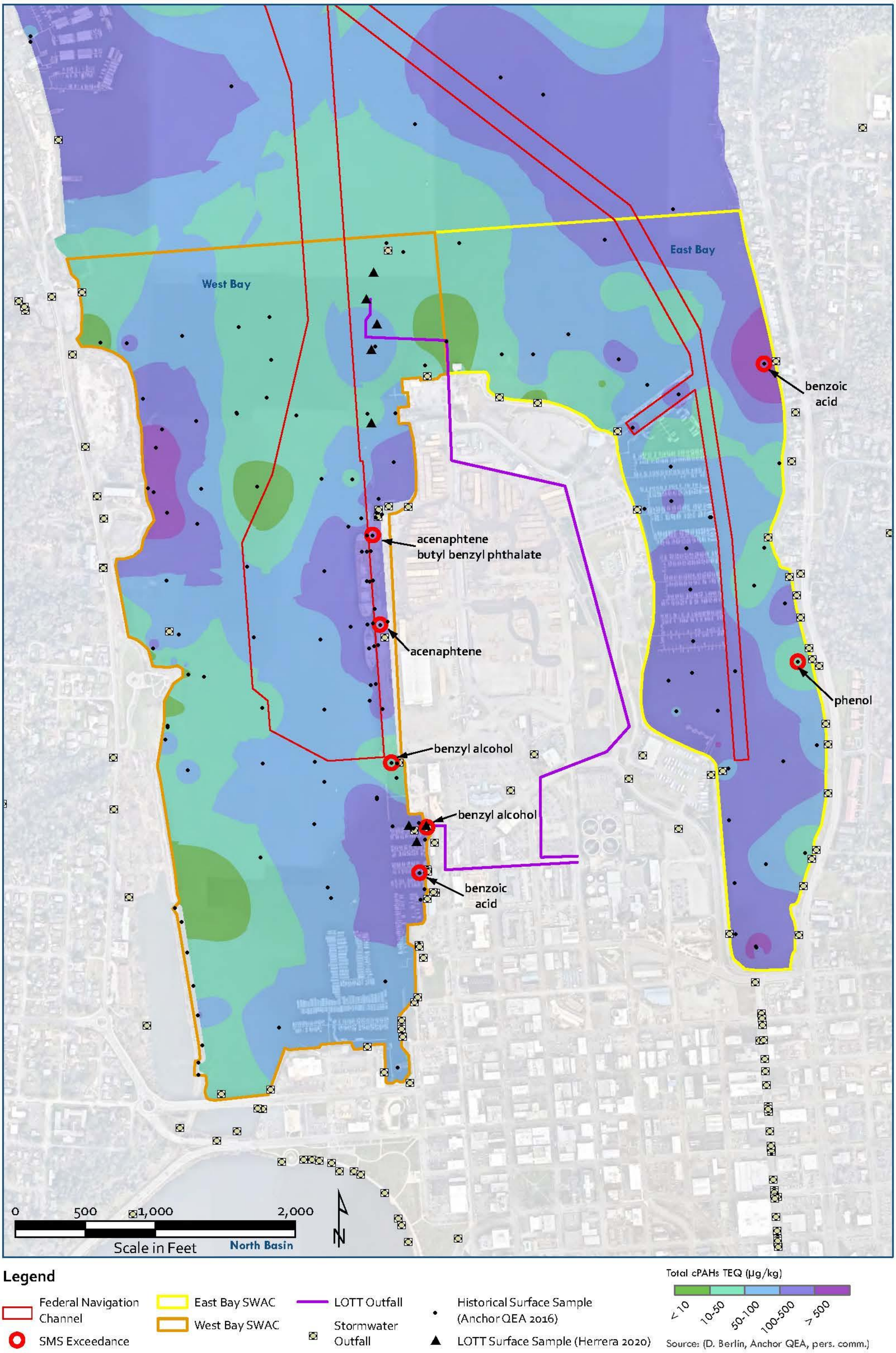


Figure 4.3. Surface Sediment Dioxins/Furans in Budd Inlet.

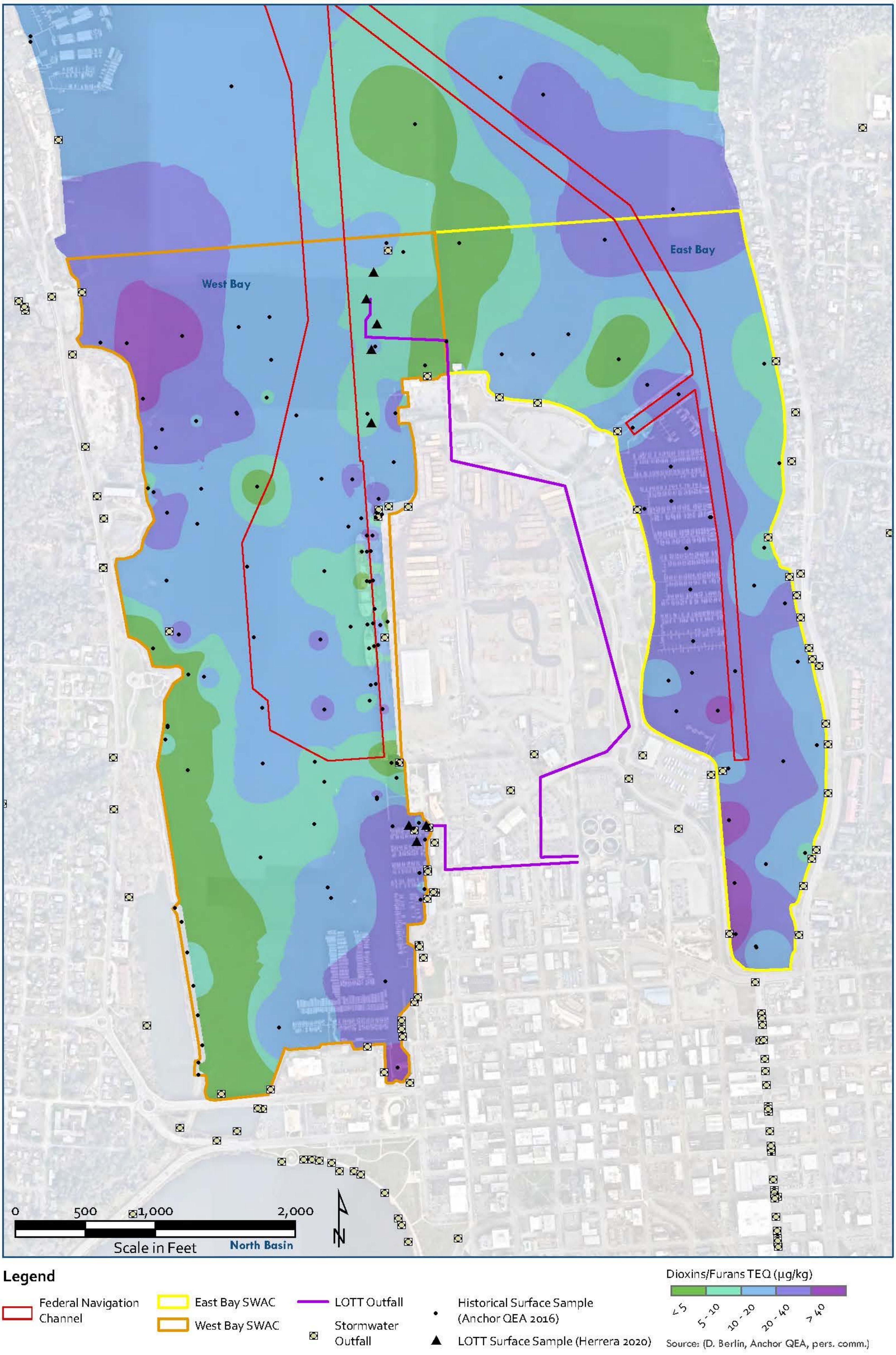
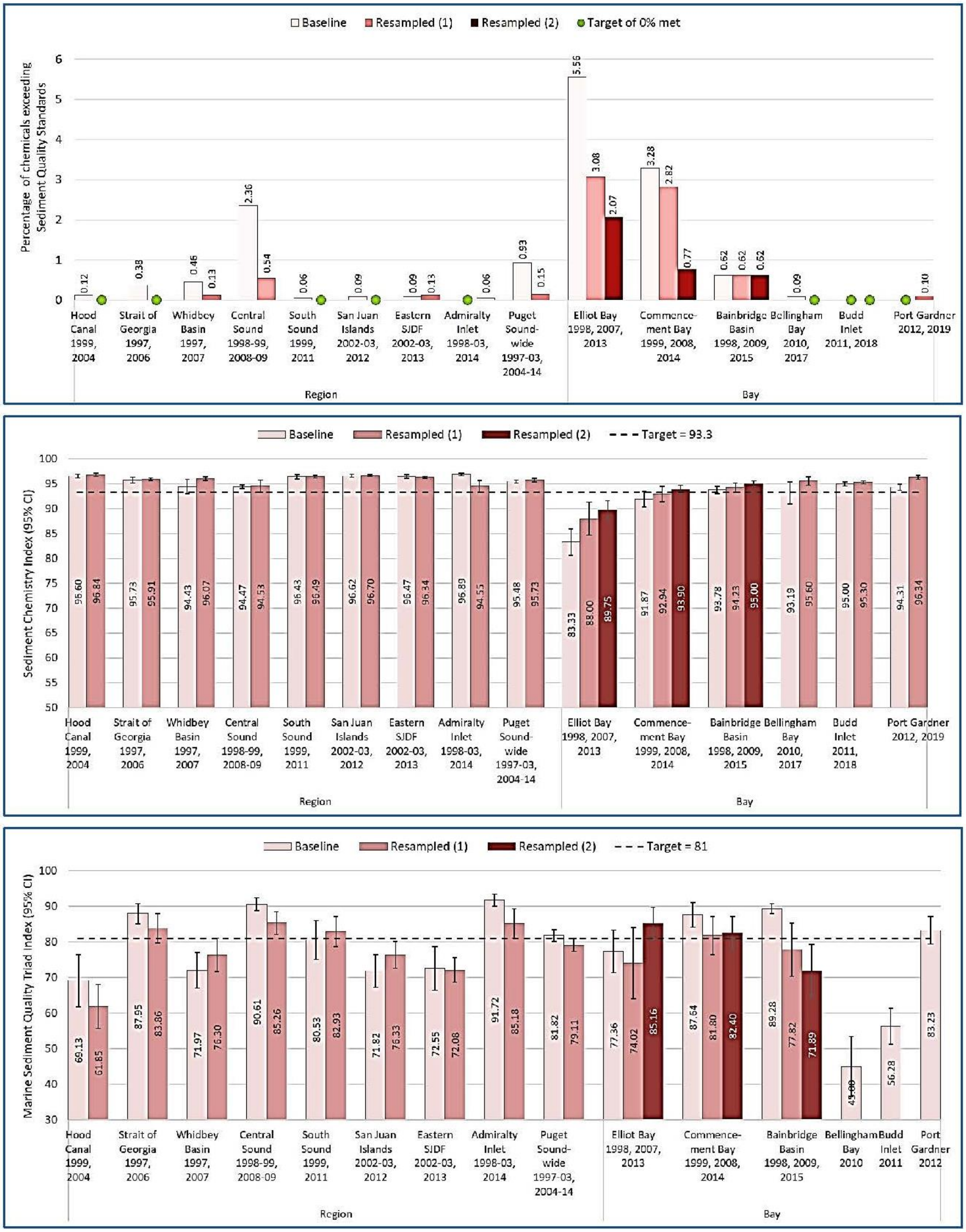


Figure 4.4. Marine Sediment Quality Indicators.



Source; PSP 2020

5.0 Impacts and Mitigation Measures

5.1 OVERVIEW

This section describes the probable significant impacts related to sediment quality from the No Action Alternative and the Build Alternatives (Managed Lake, Estuary, and Hybrid Alternatives). This section also identifies mitigation measures that could avoid, minimize, or reduce the identified impact below the level of significance.

5.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, the 5th Avenue Dam would remain in its current configuration, with limited repair and maintenance activities. Based on this, the No Action Alternative would not result in construction impacts on sediment quality because there is no construction. It is expected that the sediment inputs to the Capitol Lake Basin would remain as they are now, so the risk of sediment quality to deteriorate is expected to be low, and impacts would be **less than significant**.

5.3 IMPACTS COMMON TO ALL BUILD ALTERNATIVES

The build alternatives have in common impacts associated with construction and operation. The extent of impacts on sediment quality may vary between alternatives and are addressed under the impacts and mitigation described for each alternative section. To avoid an adverse impact from the build alternatives, sediment quality cannot be degraded by exceeding sediment cleanup criteria (see Section 3.3).

5.3.1 Impacts from Construction

Construction-related impacts common to all build alternatives are associated with initial dredging and placement or export of dredged sediments. For the Managed Lake Alternative, 348,000 cubic yards would be dredged from the entire 127 acres of the North Basin, and all dredged sediments would be placed over approximately 35 percent of the 147-acre Middle Basin to construct habitat islands. For the Estuary Alternative, 526,000 cubic yards would be dredged from approximately 30 acres of the

North Basin, 30 acres of the Middle Basin, and less than 5 acres at the Fifth Avenue opening. All but 3 percent of the dredged sediments would be placed in other areas of the North and Middle Basin to construct habitat islands covering approximately 30 percent of each basin. In addition, approximately 10 acres of the west shoreline of each basin would be filled to stabilize Deschutes Parkway. Initial dredging for the Hybrid Alternative would be similar to that described for the Estuary Alternative except less sediment would be dredged from the North Basin and placed in the North Basin with a lower total dredge volume of 499,000 cubic yards, and with 20 percent of that being exported compared to 3 percent for the Estuary Alternative.

Sediment dredging and placement of dredged sediments in constructed habitat areas would have **no adverse impacts** on sediment quality because sediment that does not require clean-up relative to applicable standards is present throughout the lake within and below the planned dredge areas. For all build alternatives, dredged sediments would not be expected to settle outside the dredge areas because it would be performed using a hydraulic dredge that does not suspend a significant amount of sediment at its intake, which suctions about 80 percent lake water with 20 percent lake sediment. Minor sediment suspension may occur if the hydraulic dredge is supplemented with a mechanical dredge to remove coarse materials that may damage the hydraulic pump. However, it is unlikely a mechanical dredge would be needed based on the low amount of gravel observed in the dredge layer samples (average of 3 percent for particles greater than 2 mm in diameter; see Appendix A). If necessary, best management practices such as a turbidity curtain would be used to prevent turbidity impacts beyond the allowed mixing zone boundary. Because Capitol Lake has recently been classified as a river due to a mean detention time of less than 15 days (USEPA 2020), the mixing zone boundary would be approximately 300 feet from the dredge area based on Washington State Surface Water Quality Standards (WAC 173-201A) (see Section 5.7). Turbidity from suspended fine sediment would not be allowed to increase beyond the mixing zone boundary and, therefore, no significant amounts of suspended sediment would be discharged to Budd Inlet.

Dredged sediments would be placed in temporary sheet-pile cells to contain sediment and allow it to settle within the constructed habitat area. Suspended sediment may have to be released from these cells because it may take an extended period of time to settle due to the high content of fines in the dredge layer samples (i.e., average of 51 percent for particles less than 62.5 microns in diameter) and the high water content (approximately 80 percent) in the dredged sediments (see grain size and water content of dredge layer samples in Appendix A). If necessary, best management practices could be employed to reduce turbidity and ensure water quality permit compliance (USACE 2012) (e.g., slow placement to allow settling or treatment to remove suspended sediment) (see Section 5.7). Water quality impacts from sediment suspension are being addressed by the *Water Resources Discipline Report* (Herrera in press).

The only parameter of concern for sediment quality impacts from dredging is total sulfides, which exceeded the freshwater CSL in both the surface sediment samples (4 inches deep) and dredge layer sediment samples (up to 12 feet deep) collected within the North and Middle Basins (see Table 4.1). Sulfide is naturally produced in lake sediments from decay of organic matter and reduction of sulfate in low oxygen conditions. Sulfide is commonly toxic to sensitive benthic invertebrates in lake sediments, allowing growth of only worms and some fly larvae that are tolerant to high sulfide (exceeding the CSL) and low oxygen (less 5 mg/L). Because sulfide and other chemical concentrations are similar in surface and dredged sediments based on the 2020 sediment sampling (see Table 4.1), initial dredging and placement of dredged sediments in the habitat areas would not substantially change sediment quality in Capitol Lake. However, sulfide concentrations are much lower in the z layer samples (see Table 4.1) and, therefore, lake sediments exposed by dredging would have low sulfide concentrations that overall would result in **minor beneficial effects** on sediment quality in Capitol Lake. The extent of these beneficial effects would vary with dredge area, ranging from approximately 50 acres for the Hybrid Alternative to 127 acres for the Managed Lake Alternative.

Some initial dredged sediments would be transported for disposal or reuse outside of the study area for the Estuary Alternative (13,000 cubic yards) and Hybrid Alternative (98,000 cubic yards) because of limited space available for habitat islands relative to the total dredge volume. However, sediment export is not assumed under the Managed Lake Alternative because sufficient habitat island area is available for the lower dredge volume. Therefore, potential impacts from off-site disposal or reuse of sediments is addressed below for the Estuary and Hybrid Alternatives.

5.3.2 Impacts from Operation

Long-term operations-related impacts common to all build alternatives are associated with recurring maintenance dredging to maintain target depths. The risk of sediment quality degradation from maintenance dredging is considered low because dredged sediment quality in both the lake basins and West Bay is expected to be similar to the sediment quality currently present in Capitol Lake surface sediments. Long-term maintenance dredging of a portion of West Bay (along the shoreline in areas used for navigation) would be performed for only the Estuary and Hybrid Alternatives and would consist of removing only those sediments transported to West Bay from the Deschutes River and lake basins, as described in Section 4.1. Chemical concentrations in those sediments are not likely to significantly change from what is presently in the lake sediments. In addition, dredging BMPs would be implemented to reduce off-site transport of sediments. As a result, maintenance dredging for all build alternatives would have **no adverse impacts** on sediment quality because operations are not anticipated to substantially affect sediment quality within or outside the project area.

For all build alternatives, all maintenance dredged sediments would be transported for reuse or disposal outside of the project area. Sediment quality would be similar to what is currently in Capitol Lake because those materials would have originated from the same source (river and lake basin). Thus, sediment disposal options would be similar and could include either open-water disposal in Puget Sound or unrestricted upland use based solely on anticipated sediment quality of the removed materials that does not require clean-up relative to applicable standards. However, long-term maintenance dredging of the Managed Lake Alternative would likely require upland disposal due to the expected presence of Aquatic Invasive Species (AIS) based on the *AIS Discipline Report* (Herrera 2022) and noted below.

Although long-term maintenance dredging would not target sediments below the project deposition depth, it is possible that dredged sediments from West Bay may contain some higher chemical concentrations if dredging occurs below the project sediment deposition depth (e.g. allowable 1 foot over-dredge depth) and that sediment has not been remediated to CULs or if upward migration of contaminants occurs by physical disturbance in nearshore areas of West Bay where DMMP SL for dioxins/furans had been exceeded, which could limit open-water disposal due to elevated concentrations of dioxins/furans. Conversely, prohibited AIS are expected to be present in materials removed from the North Basin for the Managed Lake Alternative but not in materials removed from West Bay for the Estuary and Hybrid Alternatives (Herrera 2022). Specifically, freshwater New Zealand mudsnails likely would be present on lake sediments but are not expected to be present in the marine sediments of West Bay (Herrera 2022) given that they have not established in West Bay to date (Johannes 2022). Therefore, open water disposal is an unlikely option for maintenance dredged sediments removed for the Managed Lake Alternative but is likely for the Estuary and Hybrid Alternatives. For any alternative, sediment quality is expected to be suitable for unrestricted upland reuse or disposal of maintenance dredged sediments because chemical concentrations do not exceed applicable standards and lake sediments would be treated to prevent transport of living New Zealand mudsnails.

5.4 MANAGED LAKE ALTERNATIVE

5.4.1 Impacts from Construction

In addition to impacts common to all build alternatives, construction impacts of the Managed Lake Alternative on sediment quality would primarily be associated with the dredging in the North Basin and using dredged sediments to create habitat areas in the Middle Basin. Impacts from initial dredging and other construction activities would be as described in Section 5.3.1, impacts common to all alternatives. Dredging generally would not change sediment quality in the North Basin except it would expose 127 acres of sediments with lower sulfide concentrations resulting in a **minor beneficial effect** on sediment quality in the lake. Implementation of best management practices during dredging would limit the transport of sediment out of the lake, resulting in **no adverse impacts** to sediment quality in Budd Inlet during construction.

There would be **no adverse impacts** to sediment quality associated with repairing the 5th Avenue Dam because all repair work would be contained with spillways, conducted overwater, or conducted on the Budd Inlet side of the dam. Sediment quality in the immediate vicinity of the dam is not known but is expected to be good because sediment samples collected nearby did not exceed SMS criteria (see Figure 4.2). Minor amounts of sediment may be suspended during dam repairs but it is anticipated that those suspended sediments would not travel far from the dam on either side of the dam because BMPs would be required to reduce turbidity impacts beyond approximately 200 feet of dredging in West Bay based on mixing zones established for estuaries in Washington State Surface Water Quality Standards (WAC 173-201A) (see Section 5.7).. Clean fill used for dam repair would not impact sediment quality.

5.4.2 Impacts from Operation

Operational impacts of the Managed Lake Alternative on sediment quality would be associated with long-term maintenance dredging in the North Basin on one occasion at year 20 to maintain target depths, as generally described in Section 5.3.1 impacts common to all alternatives. Maintenance dredging would have **no adverse impacts** on sediment quality because those operations are not anticipated to substantially affect sediment quality within or outside the project area.

Sediment that does not require clean-up relative to applicable standards is present throughout the lake within and below the planned dredge layer areas, except for elevated sulfides in the dredge layer. Only minor amounts of sediments would be suspended during dredging, those sediments would settle within the lake, and the settled sediments would be of the same quality as other sediments present in the lake. As noted for initial dredging during construction in Section 5.3.1, turbidity from suspended fine sediment would not be allowed to increase beyond the 300-feet mixing zone boundary and, therefore, no significant amounts of suspended sediment would be discharged to Budd Inlet.

Dredged sediments would be placed on a barge and allowed to settle to remove water prior to transport to an upland reuse or disposal site. Water returned to the lake would contain very little suspended sediment because best management practices would be employed to reduce turbidity and ensure water quality permit compliance for the return water discharge. In addition, settling of minor amounts of suspended sediment in the return water discharge would not change sediment quality in the lake because it will be the same as that in the dredged sediments. Water quality impacts from sediment dredging and dewatering are being addressed by the *Water Resources Discipline Report (Herrera 2022).*

5.5 ESTUARY ALTERNATIVE

5.5.1 Impacts from Construction

Construction impacts of the Estuary Alternative on sediment quality would generally be as described in Section 5.3.1, impacts common to all alternatives. **No adverse impacts** to sediment quality would occur during dredging in the North Basin and Middle Basin and using dredged sediments to create habitat areas in both basins. Reusing dredged sediments within the system is a key design element that avoids or minimizes the disposal of sediments outside the project area.

Dredging generally would not change sediment quality in the lake basin except it would expose approximately 60 acres of sediments with lower sulfide concentrations resulting in a **minor beneficial effect** on sediment quality in the dredge areas. As noted for the Managed Lake Alternative, the required implementation of best management practices during dredging and placement of dredge materials in habitat areas would limit the transport of sediment out of the lake, resulting in **no adverse impacts** to sediment quality in Budd Inlet during construction.

A small portion (less than 3 percent) of the dredged sediments would be transported off site for upland reuse or landfill disposal because of the limited area for constructing habitat islands, None of these sediments would be suitable for disposal at an open-water disposal site in Puget Sound due to the presence of aquatic invasive species (AIS) (Herrera 2022). None of the dredge layer sediment samples collected for this study exceeded MTCA Method B direct contact soil cleanup criteria and all dredged sediments are expected to be suitable for unrestricted upland reuse with respect to sediment chemical concentrations if a viable location can be identified (see Section 4.1).

There would be **no adverse impacts** to sediment quality associated with removing the 5th Avenue Dam because all dam demolition would be contained to prevent the spread of sediment beyond the mixing zone established by the water quality permit. Sediment quality in the immediate vicinity of the dam is not known but is expected to not require clean-up relative to applicable standards because representative sediment samples collected nearby did not exceed SMS criteria (see Figure 4.2).

5.5.2 Impacts from Operation

Operational impacts of the Estuary Alternative on sediment quality would generally be as described in Section 5.3.2, impacts common to all alternatives. Operation impacts on sediment quality associated with the Estuary Alternative primarily relate to the following activities:

- Erosion of sediments in the constructed estuary and deposition of eroded sediments along with suspended sediments from the Deschutes River into portions of the West Bay of Budd Inlet during periods of high river flow and low tide.
- Recurring maintenance dredging of a portion of West Bay, generally occurring every six years at the Olympia Yacht Club and every 12 years at the marinas and Port of Olympia/turning basin area (see Figure 4.1).

Sediments in the Deschutes River and lake basin would be flushed into the West Bay of Budd Inlet after removal of the 5th Avenue Dam. Most of the sediment would originate from the Deschutes River and not be eroded from the lake basin. Table 5.1 presents sediment transport model results in terms of average annual deposition rates in areas of Budd Inlet for the Estuary and Hybrid Alternatives (Moffatt & Nichol 2020). Figure 5.1 depicts approximate areas of varying sediment deposition rates in the West Bay of Budd Inlet based on model results for the Estuary Alternative. Most of West Bay is expected to receive 1 to 10 cm of sediment deposition per year, with greater accumulation (up to 16 cm/year) occurring at Olympia Yacht Club in the southeast portion of the West Bay. Minimal sediment deposition (less than 1 cm/year) would occur along the western shoreline and north West Bay, with minimal to no sediment deposition in East Bay. These average annual rates compare to the current range of 0.1 to 4.3 cm/year in West Bay for the No Action and Managed Lake Alternatives. Thus, sediment deposition rates would more than triple north from the Olympia Yacht Club to the Port of Olympia and Turning Basin for the Estuary and Hybrid Alternatives with annual amounts similar or much greater than the 10 cm depth used to characterize surface sediment quality.

Figure 5.1. Modeled Future Sediment Deposition without Sea Level Rise for Estuary and Hybrid Alternatives and Existing Surface Contamination in Budd Inlet.

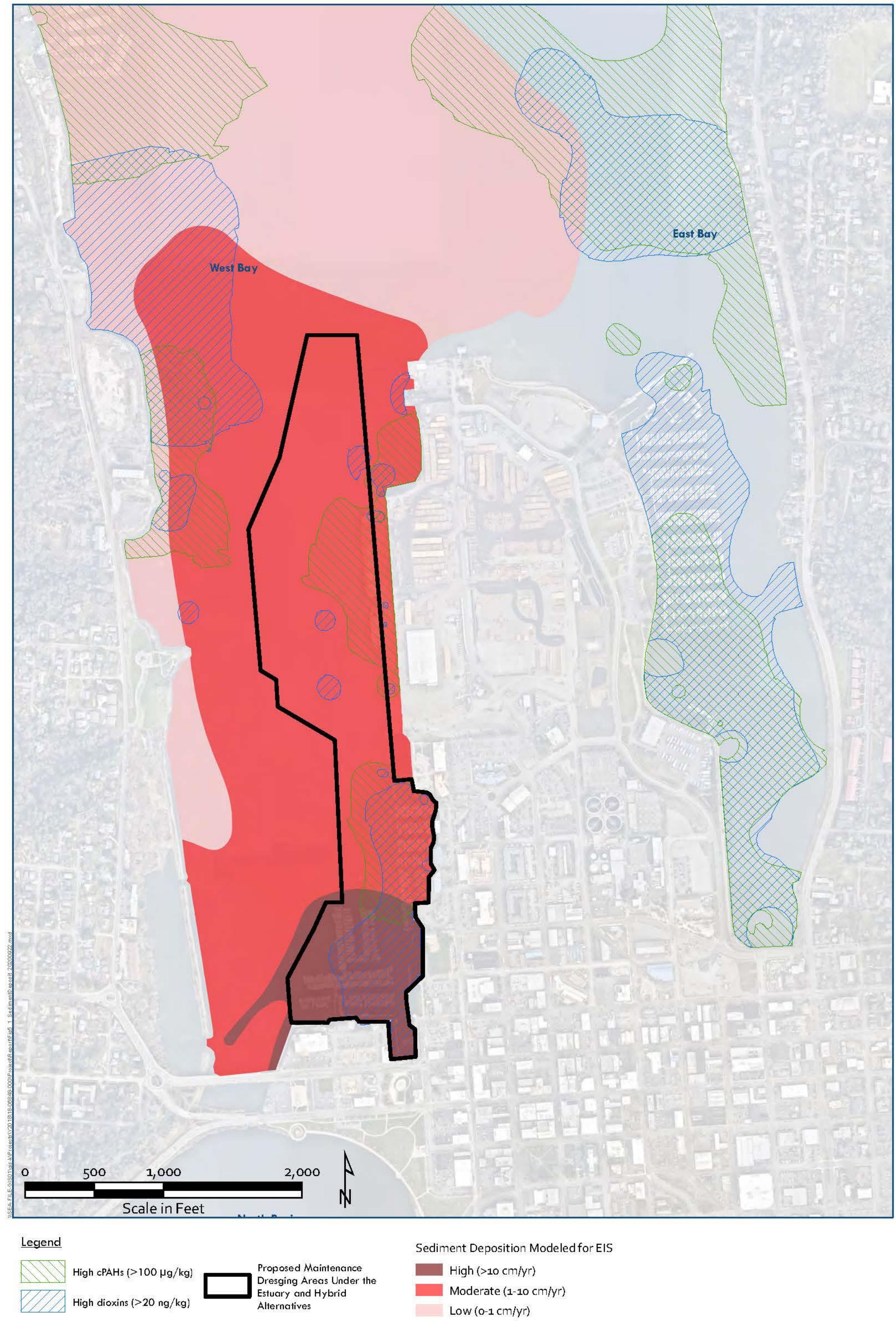


Table 5.1. Average Annual Sediment Deposition in Budd Inlet for Modeling without Relative Sea Level Rise.

	Sediment Deposition (cm/yr)[a]			
	No Action	Managed Lake	Estuary	Hybrid
Olympia Yacht Club	4.3	4.3	15.7	19.4
Martin and Fiddlehead Marinas	2.1	2.1	8.2	9.9
Port of Olympia Terminal & Turning Basin	2.2	2.1	7.8	9.1
Navigation Channel (excluding Turning Basin)	0.1	0.1	0.3	0.3
Rest of Budd Inlet	0.1	0.2	0.4	0.5

[a] Estimated average annual sediment deposition rates are without relative sea level rise (RSLR) (Moffatt & Nichol 2020).

As shown in Table 5.2, sediment quality is better in the lake than that in Budd Inlet, and it is expected that downstream deposition of both river sediment and eroded sediment in the estuary would improve sediment quality in Budd Inlet. A decrease in surface sediment concentrations of dioxins/furans (from 20 to less than 5 ng/kg TEQ) and cPAHs (from 170 to less than 10 µg/kg TEQ) would be expected in West Bay based on sediment deposition from operation of the Estuary Alternative. The decrease in chemical contaminant concentrations would occur within one year for most of West Bay where annual sediment deposition rates approach or exceed the 10 cm depth used to characterize sediments for comparison to SMS criteria.

A decrease in the organic matter content of surface sediments also would be expected in West Bay based on sediment deposition from operation of the Estuary Alternative. The benthic invertebrate community in West Bay currently is impacted from the high organic matter content of surface sediments, not the low chemical concentrations (PSP 2020). The average total organic carbon (TOC) concentration in Budd Inlet is 3.7 percent (see existing conditions Table 5.2), which slightly exceeds the typical range of 0.5 to 3.5 percent for Puget Sound (Ecology 2019). TOC in lake sediments ranged from 1.1 to 4.0 percent among the different sampled layers (see future conditions in Table 5.2). The actual TOC content of deposition sediments would be most similar to the low TOC concentration of 1.5 percent for the z-layer samples collected below the dredge layer, which likely approximates that in river sediment, because organic matter is elevated in the dredge layer due to its production by algae and aquatic plants in the lake. Thus, TOC concentrations in West Bay sediments would substantially decrease from an average of 3.7 percent to less than 2 percent from sediment deposition by operation of the Estuary Alternative. The decrease in organic matter content would occur within one year for most of West Bay where annual sediment deposition rates approach or exceed the 10 cm depth used to characterize sediments for effects on benthic invertebrates.

Table 5.2. Operational Impacts to Sediment Quality in Budd Inlet for the Estuary and Hybrid Alternatives.

	Existing Conditions[a]		Future Conditions for Estuary and Hybrid Alternatives [b]	
	Maximum Detected Result	Average Detected Result	Range of Average Detected Results	Increase or Decrease in Concentration
Conventionals				
Total fines (silt and clay) (%)	99	63	40–82	None
Total organic carbon (%)	9.4	3.7	1.1–4.0	Decrease
Total sulfides (mg/kg)	–	–	10–1,646	–
Metals (mg/kg)				
Cadmium	4.2	1.8	0.1-0.4	Decrease
Mercury	0.51	0.12	0.03-0.26	None
Silver	0.61	0.42	0.05-0.21	Decrease
Zinc	182	98	37-78	Decrease
Semivolatile Organics (µg/kg)				
1,2,4-Triclorobenzene	ND	ND	ND	None
1.2-Dichlorobenzene	11	5	ND	None
1,4-Dichlorobenzene	17	6	ND	None
2,4-Dimethylphenol	18	9	ND	None
2-Methylphenol	18	9	ND	None
4-Methylphenol	420	125	6-18	Decrease
Benzoic Acid	780	277	ND	Decrease
Benzyl alcohol	70	29	ND	Decrease
bis(2-Ethylhexyl)phthalate	2,300	226	14-92	Decrease
Butylbenzyl phthalate	86	22	6-7	Decrease
Dibenzofuran	140	30	ND	Decrease
n-Nitrosodiphenylamine	17	8	ND	None
PAHs (µg/kg)				
2-Methylnaphthalene	150	33	3	Decrease
Acenaphthene	830	59	ND	Decrease
Acenaphthylene	110	26	3	Decrease
Anthracene	240	50	4-7	Decrease
Benzo(a)anthracene	1,100	103	6-14	Decrease
Benzo(a)pyrene	2,100	127	6-13	Decrease

Table 5.2 (continued). Operational Impacts to Sediment Quality in Budd Inlet for the Estuary and Hybrid Alternatives.

	Existing Conditions[a]		Future Conditions for Estuary and Hybrid Alternatives [b]	
	Maximum Detected Result	Average Detected Result	Range of Average Detected Results	Increase or Decrease in Concentration
PAHs (µg/kg) (continued)				
Benzo(g,h,i)perylene	1,700	87	5-10	Decrease
Chrysene	1,400	173	5-15	Decrease
Dibenzo(a,h)anthracene	340	30	4	Decrease
Fluoranthene	1,900	315	4-32	Decrease
Fluorene	330	36	4	Decrease
Indeno(1,2,3-cd)pyrene	1,300	73	5-11	Decrease
Naphthalene	1,200	111	6-12	Decrease
Phenanthrene	650	149	9-14	Decrease
Pyrene	1,900	334	16-22	Decrease
Total Benzofluoranthenes	3,000	259	11-24	Decrease
Total HPAH	14,800	1,480	4-144	Decrease
Total LPAH	2,380	376	16-29	Decrease
Total cPAH TEQ (U=1/2)	**2,690**	**170**	2-10	Decrease
Dioxins/Furans (ng/kg)				
Total dioxins/furans TEQ (U=1/2)	**98.9**	**19.5**	1.0-4.6	Decrease
PCB Aroclors (µg/kg)				
Total PCB Aroclors	222	35	5-12	Decrease

Light Shaded Concentration exceeds SMS marine benthic SCO criterion.

Dark Shaded Concentration exceeds SMS marine benthic CSL criterion.

Red concentration exceeds Puget Sound natural background for protection of human and ecological health (and DMMP screening level for dioxins/furans at dispersive open-water disposal site only).

Bold Red Concentration exceeds Budd Inlet regional background for protection of human and ecological health.

-- no data. ND not detected

a Existing conditions in Budd Inlet as summarized in Table 4.2 that also represent the future conditions in Budd Inlet under the No Action and Managed Lake Alternatives because no substantial change in sediment deposition would occur.

b Future conditions predicted in the West Bay of Budd Inlet where moderate to high sediment deposition rates (greater than 1 cm/yr) would occur for the Estuary and Hybrid Alternatives based on the current range of average concentrations among sediment layers in the North and Middle Basins of Capitol Lake.

The anticipated decrease in sediment chemical and organic carbon concentrations would provide natural recovery to most areas within the West Bay of Budd Inlet that are not subject to maintenance dredging. Therefore, the export of sediment into the West Bay of Budd Inlet would have **minor to moderate beneficial effects** on sediment quality in the West Bay of Budd Inlet depending on the location, deposition rates, and chemical parameter. **Moderate beneficial effects** on sediment quality would be expected particularly where moderate to high deposition rates would cover high concentrations of dioxins/furans and carcinogenic PAHs that include the following areas of West Bay (see Figures 5.1 for concentrations and Figure 4.1 for features):

- Southeast—Olympia Yacht Club, Martin Marina, and Fiddlehead Marina.
- East – Port of Olympia Marine Terminal and Navigational Channel Turning Basin.
- Northwest —Reliable Steel and Hardel Mutual Plywood cleanup areas.

The EIS assumes that existing sediment contamination in West Bay would be remediated by the Port of Olympia within the next 10 years, before removal of the 5th Avenue Dam under the Estuary Alternative. If this occurs, it increases the likelihood that the sediment removed during project maintenance dredging would be suitable for in-water disposal. In the areas that are not used for navigation and therefore not subject to future maintenance dredging, sediment quality would improve if sediment cleanup occurs before operation of the Estuary Alternative and as a result of the natural recovery (deposition of cleaner sediment in these areas).

As presented in the *Hydrodynamics and Sediment Transport Discipline Report* (Moffat & Nichol 2020), the predominant direction of sediment erosion would be from the constructed estuary to the West Bay of Budd Inlet. If minor amounts of sediment are suspended and washed into the constructed estuary from West Bay by high waves and strong currents during flood tides, those sediments likely would have originated from the constructed estuary and would be of good quality similar to that in the Capitol Lake basin. Therefore, **no adverse impacts** on sediment quality would be expected from minor amounts of West Bay sediments deposited in the constructed estuary during flood tides.

Maintenance dredging of West Bay would have **no adverse impacts** on sediment quality because those operations are not anticipated to substantially affect sediment quality within or outside the study area, as described above in Section 5.3.2. The risk of sediment quality degradation from maintenance dredging is considered low because dredged sediment quality in West Bay is expected to be similar to the quality currently present in Capitol Lake surface sediments. As described in Section 4.1, dredged sediments would have originated from the Deschutes River or lake basin. Chemical concentrations in those materials are not likely to significantly change from what is presently in the lake sediments. In addition, dredging BMPs would be implemented to reduce off-site transport of sediments during dredging.

All maintenance dredged sediments would be transported for disposal outside of the project area. Sediment disposal options could include either open-water disposal in Puget Sound or unrestricted upland reuse based on the anticipated sediment quality of the removed materials expected from the lake sediment characterization that does not require clean-up relative to applicable standards. It is likely that all maintenance dredged sediments could be disposed at a non-dispersive open-water disposal site in Puget Sound (e.g., Anderson/Ketron Islands disposal site) because chemical concentrations are expected to be less than the associated DMMP SL and dredging would target the recently deposited sediment that had been deposited from the Deschutes River. It is possible that dredged sediments from West Bay may contain some higher chemical concentrations if dredging occurs below the project sediment deposition depth in nearshore areas of West Bay where DMMP SL for dioxins/furans had been exceeded, which could limit open-water disposal due to elevated concentrations of dioxins/furans. Sediment quality would be suitable for unrestricted upland reuse of maintenance dredged sediments if open-water disposal is restricted due to chemical contamination or presence of AIS. Although this is not expected to be the likely scenario, there is inherent uncertainty in sediment quality and the timing of the sediment remediation in Budd Inlet and, therefore, upland reuse is maintained as a potential outcome.

5.6 HYBRID ALTERNATIVE

5.6.1 Impacts from Construction

Construction impacts of the Hybrid Alternative on sediment quality would generally be as described for the Estuary Alternative in Section 5.5.1. **No adverse impacts** to sediment quality would occur for the Hybrid Alternative initial dredging of the North Basin and Middle Basin and using dredged sediments to create habitat areas in both basins. Reusing dredged sediments within the system is a key design element that avoids or minimizes the disposal of sediments outside the project area. Implementation of best management practices during dredging and placement of dredged sediments in habitat areas would limit the transport of sediment out of the lake.

In addition, **minor beneficial effects** of reduced sulfide concentrations in dredge areas common to all build alternatives would occur as described in Section 5.3.1.

A small portion of the dredged sediments would be transported off site for upland disposal, and not to an open-water disposal site in Puget Sound due to the presence of aquatic invasive species (AIS) (Herrera 2022). None of the dredge layer sediment samples collected for this study exceeded MTCA Method B cleanup criteria and all dredged sediments are expected to be suitable for unrestricted upland disposal (see Section 4.1).

There would be **no adverse impacts** to sediment quality associated with removing the 5th Avenue Dam because all dam demolition would be contained to prevent the spread of sediment beyond the mixing zone established by the water quality permit. Sediment quality in the immediate vicinity of the dam is not known but is expected to be good because sediment samples collected nearby did not exceed SMS criteria (see Figure 4.2).

5.6.2 Impacts from Operation

Operational impacts of the Hybrid Alternative on sediment quality would generally be as described for the Estuary Alternative in Section 5.3.2. Operation impacts on sediment quality associated with the Estuary Alternative primarily relate to the following activities:

- Recurring maintenance dredging of a portion of West Bay, generally occurring every six years at the Olympia Yacht Club and every 12 years at the marinas and Port of Olympia/turning basin area (see Figure 4.1).
- Recurring maintenance dredging of the reflecting pool every 15 years to maintain recreational depths.
- Erosion of sediments in the constructed estuary and deposition of eroded sediments along with suspended sediments in the Deschutes River in portions of the West Bay of Budd Inlet during periods of high river flow and low tide.

Maintenance dredging of West Bay and the reflecting pool would have **no adverse impacts** on sediment quality because those operations are not anticipated to substantially affect sediment quality within or outside the study area, as described above in Section 5.3.2.

As described above for the Estuary Alternative (Section 5.5.2), lake sediment would be flushed into the West Bay of Budd Inlet after removal of the 5th Avenue Dam. As shown in Table 5.1, downstream deposition of both river sediment and eroded sediment in the constructed estuary is expected to occur at rates up to 20 cm/year (Moffatt & Nichol 2020). As described for the Estuary Alternative (Section 5.5.2), sediment quality is better in the lake than that in Budd Inlet and it is expected that downstream deposition of both river sediment and eroded estuary sediment would improve sediment quality where it deposits in the West Bay of Budd Inlet (see Table 5.2). A decrease in surface sediment concentrations of dioxins/furans (from 20 to less than 5 ng/kg TEQ) and cPAHs (from 170 to less than 10 µg/kg TEQ) would be expected based on sediment deposition from the estuary. This decrease in concentrations would provide natural recovery to areas within the West Bay of Budd Inlet. Therefore, the export of sediment into the West Bay of Budd Inlet would have **minor to substantial beneficial effects** on sediment quality in the West Bay of Budd Inlet depending on the location, deposition rates, and chemical parameter. **Substantial beneficial effects** on sediment quality would be expected particularly where high deposition rates would cover high concentrations of dioxins/furans and carcinogenic PAHs, as described for the Estuary Alternative and shown in Figure 5.1. The decrease in chemical concentrations would occur within one year for most of West Bay where annual sediment deposition rates approach or exceed the 10 cm depth used to characterize sediments for comparison to SMS criteria. In addition, a substantial decrease in the organic matter content of surface sediments also would be expected in West Bay as described for the Estuary Alternative. The benthic invertebrate community in West Bay currently is impacted from the high organic matter content of surface sediments, not the low chemical concentrations (PSP 2020).

5.7 AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES

Enterprise Services would avoid and minimize potential impacts by complying with regulations, permits, plans, and authorizations. These anticipated measures, and other mitigation measures that could be recommended or required, are described below.

5.7.1 Measures Common to All Build Alternatives

In accordance with the environmental permits that would be obtained prior to dredging, best management practices for turbidity management and spill prevention would be implemented during construction and operational dredging activities to minimize and avoid impacts. The BMPs are non-discretionary actions that are needed to maintain water quality standards throughout the work. They often include the following measures.

- Hydraulic dredging
- Closed bucket
- Limiting barge overflow
- Slowing dredge rate
- Seasonal/migratory windows
- Tidal dredging
- Silt curtain

A water quality monitoring and protection plan (WQMPP) would also be prepared, approved by the regulatory agencies, and implemented throughout construction. This plan is intended to measure the performance of the BMPs implemented to maintain water quality standards, identify potential violations and outline contingency measures that would be implemented if water quality standards were violated. The plan will include monitoring of turbidity within the established mixing zone of approximately 200 to 300 feet from the dredging and placement areas during construction, and in maintenance dredging and dewatering areas. In addition, the WQMPP will include inspection of spill control equipment and actions required by the certification. Therefore, no specific sediment quality mitigation plans would be necessary for the project.

5.7.2 Significant Unavoidable Adverse Impacts

There would be no significant unavoidable adverse impacts related to sediment quality under any of the build alternatives.

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Appendix A

2020 Sediment Data Report

CAPITOL LAKE – DESCHUTES ESTUARY

Long-Term Management Project Environmental Impact Statement

Capitol Lake Sediment Monitoring Data Report

Prepared for:

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November 25, 2020

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List of Acronyms and Abbreviations

Acronyms/ Abbreviations	Definition
°C	degrees Celsius
µg/kg	micrograms per kilogram (parts per billion)
µg/kg dw	micrograms per kilogram dry weight
AETs	apparent effects thresholds
CLDE	Capitol Lake / Deschutes Estuary
CSL	cleanup screening level
COC	chain of custody
COCs	chemicals of concern
DMMP	Dredged Material Management Program
dw	dry weight
EIS	Environmental Impact Study
GPS	global positioning system
HPAH	high molecular weight polynuclear aromatic hydrocarbon compounds
ID	identification
IEH	Institute for Environmental Health
LPAH	low molecular weight polynuclear aromatic hydrocarbon compounds
mg/kg	milligrams per kilogram (parts per million)
mg/kg dw	milligrams per kilogram dry weight
mg/kg OC	milligrams per kilogram organic carbon
mg/L	milligram per liter
MTCA	Model Toxics Control Act
NAD 83	North American Datum of 1983
NWTPH-Dx	northwest total petroleum hydrocarbons-diesel fraction
OC	organic carbon
P	phosphorous
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
pg/g	picograms per gram
QA/QC	quality assurance/quality control
RLs	reporting limit

Acronyms/ Abbreviations	Definition
RTK	real-time kinematic
R/V	research vessel
SAP	sampling and analysis plan
SCO	sediment cleanup objective
SMS	Sediment Management Standards
SPLP	synthetic precipitation leaching procedure
SVOCs	semivolatile organic compounds
TCLP	toxicity characteristic leaching procedure
TEQ	toxicity equivalency quotient
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TVS	Total volatile solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

1.0 Introduction

The Capitol Lake – Deschutes Estuary includes the 260-acre Capitol Lake Basin, located on the Washington State Capitol Campus, in Olympia, Washington (Figure 1.1). The waterbody has long been a valued community amenity. Capitol Lake was formed in 1951 following construction of a dam and provided an important recreational resource. Historically, the Deschutes Estuary was used by local tribes for subsistence and ceremonial purposes. Today, the expansive waterbody is closed to active public use. It is plagued by environmental issues including the presence of invasive species, violations of water quality standards, and inadequate sediment management.

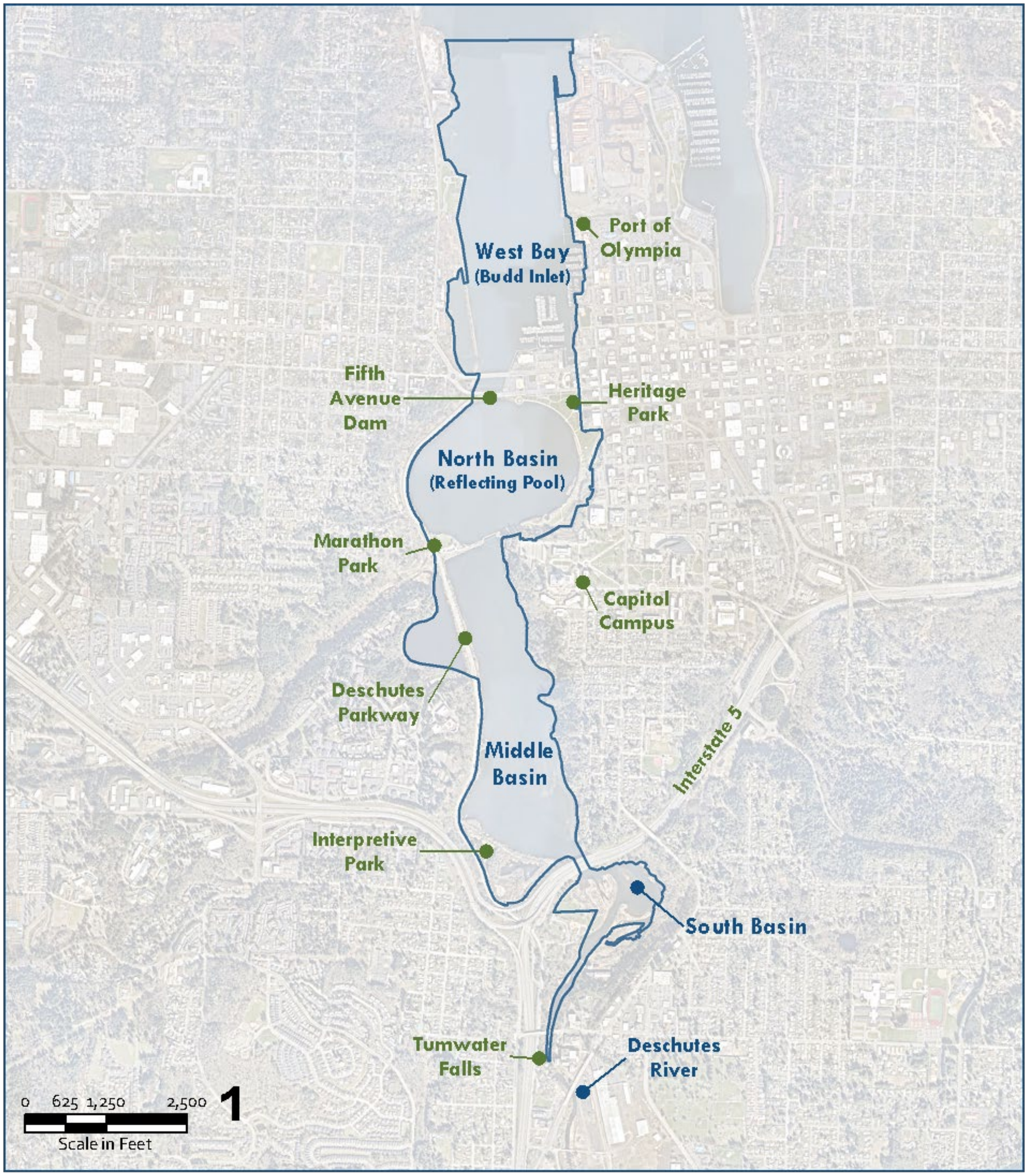
The Washington State Department of Enterprise Services (Enterprise Services) is responsible for the stewardship, preservation, operation, and maintenance of the Capitol Lake Basin. The 260-acre Capitol Lake Basin is maintained by Enterprise Services under long-term lease agreement from the Washington Department of Natural Resources.

In 2016, as part of Phase 1 of long-term planning, a diverse group of stakeholders, in collaboration with the state, identified shared goals for long-term management and agreed an Environmental Impact Study (EIS) was needed to evaluate a range of alternatives and identify a preferred alternative. In 2018, the state began the EIS process. The EIS evaluates four alternatives, including a no Action, Managed Lake, Estuary, and Hybrid Alternatives.

Sediment sampling was performed to adequately characterize physical and chemical parameters in lake surface sediments and the conceptual subsurface dredged sediments for the EIS. This information is needed to understand current and future compliance with Washington State Sediment Management Standards (SMS), evaluate potential impacts on humans and aquatic biota from sediment removal and disposal activities with respect to the Dredge Material Management Program (DMMP) for open-water disposal and the Model Toxic Control Act (MTCA) for upland disposal, develop mitigation measures for sediment removal and disposal activities, and evaluate the resulting change in freshwater and marine sediment quality from the project alternatives. Sampling activities were conducted by Herrera Environmental Consultants (Herrera), and followed the *Capitol Lake Sediment Characterization Study Sampling and Analysis Plan* (SAP) (Herrera 2020).

This data report summarizes the methods and results of the sediment characterization study and is provided as an appendix to the Sediment Quality Discipline Report. It includes data quality review of the results and comparisons of the results to SMS.

Figure 1.1 Project Area



2.0 Methods

This section briefly describes the methodology for surface and subsurface sediment sample collection and analysis for the sediment characterization of Capitol Lake. Methods are described in more detail in the SAP (Herrera 2020) and deviations from the SAP are summarized below.

2.1 SEDIMENT SAMPLING OVERVIEW

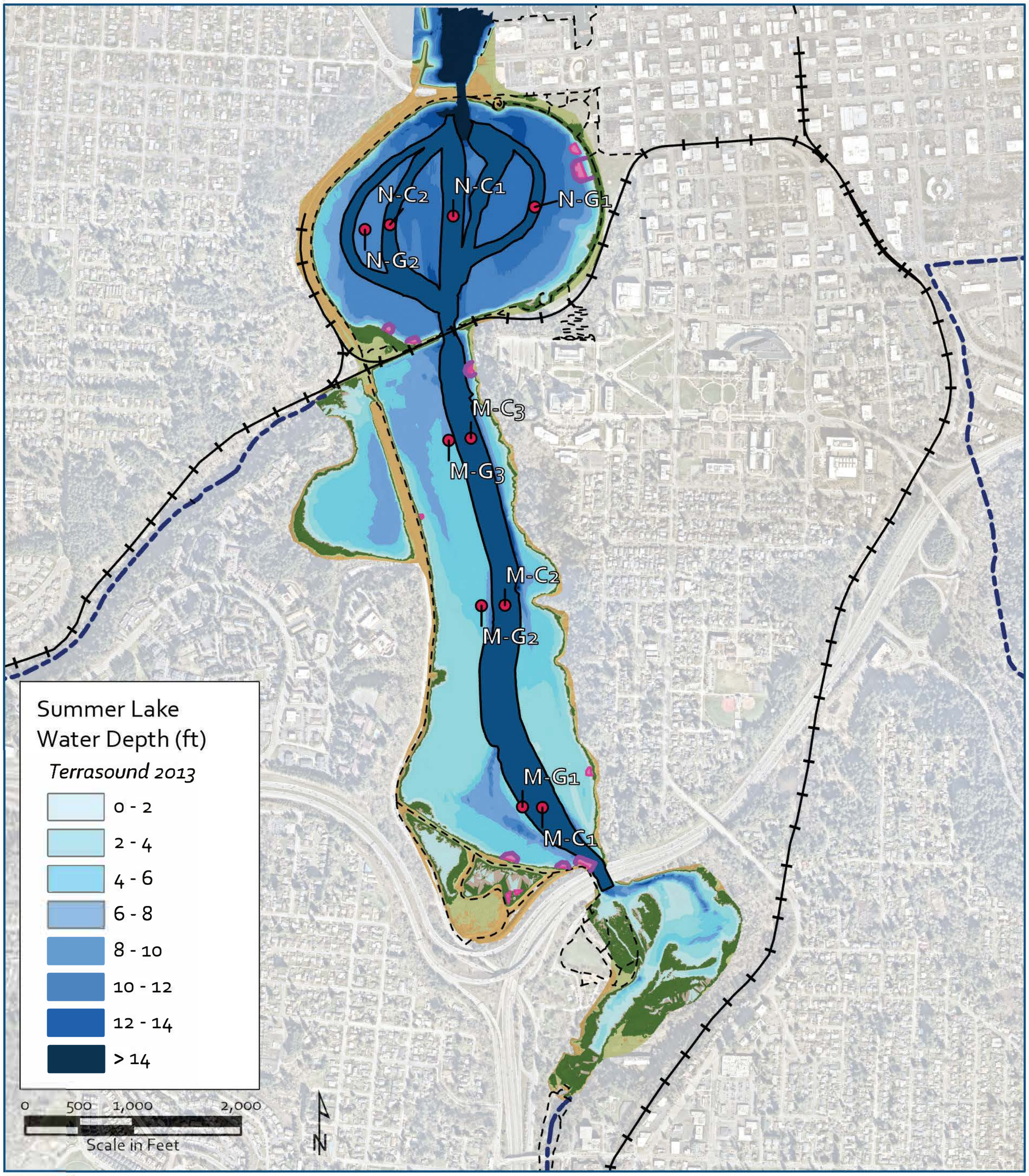
Sediment surface grab samples and subsurface sediment cores were collected on March 25, 2020 in the Middle Basin and March 26, 2020 in the North Basin. Sediment grab samples were collected using a power grab sampler and processed aboard the R/V Houma, which was launched at Tumwater Historical Park for access to the Middle Basin and lowered by crane into the North Basin. All surface grab sample attempts had greater than 10 cm of sediment penetration, and no observations of odor or sheen were noted. Sediment cores were collected using a vibracore sampler deployed from the R/V *Houma* and processed on shore the same day they were collected. Both North Basin cores were easily driven to target depths and percent recoveries were at least 91 percent. It took two attempts for each of the three Middle Basin cores to get sufficient penetration or recovery; all sampled cores had greater than 85 percent recovery. Herrera personnel were responsible for evaluating, homogenizing, and transferring grab and core samples to appropriate containers, while Gravity personnel were responsible for station positioning, operating grab and core sampling equipment, and measuring water depth.

Excess sediment collected but not submitted to the laboratories for analysis were stored in two 55-gallon drums at the DES powerhouse until analytical results were received and designated for non-hazardous disposal. The sampling vessel and equipment were thoroughly decontaminated by WDFW before leaving the site.

2.2 SAMPLING LOCATIONS

Collection of sediment grab and core samples was successful at all 10 stations targeted, as shown on Figure 2-1 and described in Table 2.1.

Figure 2.1. Sediment Sample Locations, Capitol Lake, Olympia, Washington.



Legend

- Sampling station
- Rail
- Estuary Channel Dredging Area
- Remediation curtain
- Footpaths
- Streams
- Remedial area

Table 2.1. Sample Collection and Analysis Schemes.

Basin	Sample Station	Sampler Type	Depth Interval (feet)[c]	SMS Physical/Chemical[a]		Phosphorus Fraction[b]	
				Sample Type	Sample ID	Sample Type	Sample ID
Middle	M-G1	Grab	0-0.3	Surface	M-G1-S	Surface Composite	M-G1, M-G2, and M-G3 to M-GScomp
	M-G2	Grab	0-0.3	Surface	M-G2-S		
	M-G3	Grab	0-0.3	Surface	M-G3-S		
	M-C1	14 ft Core	0-12	Dredge	M-C1-D	-	-
			12-14	Z-layer Composite	M-C1-Z to M-Zcomp	Z-layer Composite	M-C1-Z to M-Zcomp
	M-C2	13 ft Core	0-11	Dredge	M-C2-D	-	-
			11-13	Z-layer Composite	M-C2-Z to M-Zcomp	Z-layer Composite	M-C2-Z to M-Zcomp
	M-C3	9.5 ft Core	0-7.5	Dredge	M-C3-D	-	-
			7.5-9.5	Z-layer Composite	M-C3-Z to M-Zcomp	Z-layer Composite	M-C3-Z to M-Zcomp
North	N-G1	Grab	0-0.3	Surface	N-G1-S	Surface Composite	N-Scomp
	N-G2	Grab	0-0.3	Surface	N-G2-S		
	N-C1	8 ft Core	0-6	Dredge	N-C1-D	-	-
			6-8	Z-layer Composite	N-C1-Z to N-Zcomp	Z-layer Composite	N-C1-Z to N-Zcomp
	N-C2	6 ft Core	0-4	Dredge	N-C2-D	-	-
			4-6	Z-layer Composite	N-C2-Z to N-Zcomp	Z-layer Composite	N-C2-Z to N-Zcomp

[a] 5 surface samples, 5 dredge samples, and 2 z-layer composite samples will be analyzed for SMS physical and chemical parameters.

[b] 2 surface composite and 2 z-layer composite samples will be analyzed for phosphorus fractions and iron.

[c] Core sediment sampling depth may be adjusted based on actual sediment mudline elevation.

2.3 STATION POSITIONING

Station positioning was accomplished using the R/V Houma's onboard Trimble Differential global positioning system (DGPS) with Hypack Navigation. This system employs a ground-based reference station that sends carrier-phase corrections to an onboard GPS receiver to achieve sub-centimeter accuracy. The DGPS system was linked to the local Washington State Real-Time Network, which used the Puget Sound base station network. Station coordinates were recorded in latitude and longitude as decimal minutes with a minimum precision of four decimal places based on the North American Datum of 1983 (NAD 83). The depth of water at each of the off-pier stations was recorded from the boat's fathometer. Target and actual station coordinates are presented with water depths and mudline elevations in Table 2.2.

Table 2.2. Sample Station Coordinates and Depths.

Sample Station	Sample Type	Target Station Coordinates[a]		Actual Station Coordinates[a]		Water Depth (feet)[b]
		X	Y			
M-G1	Grab	47.02549	122.90608	47.02549	122.90608	6.1
M-G2	Grab	47.03056	122.90783	47.03056	122.90783	7.0
M-G3	Grab	47.03473	122.90923	47.03473	122.90923	7.7
M-C1	Core	47.02549	122.90534	47.02549	122.90534	5.9
M-C2	Core	47.03059	122.90696	47.03059	122.90696	5.8
M-C3	Core	47.03480	122.90841	47.03480	122.90841	10
N-G1	Grab	47.04024	122.91062	47.04024	122.91062	14.9
N-G2	Grab	47.04001	122.91258	47.04001	122.91258	10.4
N-C1	Core	47.04042	122.90932	47.04042	122.90932	10.5
N-C2	Core	47.04015	122.91166	47.04015	122.91166	10.8

[a] Coordinate system is NAD 1983 HARN State Plane Washington North FIPS 4601 feet.

[b] Measured during field sampling.

2.4 SAMPLE COLLECTION METHODS

Grab and core sediment samples were collected and processed as described in the SAP. Grab samples were collected using a power grab. Surface sediment was collected from the 0 to 10 centimeter (0 to 4 inch) depth interval. Adequate sample volume for all analyses required was obtained from a single successful grab at all stations. Core samples were collected using a vibracore sampler. Both North Basin cores were easily driven to target z-layer depths and percent recoveries were at least 91 percent. It took two attempts for each of the three Middle Basin cores to get sufficient penetration or recovery; all sampled cores had greater than 85 percent recovery. The number of replicate grab samples or core attempts, and sediment characteristics were recorded on a field form (Appendix A).

2.5 CHAIN-OF-CUSTODY AND SAMPLE HANDLING PROCEDURES

Samples were retained at all times in the field crew's custody until samples were delivered to the laboratories by Herrera personnel. Chain-of-custody forms were initiated at the time of sample collection to ensure that all collected samples were properly documented and traceable through storage, transport, and analysis.

Samples for chemical analyses were hand-carried to the analytical laboratories at the completion of the sampling event and accompanied by the chain-of-custody records, which identified the cooler contents.

2.6 SAMPLE IDENTIFICATION

All samples collected were assigned a unique identification (ID) code using consecutive letters and numbers identifying:

- Basin location (M for middle and N for north)
- Sampler type (G for grab and C for core)
- Station number (1-3 in middle basin and 1-2 in north basin
- Sample type (S for surface, D for dredge layer, and Z for z-layer)

ID codes for surface and z-layer samples that were composited for each basin used the basin location (M or N) followed by the sample type (Scomp or Zcomp). Care was taken to label samples clear and legibly, taking particular attention to distinguish G from C and Z from 2.

2.7 CHEMICAL ANALYSIS METHODS

The specific chemical and conventional parameters, sample preparation methods, analytical methods, and target detection limits are discussed in detail in the SAP (Herrera 2020). All samples collected for SMS physical and chemical parameters and SPLP analyses were submitted to ALS Environmental (ALS), located in Kelso, Washington. Samples collected for phosphorus fractions were submitted to IEH Analytical Laboratories (IEH), located in Seattle, Washington. A list of samples collected and analyses performed are provided above in Table 2.2.

2.8 DEVIATIONS FROM THE SAP

2.8.1 Field Sampling

Samples were collected from all stations specified in the SAP. Sediment sampling was delayed by a week due to low lake levels that prevented launching of the sampling vessel until the lake level was raised.

2.8.2 Laboratory Analysis

Laboratory analysis of conventionals and chemicals did not deviate from the SAP, with the following exception:

- SPLP metals was analyzed for all surface grab, dredge layer, and z-layer samples; the SAP specified only the five dredge layer samples for analysis of SPLP metals.
- Iron analysis was not requested or performed as per the SAP due to oversight.

Table 2.2. Sediment Sample Analyses.

Sample ID	Grain Size	Total Organic Carbon	TS/TVS	Sulfides	Ammonia	Butyltins	TPH – Diesel/Oil	Metals	SVOCs	Pesticides	PCBs as Aroclors	Dioxins	SPLP Metals	Phosphorus Fractions
M-C1-D	X	X	X	X	X	X	X	X	X	X	X	X	X	
M-C2-D	X	X	X	X	X	X	X	X	X	X	X	X	X	
M-C3-D	X	X	X	X	X	X	X	X	X	X	X	X	X	
M-Zcomp	X	X	X	X	X	X	X	X	X	X	X	X	X	X
M-G1-S	X	X	X	X	X	X	X	X	X	X	X	X	X	
M-G2-S	X	X	X	X	X	X	X	X	X	X	X	X	X	
M-G3-S	X	X	X	X	X	X	X	X	X	X	X	X	X	
M-Gscomp														X
N-G1-S	X	X	X	X	X	X	X	X	X	X	X	X	X	
N-G2-S	X	X	X	X	X	X	X	X	X	X	X	X	X	
N-C1-D	X	X	X	X	X	X	X	X	X	X	X	X	X	
N-C2-D	X	X	X	X	X	X	X	X	X	X	X	X	X	
N-Zcomp	X	X	X	X	X	X	X	X	X	X	X	X	X	X
N-Gscomp														X

3.0 Results

Sediment sample records and data tables are presented in Appendix A. Chemistry laboratory reports (including chain of custody forms) are presented in Appendix B. The data validation checklist is provided in Appendix C.

Sediment chemistry data collected are compared to SMS chemical criteria for both freshwater and marine sediments. Appendix Table A.1 presents SMS chemical criteria that include the Sediment Cleanup Objective (SCO) and Cleanup Screening Level (CSL) (WAC 173 204 562 and WAC 173-204-563). Sediment values at or below the SCO are predicted to have no adverse effects on the benthic community. Sediment values above the SCO but not the CSL are expected to have minor adverse effects on the benthic community. Sediment values above the CSL are expected to have significant effects on the benthic community. Appendix Table A.1 also includes marine sediment apparent effects thresholds (AETs) that are based on dry weight and used as an alternative to SMS marine sediment criteria based on organic carbon (OC) content when the OC content in samples is outside the recommended range of 0.5 to 3.5 percent. Appendix Table A.1 also includes the DMMP Screening Levels (SLs) that are nearly equivalent to the marine AET SCOs and used to evaluate potential for disposal at open-water disposal sites in Puget Sound.

Metals concentrations in the SPLP extracts were compared to Surface Water Quality Standards (WAC 173-201A) for evaluating potential impacts to freshwater aquatic organisms exposed to suspended dredge sediments (see Appendix Table A.1). The results were compared to acute toxicity criteria based on a 1-hour average concentration (versus chronic criteria based on a 4-day average concentration). Acute toxicity criteria are hardness-dependent for most metals, requiring estimation of water hardness from historical data. A hardness value of 45 mg/L was selected based on historical data collected from the Deschutes River between 1981 and 2017 at the E Street bridge.

In the data table (Table A.1) values exceeding freshwater SCO (or AET) chemical criteria are highlighted in gray, while values highlighted in black indicate exceedance of freshwater CSL (or corresponding second lowest AET) chemical criteria. Data table A.2 presents the phosphorus fractions data.

Several chemical groups are represented by a total concentration, including low molecular weight polycyclic aromatic hydrocarbons (LPAHs), high molecular weight polycyclic aromatic hydrocarbons (HPAHs), and polychlorinated biphenyls (PCBs). Total concentrations are calculated by summing detected results. If all results are non-detect, then the maximum reporting limit (RL) of any constituent is used as the RL for the associated total. Dioxin/furan congeners were calculated as a toxicity equivalency quotient (TEQ) for each sample using the toxicity equivalency factor (TEF) values from the World Health Organization (Van den Berg et al. 2006). TEQ values were calculated by substituting one-half the sample detection limit for non-detected compounds.

Validated test results of the Capitol Lake sediment sampling event are summarized in this section. Conventional and chemical concentrations are summarized below for the North and Middle Basins. All conventional and chemical data have undergone a Quality Assurance Level 1 (QA1) data validation (see Section 3.1). Results are summarized separately for conventional parameters (Section 3.2), SMS chemical parameters (Section 3.3), SPLP metals (Section 3.4), and phosphorus fractions (Section 3.5).

3.1 QUALITY ASSURANCE AND QUALITY CONTROL

A QA1 data validation was performed on the chemistry data. The QA1 data validation checklist is presented in Appendix C. The laboratories flagged reported data detected above the method detection limit (MDL), but below the reporting limit (RL), as estimated (J). All data were acceptable as reported by the laboratory.

3.2 CONVENTIONAL PARAMETERS

The conventional parameter results are presented in Table A 1. SMS criteria are established for total sulfides and ammonia in freshwater sediments. All ammonia samples (ranging from 17.5 to 117 mg/kg) met the SMS SCO criterion of 230 mg/kg. Several total sulfides results exceeded the freshwater SMS SCO criterion of 39 mg/kg or CSL criterion of 61 mg/kg, as follows:

- Total sulfides in the Middle Basin exceeded the SCO criterion in the dredge layer sample collected from station M-C2 (43.2 mg/kg), and exceeded the CSL criterion in surface sample M-G3 (277 mg/kg) and dredged layer samples M-C1 and M-C3 (360 and 61.7 mg/kg, respectively).
- Total sulfides in the North Basin exceeded the CSL criterion in surface sample N-G1 (3,270 mg/kg) and dredged layer samples N-C1 and N-C2 (130 and 770 mg/kg, respectively).

3.3 SMS CHEMICAL PARAMETERS

All results for butyltins, SVOCs, pesticides, PCBs, and TPH analyses were below freshwater and marine SMS criteria across all stations (Table A.1). The following metals exceeded criteria at one or more stations:

- Mercury slightly exceeded the marine SCO criterion and DMMP SL of 0.41 mg/kg in dredge layer samples collected at stations M-C2 (0.426 mg/kg) and N-C2 (0.432 mg/kg).

- Nickel exceeded the 26 mg/kg freshwater SCO criterion in two surface grab stations (26.9 and 27.6 mg/kg) and one dredge layer sample (28.8 mg/kg) from the Middle Basin, and in both surface samples (32.4 and 29.2 mg/kg) and one dredge layer sample (36.2 mg/kg) from the North Basin.

3.4 DIOXINS/FURANS

Dioxins/furans TEQ results, ranging from 0.88 to 3.14 parts per trillion (ppt), were below the Puget Sound natural background value and DMMP SL of 4 ppt, with one exception. The dioxins/furans TEQ result in the dredge layer sample at station N-C2 (7.43 ppt) exceeded the 4 ppt criterion, but did not exceed the regional background criterion of 19 ppt for Budd Inlet (Table A.1).

3.5 SPLP METALS

Surface Water Quality Standards (WAC 173-201A) were met for arsenic, chromium, mercury, and nickel at all locations. The following metals exceeded acute criteria at one or more locations (Table A.1):

- Cadmium was not detected above the reporting limit in any sample, however, the reporting limit (0.010 mg/L) was greater than the 0.0016 mg/L acute criterion.
- Copper exceeded the 0.008 milligram per liter (mg/L) acute criterion in one of the dredged layer samples from the Middle Basin (0.009 mg/L), and in all North Basin samples (ranging from 0.009 to 0.014 mg/L).
- Lead exceeded the 0.003 mg/L acute criterion at all stations with concentrations ranging from 0.005 to 0.019 mg/L.
- Selenium exceeded the 0.020 mg/L acute criterion in the dredge layer sample collected from Middle Basin station M-C2 (0.022 mg/L).
- Silver was detected above the 0.0009 mg/L acute criterion in two surface samples (both 0.001 mg/L) and the Z-layer sample (0.001 mg/L) in the Middle Basin; undetected amounts at a reporting limit of 0.020 mg/L were present in all other Middle Basin samples and in surface and dredge layer samples from the North Basin.
- Zinc was not detected above the reporting limit in any sample, however, the reporting limit (0.20 mg/L) was greater than the 0.058 mg/L acute criterion.

3.6 PHOSPHORUS FRACTIONS

Phosphorus fraction results are presented in Table A.2. The total phosphorus concentration in surface samples were higher for the North Basin (1,710 mg/kg) than the Middle Basin (1,035 mg/kg) and was much lower in both z-layer samples (521 and 564 mg/kg in North and Middle Basin samples, respectively). Mobile phosphorus fractions (which include loosely bound, iron bound, and biogenic phosphorus that may be recycled into surface waters for algae uptake) comprised a relatively small but higher proportion of total phosphorus in the surface samples (34 and 27 percent in North and Middle Basin samples, respectively) than the z-layer samples 14 and 19 percent in North and Middle Basin samples, respectively).

4.0 Conclusions

Sediment was collected from a total of 10 stations in March 2020 and analyzed as prescribed by the project SAP with minor exceptions. All the data were found to be acceptable for use in this evaluation of sediment conditions in the Middle Basin (three surface and three core stations) and North Basin (two surface and two core stations). The project data were compared to freshwater and marine SMS criteria for assessing benthic community and human health protection, DMMP criteria for assessing future impacts to dredging projects, and to Surface Water Quality Standards for evaluating potential impacts to freshwater aquatic organisms exposed to suspended dredge sediments.

Sediment core samples were also analyzed for phosphorus fractions. This data was collected to support development of a phosphorus budget and to evaluate potential impacts of sediment removal on lake phosphorus concentrations.

4.1.1 North Basin

Surface sediments in the North Basin had one freshwater CSL criterion exceedance for total sulfides, and nickel exceeded the freshwater SCO criterion in both surface sediment samples. The dredge layer sediments exceeded the freshwater CSL criterion for total sulfides in both samples, and exceeded the freshwater SCO criterion for nickel and the marine SCO criterion for mercury in one dredge layer sample. In addition, the dioxins/furans TEQ result in one dredge layer sample exceeded Puget Sound natural background, but not the Budd Inlet regional background.

SPLP concentrations of copper and lead exceeded acute criteria of the Surface Water Quality Standards for all samples in the North Basin.

Total and mobile phosphorus concentrations were higher in surface than deep z-layer sediments, and generally were higher in the North Basin than the Middle Basin.

4.1.2 Middle Basin

Surface sediments in the Middle Basin had one freshwater CSL criterion exceedance for total sulfides, and nickel exceeded the freshwater SCO criterion in two of the three surface sediment samples. The dredge layer sediments exceeded the freshwater SCO (one sample) or CSL (two samples) criteria for total sulfides, and exceeded the freshwater SCO criterion for nickel and the marine SCO criterion for mercury in one dredge layer sample. Dioxins/furans TEQ results were below the Puget Sound natural background level.

SPLP concentrations of copper and selenium exceeded acute criteria of the Surface Water Quality Standards in one dredge layer sample, and exceeded acute criteria for lead in all Middle Basin samples.

Total and mobile phosphorus concentrations were higher in surface than deep z-layer sediments, and generally were lower in the Middle Basin than the North Basin.

5.0 References

Herrera Environmental Consultants (Herrera). 2020. *Capitol Lake Sediment Characterization Study Sampling and Analysis Plan*. Prepared for Washington Department of General Administration and Capitol Lake Adaptive Management Plan Steering Committee. March 12.

APPENDIX A

SEDIMENT SAMPLE RECORDS AND DATA TABLES

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Sediment Sample Record

Project Name/Number: 2020 Capitol Lake Sediment Sampling / 18-06055-003 Dates: 3/26/2020

Location: Capitol Lake – north basin Crew: N. Maas, G. Iftner Gear: Power Grab, Vibracore

Sample Number	Date	Time	Rep No.	Water Depth (ft)	Recovery Depth (cm)	Sample Interval (cm)	Characteristic (Color, Type, Debris, Odor)
N-G2-S	3/26/20	1015	1	10.4	29.5	0–10	Light brown surface, dark gray silty sand. No odor/debris or sheen
N-G1-S	3/26/20	1035	1	14.9	18	0–10	Some debris in jaw, not washed out. Light brown surface, very dark gray silty sand, woody debris present and strong sulfur smell
N-C1-D	3/26/20	1130	1	10.5	7′3″	–	91% Recovery
							1′–2′: Dark gray sandy silt w/ organic debris
							2′–3′: Dense shell fragment layer, little to no fines
							3′–7′3″: Dark gray sandy silt w/ shells in decreasing frequency from
N-C2-D	3/26/20	1155	1	10.8	6′	–	100% Recovery

Notes:

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Sediment Sample Record

Project Name/Number: 2020 Capitol Lake Sediment Sampling / 18-06055-003 Dates: 3/25/2020

Location: Capitol Lake – middle basin Crew: N. Maas, G. Iftner Gear: Power Grab, Vibracore

Sample Number	Date	Time	Rep No.	Water Depth (ft)	Recovery Depth (cm)	Sample Interval (cm)	Characteristic (Color, Type, Debris, Odor)
M-C1-D	3/25/20	1100	1	5.9	4.3′	–	Low recovery (31%)
		1115	2		12.3′	–	88% recovery
							0–8′: Dark gray sand
							8–12′: Dark gray silt with trace sand
M-C2-D	3/25/20	1250	1	5.6	9′	–	Low recovery (69%)
		1300	2	5.8	11.25	–	87% recovery
							0–3′: Brown silty sand, some woody debris
							3–4′: Brown/gray sand, trace silt
							4–5.25′: Dense woody debris
							6–7.5′: Brown/gray sand, trace silt
							7.5–10′: Light brown/gray silt
							10–11.25′: Coarse sand and shells
MC3-D	3/25/20	1400	1	9.7	7′	–	Could only drive 9′. 7′ of recovery
		1410	2	10	8.08′	–	85% recovery
							0–8.08′: Dark brown/gray sandy silt. Golf ball at 5′
M-G3-S	3/25/20	1535	1	7.7	24	0–10	Light brown surface, gray sandy silt with shells and organic debris. No odor/sheen
M-G2-S	3/25/20	1600	1	6.9	–	–	Over penetrated
		1615	2	7.0	28	0–10	Light brown surface, gray sandy silt, no debris or odor/sheen
M-G1-S	3/25/20	1640	1	6.1	18	0–10	Brown surface, dark brown/gray sandy silt. Large shells and organic debris.

Notes:

Table A-1. DRAFT Physical and Chemical Test Results for March 2020 Sediment Samples from Capitol Lake.

Parameter	Units	Sediment Management Standard						DMMP	Aquatic Life	Middle Basin Samples							North Basin Samples				
		Freshwater[a]		Marine[b]		Marine AETs[c,d]		Marine	Freshwater	Surface			Dredge Layer			Z Layer	Surface		Dredge Layer		Z Layer
		SCO	CSL	SCO	CSL	SCO	CSL	SL	Acute	M-G1-S	M-G2-S	M-G3-S	M-C1-D	M-C2-D	M-C3-D	M-Zcomp	N-G1-S	N-G2-S	N-C1-D	N-C2-D	N-Zcomp
Conventionals																					
Total Solids	%	–	–	–	–	–	–	–	–	48.5	36.9	32.58	65.5	59.5	54.4	72.4	28.9	29.4	60.4	40.2	62.9
Total Volatile Solids	%	–	–	–	–	–	–	–	–	6.6	9.4	10.9	3.9	6.9	7.5	3.1	12.1	12.8	4.70	9.20	5.00
Total Organic Carbon	%	–	–	–	–	–	–	–	–	3.13	2.26	3.70	1.02	2.41	2.66	1.07	3.60	4.44	1.66	2.95	1.93
Total Sulfides	mg/kg	39	61	–	–	–	–	–	–	7.7	1.4 U	**277**	**360**	**43.2**	**61.7**	10.4	**3,270**	21.9	**130**	**770**	10.0
Ammonia	mg/kg	230	300	–	–	–	–	–	–	29.3	17.5	19.3	65.8	80.5	117	43.9	37.3	26.8	35.7	113	39.0
Gravel (>2 mm)	%	–	–	–	–	–	–	–	–	0.02	0.01 U	0.09	0.46	5.36	0.29	22.94	0.51	0.07	11.03	0.01 U	7.82
Very Coarse Sand (1–2 mm)	%	–	–	–	–	–	–	–	–	0.79	2.18	0.61	0.92	1.54	0.29	2.49	0.36	0.79	4.90	0.27	2.27
Coarse Sand (0.5–1 mm)	%	–	–	–	–	–	–	–	–	2.49	1.84	1.24	3.83	3.92	0.65	6.37	0.75	1.57	7.18	0.40	1.81
Medium Sand (0.25–0.5 mm)	%	–	–	–	–	–	–	–	–	14.29	1.56	1.35	24.22	18.04	3.40	13.32	2.05	1.65	13.04	1.01	5.48
Fine Sand (125–250 µm)	%	–	–	–	–	–	–	–	–	20.09	6.14	2.46	22.48	22.13	13.0	4.10	3.38	2.60	16.56	7.27	23.25
Very Fine Sand (62.5–125 µm)	%		–	–	–	–	–	–	–	21.13	16.38	12.18	10.89	7.63	16.95	5.40	6.07	8.42	14.50	11.26	18.45
Coarse Silt (31–62.5 µm)	%	–	–	–	–	–	–	–	–	14.73	28.39	26.85	11.97	5.79	9.41	9.73	7.83	7.80	6.83	9.69	8.33
Medium Silt (15.6–31 µm)	%	–	–	–	–	–	–	–	–	8.79	17.30	20.61	8.52	9.35	16.69	9.68	41.35	23.06	5.85	15.99	6.28
Fine Silt (7.8–15.6)	%	–	–	–	–	–	–	–	–	6.40	12.74	14.93	5.43	9.57	13.28	7.17	15.46	21.80	4.84	21.10	4.81
Very Fine Silt (3.6–7.8 µm)	%	–	–	–	–	–	–	–	–	5.26	7.54	10.37	3.51	6.28	7.44	4.89	6.89	12.94	4.04	15.18	4.3
Coarse Clay (2–3.9 µm)	%	–	–	–	–	–	–	–	–	3.07	2.98	5.30	2.29	4.97	4.70	3.46	3.89	6.83	3.31	10.46	3.88
Medium Clay (1–2 µm)	%	–	–	–	–	–	–	–	–	2.34	1.41	1.69	2.15	1.79	3.33	2.77	3.00	3.49	2.68	3.91	3.59
Fine Clay/Colloid (<1 µm)	%	–	–	–	–	–	–	–	–	1.61	1.21	1.88	4.71	4.56	7.01	5.25	5.81	4.41	3.90	4.12	8.42
Total Fines (<62.5 µm)	%	–	–	–	–	–	–	–	–	42.20	71.57	81.63	38.58	42.31	61.86	42.95	84.23	80.33	31.45	80.45	39.64
Total Metals																					
Arsenic	mg/kg	14	120	57	93	57	93	57	–	2.52	3.55	3.62	3.34	3.23	4.55	3.39	6.2	4.7	3.35	6.54	5.15
Cadmium	mg/kg	2	5	5.1	6.7	5.1	6.7	5.1	–	0.084	0.107	0.116	0.245	0.158	0.176	0.282	0.230	0.173	0.315	0.410	0.94
Chromium	mg/kg	72	88	260	270	260	270	260	–	26.2	29.5	30.1	25.8	25.4	31.0	22.8	36.8	32.9	22.5	41.6	27.0
Copper	mg/kg	400	1,200	390	390	390	390	390	–	33.7	48.2	50.4	22.8	33.8	46.4	21.0	63.1	51.5	26.8	51.7	25.6
Lead	mg/kg	360	>1,300	450	530	450	530	450	–	4.26	5.48	5.67	3.9	5.85	10.5	3.28	7.52	7.24	5.89	16.9	6.06
Mercury	mg/kg	1	1	0.41	0.59	0.41	0.59	0.41	–	0.019 J	0.045 J	0.038 J	0.031	**0.426**	0.103	0.109	0.056 J	0.071	0.082	**0.432**	0.067
Nickel	mg/kg	26	110	–	–	–	–	–	–	23.8	**26.9**	**27.6**	24.2	24.6	**28.8**	21.5	**32.4**	**29.2**	20.0	**36.2**	21.6
Selenium	mg/kg	11	>20	–	–	–	–	–	–	0.24 J	0.30 J	0.3 J	0.24 J	0.24 J	0.32 J	0.26 J	0.50 J	0.50 J	0.30 J	0.50 J	0.40 J
Silver	mg/kg	1	2	6.1	6.1	6.1	6.1	6.1	–	0.036	0.048	0.055	0.04	0.053	0.066	0.092	0.087	0.087	0.125	0.297	0.091
Zinc	mg/kg	3,200	>4,200	410	960	410	960	410	–	49.9	62.0	63.6	42.1	51.2	61.8	36.9	81.5	74.2	44.6	90.4	44.8
SPLP Metals																					
Arsenic	mg/L	–	–	–	–	–	–	–	0.360[f]	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Cadmium	mg/L	–	–	–	–	–	–	–	0.0016[ef]	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U
Chromium	mg/L	–	–	–	–	–	–	–	0.285[e]	0.002 J	0.003 J	0.010 U	0.004 J	0.005 J	0.003 J	0.004 J	0.010 U	0.004 J	0.004 J	0.004 J	0.004 J
Copper	mg/L	–	–	–	–	–	–	–	0.0080[ef]	0.003 J	0.002 J	0.003 J	0.004 J	0.009 J	0.006 J	0.005 J	0.010	0.014	0.009 J	0.029	0.009 J
Lead	mg/L	–	–	–	–	–	–	–	0.0027[ef]	0.007 J	0.010	0.008 J	0.011	0.014	0.009 J	0.017	0.005 J	0.019	0.013	0.013	0.016
Mercury	mg/L	–	–	–	–	–	–	–	0.0021[f]	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 J	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Nickel	mg/L	–	–	–	–	–	–	–	0.720[ef]	0.004 J	0.003 J	0.002 J	0.004 J	0.005 J	0.003 J	0.005 J	0.002 J	0.006 J	0.004 J	0.005 J	0.005 J
Selenium	mg/L	–	–	–	–	–	–	–	0.020	0.020 U	0.020 U	0.020 U	0.012 J	0.022	0.020 U	0.006 J	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
Silver	mg/L	–	–	–	–	–	–	–	0.00087[ef]	0.001 J	0.020 U	0.001 J	0.020 U	0.020 U	0.020 U	0.001 J	0.020 U	0.020 U	0.020 U	0.020 U	0.0008 J
Zinc	mg/L	–	–	–	–	–	–	–	0.058[ef]	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U

Table A-1. DRAFT Physical and Chemical Test Results for March 2020 Sediment Samples from Capitol Lake.

Parameter	Units	Sediment Management Standard						DMMP	Aquatic Life	Middle Basin Samples							North Basin Samples				
		Freshwater[a]		Marine[b]		Marine AETs[c,d]		Marine	Freshwater	Surface			Dredge Layer			Z Layer	Surface		Dredge Layer		Z Layer
		SCO	CSL	SCO	CSL	SCO	CSL	SL	Acute	M-G1-S	M-G2-S	M-G3-S	M-C1-D	M-C2-D	M-C3-D	M-Zcomp	N-G1-S	N-G2-S	N-C1-D	N-C2-D	N-Zcomp
Organometallics																					
Monobutyltin	µg/kg	540	*>4,800*	–	–	–	–	–	–	0.82 J	2.6 U	1.4 J	1.5 U	1.7 U	0.61 J	0.40 J	3.3 U	3.3 U	1.6 U	2.4 U	1.5 U
Dibutyltin	µg/kg	910	130,000	–	–	–	–	–	–	2.0 U	2.6 U	2.9 U	1.5 U	1.7 U	1.8 U	1.4 U	3.3 U	3.3 U	1.6 U	2.4 U	1.5 U
Tributyltin	µg/kg	47	320	–	–	–	–	–	–	2.0 U	2.6 U	2.9 U	1.5 U	1.7 U	1.8 U	1.4 U	3.3 U	3.3 U	1.6 U	2.4 U	1.5 U
Tetrabutyltin	µg/kg	97	*>97*	–	–	–	–	–	–	2.0 U	2.6 U	2.9 U	1.5 U	1.7 U	1.8 U	1.4 U	3.3 U	3.3 U	1.6 U	2.4 U	1.5 U
Miscellaneous Organics																					
2,4-Dimethylphenol	µg/kg	–	–	29	29	29	29	29	–	8.6 U	12 U	13 U	6.3 U	7.0 U	7.7 U	6.3 U	11 U	11 U	6.3 U	7.7 U	6.3 U
2-Methylpheno	µg/kg	–	–	63	63	63	63	63	–	5.6 U	7.4 U	8.1 U	4.1 U	4.5 U	5.0 U	4.1 U	7.1 U	7.0 U	4.1 U	5.0 U	4.1 U
4-Methylpheno	µg/kg	260	2,000	670	670	670	670	670	–	6.1 U	8.1 U	8.9 U	4.5 U	18	5.5 U	4.5 U	7.8 U	7.7 U	5.8 J	5.5 U	11
Benzoic acid	µg/kg	2,900	3,800	650	650	650	650	650	–	130 U	180 U	190 U	96 U	110 U	120 U	96 U	170 U	170 U	96 U	120 U	96 U
Benzyl alcohol	µg/kg	–	–	57	73	57	73	57	–	6.7 U	8.8 U	9.7 U	4.9 U	5.4 U	6.0 U	4.9 U	8.5 U	8.4 U	4.9 U	6.0 U	4.9 U
Dibenzofurar	µg/kg	200	680	–	–	540	540	540	–	4.6 U	6.1 U	6.8 U	3.4 U	3.8 U	4.2 U	3.4 U	5.9 U	5.8 U	3.4 U	4.2 U	3.4 U
Dibenzofurar	mg/kg OC	–	–	15	58	–	–	–	–	0.15 U	0.27 U	0.18 U	0.33 U	0.16 U	0.16 U	0.32 U	0.16 U	0.13 U	0.20 U	0.14 U	0.18 U
Phenol	µg/kg	120	210	420	1,200	420	1,200	420	–	8.7 J	11 J	11 J	8.4 J	7.7 J	8.0 J	5.9 J	5.4 U	5.3 U	3.1 U	3.8 U	3.1 U
N-nitrosodiphenylamine	µg/kg	–	–	–	–	28	40	28	–	4.4 U	5.8 U	6.4 U	3.2 U	3.6 U	3.9 U	3.2 U	5.6 U	5.5 U	3.2 U	3.9 U	3.2 U
N-nitrosodiphenylamine	mg/kg OC	–	–	11	11	–	–	–	–	0.14 U	0.26 U	0.17 U	0.31 U	0.15 U	0.15 U	0.30 U	0.16 U	0.12 U	0.19 U	0.13 U	0.17 U
Phthalates																					
bis(2-Ethylhexyl)phthalate	µg/kg	500	22,000	–	–	1,300	1,900	1,300	–	13 U	16 U	18 U	10 J	14 J	19 J	8.9 U	92 J	16 U	8.9 U	19 J	8.9 U
bis(2-Ethylhexyl)phthalate	mg/kg OC	–	–	47	78	–	–	–	–	0.42 U	0.71 U	0.49 U	0.98 J	0.58 J	0.71 J	0.83 U	2.56 J	0.36 U	0.54 U	0.64 J	0.46 U
Butylbenzylphthalate	µg/kg	–	–	–	–	63	900	63	–	5.0 U	6.7 U	7.4 U	5.7 J	8.1 J	8.5 J	6.3 J	6.4 U	6.3 U	9.0	5.2 J	6.3 J
Butylbenzylphthalate	mg/kg OC	–	–	4.9	64	–	–	–	–	0.16 U	0.30 U	0.20 U	0.56 J	0.34 J	0.32 J	0.59 J	0.18 U	0.14 U	0.54 0	0.18 J	0.33 J
Diethylphthalate	µg/kg	–	–	–	–	200	*>1,200*	200	–	5.0 U	6.7 U	7.4 U	3.7 U	4.1 U	4.5 U	3.7 U	6.4 U	6.3 U	3.7 U	4.6 U	3.7 U
Diethylphthalate	mg/kg OC	–	–	61	110	–	–	–	–	0.16 U	0.30 U	0.20 U	0.36 U	0.17 U	0.17 U	0.35 U	0.18 U	0.14 U	0.22 U	0.16 U	0.19 U
Dimethylphthalate	µg/kg	–	–	–	–	71	160	1,400	–	5.4 U	7.2 U	7.9 U	4.0 U	4.4 U	4.9 U	4.0 U	7.0 U	6.8 U	4.0 U	4.9 U	4.0 U
Dimethylphthalate	mg/kg OC	–	–	53	53	–	–	–	–	0.17 U	0.32 U	0.21 U	0.39 U	0.18 U	0.18 U	0.37 U	0.19 U	0.15 U	0.24 U	0.17 U	0.21 U
Di-n-Butylphthalate	µg/kg	380	1,000	–	–	1,400	1,400	1,400	–	9.5 J	22 J	19 J	8.6 J	14 J	9.8 J	8.3 J	13 J	18 J	5.8 J	10 J	5.9 J
Di-n-Butylphthalate	mg/kg OC	–	–	220	1,700	–	–	–	–	0.30 J	0.97 J	0.51 J	0.84 J	0.58 J	0.37 J	0.78 J	0.36 J	0.41 J	0.35 J	0.34 J	0.31 J
Di-n-Octyl phthalate	µg/kg	39	*>1,100*	–	–	6,200	6,200	6,200	–	6.5 J	5.8 U	6.4 U	3.2 U	3.6 U	3.9 U	3.2 U	5.6 U	12 J	3.2 U	3.9 U	3.2 U
Di-n-Octyl phthalate	mg/kg OC	–	–	58	4,500	–	–	–	–	0.21 J	0.26 U	0.17 U	0.31 U	0.15 U	0.15 U	0.30 U	0.16 U	0.27 J	0.19 U	0.13 U	0.17 U
Petroleum Hydrocarbons																					
Diesel Range Organics	mg/kg	340	510	–	–	–	–	–	–	9.4 J	13 J	14 J	6.8 J	9.3 J	15 J	4.6 J	19 J	26 J	16 J	22 J	11 J
Residual Range Organics	mg/kg	3,600	4,400	–	–	–	–	–	–	36 J	61 J	80 J	46 J	36 J	67 J	20 J	55 J	110 J	57 J	77 J	35 J
Pesticides and PCBs																					
beta-BHC	µg/kg	7	11	–	–	–	–	–	–	1.5 U	2.5 U	4.8 U	1.3 U	1.5 U	1.3 U	1.1 U	3.3 U	3.2 U	1.5 U	2.1	1.3 U
Carbazole	µg/kg	900	1,100	–	–	–	–	–	–	5.2 U	6.9 U	7.6 U	3.8 U	4.2 U	8.4 J	3.8 U	6.6 U	6.5 U	3.8 U	4.7 U	3.8 U
Dieldrin	µg/kg	5	9	–	–	–	–	1.9	–	1.5 U	2.5 U	2.2 U	1.3 U	1.5 U	1.3 U	1.1 U	3.3 U	3.2 U	1.5 U	0.60 J	1.3 U
Endrin Ketone	µg/kg	9	[g]	–	–	–	–	–	–	1.5 U	2.5 U	2.2 U	1.3 U	1.5 U	1.3 U	1.1 U	3.3 U	3.2 U	1.5 U	2.1 U	1.3 U
Total Aroclors	µg/kg	110	2,500			130	1,000	130	–	4.7 J	51 U	45 U	26 U	31 U	12 J	23 U	66 U	64 U	4.6 J	42 U	26 U
Total Aroclors	mg/kg OC	–	–	12	65	–	–	–	–	0.15 J	2.26 U	1.22 U	2.5 U	1.29 U	0.45 J	2.15 U	1.83 U	1.44 U	0.28 J	1.42 U	1.35 U
DDDs	µg/kg	310	860	–	–	–	–	16	–	3 U	5.1 U	4.4 U	2.5 U	2.9 J	1.8 J	2.2 U	6.6 U	6.4 U	3.0 U	2.0 J	2.5 U
DDEs	µg/kg	21	33	–	–	–	–	9	–	1.5 U	2.5 U	2.2 U	1.3 U	2.0 J	0.82 J	1.1 U	3.3 U	3.2 U	1.5 U	1.2 J	1.3 U
DDTs	µg/kg	100	8,100	–	–	–	–	12	–	3.0 U	5.1 U	4.4 U	2.5 U	3.1 U	2.7 U	2.2 U	6.6 U	6.4 U	3.0 U	4.2 U	2.5 U

Table A-1. DRAFT Physical and Chemical Test Results for March 2020 Sediment Samples from Capitol Lake.

Parameter	Units	Sediment Management Standard						DMMP	Aquatic Life	Middle Basin Samples							North Basin Samples				
		Freshwater[a]		Marine[b]		Marine AETs[c,d]		Marine	Freshwater	Surface			Dredge Layer			Z Layer	Surface		Dredge Layer		Z Layer
		SCO	CSL	SCO	CSL	SCO	CSL	SL	Acute	M-G1-S	M-G2-S	M-G3-S	M-C1-D	M-C2-D	M-C3-D	M-Zcomp	N-G1-S	N-G2-S	N-C1-D	N-C2-D	N-Zcomp
Polycyclic Aromatic Hydrocarbons																					
Total PAHs	µg/kg	17,000	30,000	–	–	–	–	–	–	5.6 U	7.4 U	8.1 U	76	110	660	8.2	7.1 U	7.0 U	79	120	110
Total LPAHS	µg/kg	–	–	–	–	5,200	5,200	5,200	–	4.9 U	6.5 U	7.2 U	6.1 J	6.3 J	37	3.6 U	6.3 U	6.2 U	15	16	29
Total LPAHS	mg/kg OC	–	–	370	780	–	–	–	–	0.16 U	0.29 U	0.19 U	0.60 J	0.26 J	1.39	0.34 U	0.18 U	0.14 U	0.90	0.54	1.50
Naphthalene	µg/kg	–	–	–	–	2,100	2,100	2,100	–	4.0 U	5.2 U	5.8 U	2.9 U	3.2 U	3.6 U	2.9 U	5.1 U	5.0 U	6.4 J	4.7 J	12
Naphthalene	mg/kg OC	–	–	99	170	–	–	–	–	0.13 U	0.23 U	0.16 U	0.28 U	0.13 U	0.14 U	0.27 U	0.14 U	0.11 U	0.39 J	0.16 J	0.62
Acenaphthylene	µg/kg	–	–	–	–	1,300	1,300	560	–	3.6 U	4.7 U	5.2 U	2.6 U	2.9 U	3.2 U	2.6 U	4.5 U	4.5 U	2.6 U	3.2 U	3.0 J
Acenaphthylene	mg/kg OC	–	–	66	66	–	–	–	–	0.12 U	0.21 U	0.14 U	0.25 U	0.12 U	0.12 U	0.24 U	0.13 U	0.10 U	0.16 U	0.11 U	0.16 J
Acenaphthene	µg/kg	–	–	–	–	500	500	500	–	4.4 U	5.8 U	6.4 U	3.2 U	3.6 U	3.9 U	3.2 U	5.6 U	5.5 U	3.2 U	3.9 U	3.2 U
Acenaphthene	mg/kg OC	–	–	16	57	–	–	–	–	0.14 U	0.26 U	0.17 U	0.31 U	0.15 U	0.15 U	0.30 U	0.16 U	0.12 U	0.19 U	0.13 U	0.17 U
Fluorene	µg/kg	–	–	–	–	540	540	540	–	4.5 U	6.0 U	6.6 U	3.3 U	3.7 U	4.0 U	3.3 U	5.8 U	5.6 U	3.3 U	4.1 U	3.7 J
Fluorene	mg/kg OC	–	–	23	79	–	–	–	–	0.14 U	0.27 U	0.18 U	0.32 U	0.15 U	0.15 U	0.31 U	0.16 U	0.13 U	0.20 U	0.14 U	0.19 J
Phenanthrene	µg/kg	–	–	–	–	1,500	1,500	1,500	–	4.9 U	6.5 U	7.2 U	6.1 J	6.3 J	30	3.6 U	6.3 U	6.2 U	8.8	9.6 J	9.9
Phenanthrene	mg/kg OC	–	–	100	480	–	–	–	–	0.16 U	0.29 U	0.19 U	0.60 J	0.26 J	1.13	0.34 U	0.18 U	0.14 U	0.53	0.33 J	0.51
Anthracene	µg/kg	–	–	–	–	960	960	960	–	4.4 U	5.8 U	6.4 U	3.2 U	3.6 U	7.0 J	3.2 U	5.6 U	5.5 U	3.2 U	3.9 U	4.4 J
Anthracene	mg/kg OC	–	–	220	1200	–	–	–	–	0.14 U	0.26 U	0.17 U	0.31 U	0.15 U	0.26 J	0.30 U	0.16 U	0.12 U	0.19 U	0.13 U	0.23 J
2-Methylnaphthalene	µg/kg	–	–	–	–	670	670	670	–	3.8 U	5.1 U	5.6 U	2.8 U	3.1 U	3.4 U	2.8 U	4.9 U	4.8 U	2.8 U	3.5 U	3.5 J
2-Methylnaphthalene	mg/kg OC	–	–	38	64	–	–	–	–	0.12 U	0.23 U	0.15 U	0.27 U	0.13 U	0.13 U	0.26 U	0.14 U	0.11 U	0.17 U	0.12 U	0.18 J
Total HPAHs	µg/kg	–	–	–	–	12,000	17,000	12,000	–	5.6 U	7.4 U	8.1 U	70	51	310	4.1 J	7.1 U	7.0 U	64	100	69
Total HPAHs	mg/kg OC	–	–	960	5300	–	–	–	–	0.18 U	0.33 U	0.22 U	6.9	2.12	11.65	0.38 J	0.20 U	0.16 U	3.86	3.39	3.58
Fluoranthene	µg/kg	–	–	–	–	1,700	2,500	1,700	–	5.0 U	6.7 U	7.4 U	14	11	72	4.1 J	6.4 U	6.3 U	14	23	17
Fluoranthene	mg/kg OC	–	–	160	1200	–	–	–	–	0.16 U	0.30 U	0.20 U	1.4	0.46	2.71	0.38 J	0.18 U	0.14 U	0.84	0.78	0.88
Pyrene	µg/kg	–	–	–	–	2,600	3,300	2,600	–	5.0 U	6.7 U	7.4 U	11	8.7 J	46	3.7 U	6.4 U	6.3 U	12	19	17
Pyrene	mg/kg OC	–	–	1000	1400	–	–	–	–	0.16 U	0.30 U	0.20 U	1.1	0.36 J	1.73	0.35 U	0.18 U	0.14 U	0.72	0.64	0.88
Benzo(a)anthracene	µg/kg	–	–	–	–	1,300	1,600	1,300	–	4.9 U	6.5 U	7.2 U	5.5 J	4.4 J	32	3.6 U	6.3 U	6.2 U	4.2 J	7.2 J	5.7 J
Benzo(a)anthracene	mg/kg OC	–	–	110	270	–	–	–	–	0.16 U	0.29 U	0.19 U	0.54 J	0.18 J	1.20	0.34 U	0.18 U	0.14 U	0.25 J	0.24 J	0.30 J
Chrysene	µg/kg	–	–	–	–	1,400	2,800	1,400	–	5.6 U	7.4 U	8.1 U	6.8 J	6.0 J	32	4.1 U	7.1 U	7.0 U	8.1 J	10 J	5.0 J
Chrysene	mg/kg OC	–	–	110	460	–	–	–	–	0.18 U	0.33 U	0.22 U	0.67 J	0.25 J	1.20	0.38 U	0.20 U	0.16 U	0.49 J	0.34 J	0.26 J
Total Benzofluoranthenes	µg/kg	–	–	–	–	3,200	3,600	3,200	–	5.4 U	7.2 U	7.9 U	13 J	7.1 J	53	4.0 U	7.0 U	6.8 U	8.5	14	7.6 J
Total Benzofluoranthenes	mg/kg OC	–	–	230	450	–	–	–	–	0.17 U	0.32 U	0.21 U	1.3 J	0.29 J	1.99	0.37 U	0.19 U	0.15 U	0.51	0.47	0.39 J
Benzo(a)pyrene	µg/kg	–	–	–	–	1,600	1,600	1,600	–	4.9 U	6.5 U	7.2 U	6.7 J	4.0 J	28	3.6 U	6.3 U	6.2 U	5.3 J	8.9 J	6.1 J
Benzo(a)pyrene	mg/kg OC	–	–	99	210	–	–	–	–	0.16 U	0.29 U	0.19 U	0.66 J	0.17 J	1.05	0.34 U	0.18 U	0.14 U	0.32 J	0.30 J	0.32 J
Indeno(1,2,3-cd)pyrene	µg/kg	–	–	–	–	600	690	600	–	4.4 U	5.8 U	6.4 U	7.0 J	4.3 J	22	3.2 U	5.6 U	5.5 U	4.7 J	11 J	4.8 J
Indeno(1,2,3-cd)pyrene	mg/kg OC	–	–	34	88	–	–	–	–	0.14 U	0.26 U	0.17 U	0.69 J	0.18 J	0.83	0.30 U	0.16 U	0.12 U	0.28 J	0.37 J	0.25 J
Dibenz(a,h)anthracene	µg/kg	–	–	–	–	230	230	230	–	4.1 U	5.4 U	6.0 U	3.0 U	3.3 U	5.7 J	3.0 U	5.2 U	5.1 U	3.0 U	3.7 U	3.0 U
Dibenz(a,h)anthracene	mg/kg OC	–	–	12	33	–	–	–	–	0.13 U	0.24 U	0.16 U	0.29 U	0.14 U	0.21 J	0.28 U	0.14 U	0.11 U	0.18 U	0.13 U	0.16 U
Benzo(g,h,i)perylene	µg/kg	–	–	–	–	670	720	670	–	5.0 U	6.7 U	7.4 U	5.6 J	5.4 J	19	3.7 U	6.4 U	6.3 U	6.9 J	8.7 J	5.4 J
Benzo(g,h,i)perylene	mg/kg OC	–	–	31	78	–	–	–	–	0.16 U	0.30 U	0.20 U	0.55 J	0.22 J	0.71	0.35 U	0.18 U	0.14 U	0.42 J	0.29 J	0.28 J

Table A-1. DRAFT Physical and Chemical Test Results for March 2020 Sediment Samples from Capitol Lake.

Parameter	Units	Sediment Management Standard						DMMP	Aquatic Life	Middle Basin Samples							North Basin Samples				
		Freshwater[a]		Marine[b]		Marine AETs[c,d]		Marine	Freshwater	Surface			Dredge Layer			Z Layer	Surface		Dredge Layer		Z Layer
		SCO	CSL	SCO	CSL	SCO	CSL	SL	Acute	M-G1-S	M-G2-S	M-G3-S	M-C1-D	M-C2-D	M-C3-D	M-Zcomp	N-G1-S	N-G2-S	N-C1-D	N-C2-D	N-Zcomp
Chlorinated Organics																					
1,2,4-Trichlorobenzene	µg/kg	–	–	–	–	31	51	31	–	3.6 U	4.7 U	5.2 U	2.6 U	2.9 U	3.2 U	2.6 U	4.5 U	4.5 U	2.6 U	3.2 U	2.6 U
1,2,4-Trichlorobenzene	mg/kg OC	–	–	0.81	1.8	–	–	–	–	0.12 U	0.21 U	0.14 U	0.25 U	0.12 U	0.12 U	0.24 U	0.13 U	0.10 U	0.16 U	0.11 U	0.13 U
1,2-Dichlorobenzene	µg/kg	–	–	–	–	35	50	35	–	3.3 U	4.4 U	4.8 U	2.4 U	2.7 U	3.0 U	2.4 U	4.2 U	4.1 U	2.4 U	3.0 U	2.4 U
1,2-Dichlorobenzene	mg/kg OC	–	–	2.3	2.3	–	–	–	–	0.11 U	0.19 U	0.13 U	0.24 U	0.11 U	0.11 U	0.22 U	0.12 U	0.09 U	0.14 U	0.10 U	0.12 U
1,4-Dichlorobenzene	µg/kg	–	–	–	–	110	110	110	–	3.4 U	4.5 U	5.0 U	2.5 U	2.8 U	3.1 U	2.5 U	4.4 U	4.3 U	2.5 U	3.1 U	2.5 U
1,4-Dichlorobenzene	mg/kg OC	–	–	3.1	9	–	–	–	–	0.11 U	0.20 U	0.14 U	0.25 U	0.12 U	0.12 U	0.23 U	0.12 U	0.10 U	0.15 U	0.11 U	0.13 U
Hexachlorobenzene	µg/kg	–	–	–	–	22	70	22	–	4.5 U	6.0 U	6.6 U	3.3 U	3.7 U	4.0 U	3.3 U	5.8 U	5.6 U	3.3 U	4.1 U	3.3 U
Hexachlorobenzene	mg/kg OC	–	–	0.38	2.3	–	–	–	–	0.14 U	0.27 U	0.18 U	0.32 U	0.15 U	0.15 U	0.31 U	0.16 U	0.13 U	0.20 U	0.14 U	0.17 U
Hexachlorobutadiene	µg/kg	–	–	–	–	11	120	11	–	4.1 U	5.4 U	6.0 U	3.0 U	3.3 U	3.7 U	3.0 U	5.2 U	5.1 U	3.0 U	3.7 U	3.0 U
Hexachlorobutadiene	mg/kg OC	–	–	3.9	6.2	–	–	–	–	0.13 U	0.24 U	0.16 U	0.3 U	0.14 U	0.14 U	0.28 U	0.14 U	0.11 U	0.18 U	0.13 U	0.16 U
Pentachlorophenol	µg/kg	1,200	*>1,200*	360	690	360	690	400	–	7.2 U	9.6 U	11 U	5.3 U	5.9 U	6.5 U	5.3 U	9.2 U	9.0 U	5.3 U	6.5 U	5.3 U
Dioxins/Furans																					
Total 2,3,7,8-TCDD Equivalence (ND=1/2 DL)	pg/g	–	–	4	19	–	–	4/10[h]	–	0.880	0.844	1.35	0.780	2.12	2.60	1.24	2.20	3.14	1.71	7.43	2.16
Total 2,3,7,8-TCDD Equivalence (ND=0)	pg/g	–	–	–	–	–	–		–	0.871	0.669	1.00	0.777	1.94	2.42	1.24	2.20	3.03	1.50	7.43	2.14
1,2,3,4,6,7,8-HpCDD	pg/g	–	–	–	–	–	–		–	17.5	21.5	36.4	18.2	27.0	53.9	12.6	48.9	75.1	26.5	139	4.67
1,2,3,4,6,7,8-HpCDF	pg/g	–	–	–	–	–	–		–	3.66	4.85	8.3	3.56	13.2	17.1	6.26	10.1	13.0	36.6	52.2	24.6
1,2,3,4,7,8,9-HpCDF	pg/g	–	–	–	–	–	–		–	0.2	0.31	0.57	0.271	0.504	0.938	0.22 U	0.640	0.796	0.434	1.81	0.131
1,2,3,4,7,8-HxCDD	pg/g	–	–	–	–	–	–		–	0.274	0.328	0.626	0.205	0.366	0.712	0.272	0.868	1.08	0.342	1.53	0.102
1,2,3,4,7,8-HxCDF	pg/g	–	–	–	–	–	–		–	0.312	0.415	0.711	0.282	2.91	1.62	1.11	0.742	1.16	0.738	5.80	0.26 U
1,2,3,6,7,8-HxCDD	pg/g	–	–	–	–	–	–		–	0.858	1.04	1.56	0.713	1.3	2.00	0.68	2.29	3.36	1.39	6.27	0.421
1,2,3,6,7,8-HxCDF	pg/g	–	–	–	–	–	–		–	0.19 U	0.254	0.443	0.201	1.22	1.08	0.518	0.408	0.701	0.627	2.52	0.296
1,2,3,7,8,9-HxCDD	pg/g	–	–	–	–	–	–		–	0.693	0.66 U	1.3 U	0.613	1.17	1.68	0.728	1.81	2.48	0.921	3.97	0.290
1,2,3,7,8,9-HxCDF	pg/g	–	–	–	–	–	–		–	0.167	0.229	0.304	0.128	0.266	0.386	0.146	0.297	0.479	0.226	0.704	0.132
1,2,3,7,8-PeCDD	pg/g	–	–	–	–	–	–		–	0.208	0.21 U	0.33 U	0.159	0.36 U	0.37 U	0.262	0.46	0.672	0.30 U	1.26	1.43
1,2,3,7,8-PeCDF	pg/g	–	–	–	–	–	–		–	0.148	0.15 U	0.292	0.073	0.671	0.439	0.294	0.266	0.364	0.321	1.33	0.201
2,3,4,6,7,8-HxCDF	pg/g	–	–	–	–	–	–		–	0.319	0.402	0.563	0.264	0.848	1.2	0.48	0.734	0.933	0.978	3.00	0.492
2,3,4,7,8-PeCDF	pg/g	–	–	–	–	–	–		–	0.196	0.213	0.40 U	0.149	1.08	0.78	0.503	0.433	0.725	0.724	2.74	0.426
2,3,7,8-TCDD	pg/g	–	–	–	–	–	–		–	0.069	0.07 U	0.12 U	0.0646	0.251	0.387	0.169	0.135	0.22 U	0.127	0.490	0.0734
2,3,7,8-TCDF	pg/g	–	–	–	–	–	–		–	0.122	0.158	0.257	0.061 U	0.647	0.474	0.295	0.295	0.440	0.425	1.60	0.271
OCDD	pg/g	–	–	–	–	–	–		–	130	170	288	142	209	462	98.8	389	565	202	1,070	26.9
OCDF	pg/g	–	–	–	–	–	–		–	11.7	16.2	28.4	8.93	20.1	37.3	10.9	29.8	35.7	23.9	85.3	9.15
Total HpCDD	pg/g	–	–	–	–	–	–		–	33	41.8	67.7	33.1	52.5	106	27	105	148	55.8	279	10.1
Total HpCDF	pg/g	–	–	–	–	–	–		–	10.6	14.4	25.2	11.5	28.2	46.4	13.1	28.5	38.6	61.9	116	36.3
Total HxCDD	pg/g	–	–	–	–	–	–		–	6.37	6.74	6.37	5.8	12	18.2	9.3	20.6	25.4	13.9	53.9	5.84
Total HxCDF	pg/g	–	–	–	–	–	–		–	5.32	7.62	11.8	6.18	18.7	25.6	8.33	14.7	21.5	25.5	63.1	13.5
Total PeCDD	pg/g	–	–	–	–	–	–		–	0.845	1.19	1.37	0.205	2.7	4.12	3.35	2.59	3.33	3.76	13.5	2.66
Total PeCDF	pg/g	–	–	–	–	–	–		–	2.43	1.16	3.34	1.74	14.9	11.3	6.78	5.07	7.60	10.5	39.6	7.15
Total TCDD	pg/g	–	–	–	–	–	–		–	1.37	0.07 U	1.6	0.670	1.31	3.2	4.3	1.29	1.9	2.14	9.55	2.52
Total TCDF	pg/g	–	–	–	–	–	–		–	2.33	2.06	2.03	0.426	16.2	8.83	7.76	2.45	5.2	9.95	34.0	7.04

Table Notes:

U = undetected at indicated reporting limit; J = estimated value

Grey shade = dectected value exceeds Freshwater SCO

Black shade = detected value exceeds Freshwater CS

Blue outline = detected value exceeds Marine SCO or DMMP Marine SL

Green outline = detected value or reporting limit exceeds acute Aquatic Life criteria.

Purple outline = detected value exceeds Disposal Site Management Objective of 4 pg/g TEQ, which is based on background concentrations of dioxins in Puget Sound. Regional background CSL for Budd Inlet is 19 pg/g.

>Italicized blue "greater than" value indicates that the toxic level is unknown, but above the concentration shown.

[a] All freshwater values are dry weight normalized.

[b] Values are dry weight normalized for metals and polar organics and normalized to total organic carbon for nonpolar organics. Units in mg/kg organic carbon (OC) represent concentrations in parts per million, normalized to organic carbon. To normalize to TOC, the dry weight concentration for each parameter is divided by the decimal fraction representing the percent TOC content of the sediment.

[c] OC normalized values and dry weight normalized marine AETs should be considered when total organic carbon is outside the recommended range of 0.5 – 3.5% for organic carbon normalization.

[d] Dry weight apparent effects thresholds (AETs) for phthalates in marine sediments are derived from Barrick et.al, 1988. The marine SCO is established as the lowest AET and the marine CSL is the 2nd lowest AET, consistent with the dry weight AETs for the other SMS chemicals. These differ from the DMMP values for phthalates which were updated in 2005, based on additional bioassay endpoints and synoptic chemistry/bioassay data. Bioassays may be used in place of these AETs if necessary.

[e] Water quality criteria is hardess dependent. A hardness value of 45 mg/L was selected based on historical data collected from the Deschutes River between 1981 and 2017 at the E Street bridge. Data was downloaded from Ecology's EIM database.

[f] Criteria based on dissolved fraction.

[g] CSL criteria does not exist.

[h] For Puget Sound, the Disposal Site Management Objective is 4 pg/g TEQ at dispersive disposal sites, and 10 pg/g TEQ at non-dispersive disposal sites.

Total LPAH represents the sum of the following low molecular weight polycyclic aromatic hydrocarbon compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.

Total HPAH represents the sum of the following high molecular weight polycyclic aromatic hydrocarbon compounds: fluoranthene, pyrene, benz(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

Total benzofluoranthenes represents the sum of the concentrations of the "b" and "k" isomers

Table A-2. Phosphorus Fractions and Iron Test Results for March 2020 Sediment Samples from Capitol Lake.

Parameter	Units	Middle Basin Samples		North Basin Samples	
		Surface	Z Layer	Surface	Z Layer
		M-Gscomp	M-Zcomp	N-Gscomp	N-Zcomp
Conventionals					
Total Solids	percent	39.8	64.4	25.4	61.7
Total Water	percent	60.20	35.6	74.6	38.3
Phosphorus Fractions					
Total Phosphorus	mg/kg	1,035	564	1,710	521
Loosely Bound Phosphorus	mg/kg	2.00 U	2.00 U	2.00 U	11.4
Iron Bound Phosphorus	mg/kg	139	60.5	208	34.9
Aluminum Bound Phosphorus	mg/kg	353	85.9	646	72.0
Biogenic Phosphorus	mg/kg	136	42.1	378	24.4
Calcium Bound Phosphorus	mg/kg	249	276	300	289
Organic Phosphorus	mg/kg	293	142	557	114
Table Notes:		27%	19%	34%	14%

mg/kg = milligrams per kilogram
U = undetected at indicated reporting limit

APPENDIX B

LABORATORY DATA REPORTS

Materials provided upon request.

APPENDIX C

DATA VALIDATION CHECKLIST

Materials provided upon request.