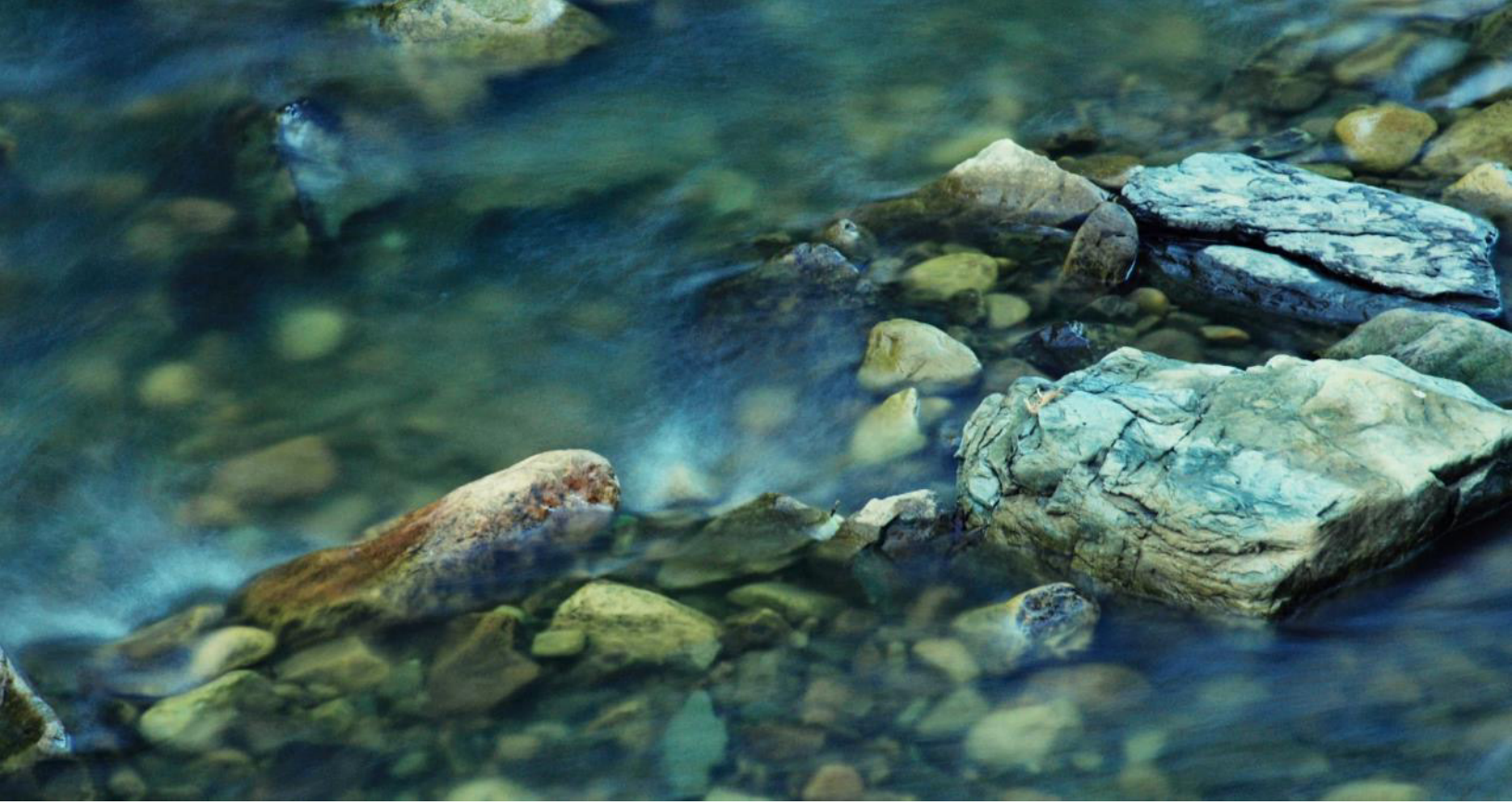

February 2023
Meydenbauer Bay Yacht Club
Maintenance Dredging Evaluation

Sampling and Analysis Plan

Prepared for
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ABBREVIATIONS

AFDW	ash-free dry-weight
ARL	Analytical Resources, LLC.
City	City of Bellevue
COC	chemical of concern
COE	United States Army Corps of Engineers Lake Washington Datum
cy	cubic yard
DGPS	differential global positioning system
DMMP User Manual	*Dredged Material Evaluation and Disposal Procedures User Manual*
DMMP	Dredged Material Management Program
DMMU	dredged material management unit
DQO	data quality objective
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	U.S. Environmental Protection Agency
Gravity	Gravity Marine Consulting
HDPE	high-density polyethylene
MBYC	Meydenbauer Bay Yacht Club
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
PARIS	Permitting and Reporting Information System
PCB	Polychlorinated biphenyl
PSEP	Puget Sound Estuary Program
QA	quality assurance
QC	quality control
QL	quantitation limit
Ref Tox	reference toxicant
RPD	relative percent difference
RTK	real-time kinematic
SAP	Sampling and Analysis Plan
SL	screening level

SIGNATURE PAGE FOR SUBCONTRACTORS

Approval signatures indicate that subcontractors have reviewed this Sampling and Analysis Plan and agree to follow the methods and quality assurance procedures contained herein.

_____ Date: _____
Shawn Hinz, Project Manager
Gravity Marine Consulting

_____ Date: _____
Shelly Fishel, Project Manager
Analytical Resources, LLC

_____ Date: _____
Stella Cuenco, Data Validator
Laboratory Data Consultants

1 Introduction

This Sampling and Analysis Plan (SAP) details the sediment characterization approach and procedures to obtain a suitability determination from the Dredged Material Management Program (DMMP) for open-water disposal of dredged sediment from the Meydenbauer Bay Yacht Club (MBYC) marina in the City of Bellevue (City), Washington (Figure 1). This SAP was developed in accordance with the DMMP guidance (DMMP 2021) and Sediment Management Standards (Washington Administrative Code 173-204-120).

The purpose of the project is to conduct maintenance dredging to restore the MBYC marina basin elevation by removing high spots of sediment accumulation (associated with deposition from Meydenbauer Creek) to allow for safe passage and mooring of vessels in the MBYC marina. The conceptual dredge design will target the permitted elevation of +13.5 feet United States Army Corps of Engineers Lake Washington Datum (COE) with 1-foot of advance maintenance and a 1-foot allowable overdredge to elevation +11.5 feet COE. The newly exposed Z-layer is the first 2 feet of sediment beyond the overdredge elevation, from elevation +11.5 to +9.5 feet COE for this project. Up to 18,500 cubic yards (cy) of sediment will be removed during construction.

The MBYC marina is ranked as "moderate" by the DMMP agencies for concern for potential contamination. To characterize dredged material and post-dredge surface material, sediment core samples will be collected from three dredged material management units (DMMUs), at seven locations, resulting in three dredged material characterization samples and three individual Z-layer samples.

Sampling locations, target core depths, sample intervals, compositing schemes, and chemical testing methods have been selected in accordance with the most recent DMMP guidance (DMMP 2021). Sediment chemical and physical data from this investigation will be presented to the DMMP agencies to determine the suitability of the sediment for open-water disposal at the Elliott Bay non-dispersive disposal site, and for antidegradation determination. MBYC may also use these data to determine practical upland disposal sites . This SAP addresses project team responsibilities, the conceptual dredge plan, sampling and analytical procedures, data quality, and data reporting procedures. Historical data are provided in Appendix A. Field collection forms are provided in Appendix B. Procedures for vessel inspection and cleaning for invasive species are provided in Appendix C.

2 Site Information

MBYC is planning to implement a maintenance dredging event within their marina located in Whalers Cove, Meydenbauer Bay, Lake Washington. Dredging is anticipated to be performed during the 2024/2025 agency-approved in-water work window (or at a later date as desired by MBYC) to the dredge elevation of approximately +11.5 feet COE. MBYC is proposing to complete a maintenance dredging action that includes 1 foot of advanced maintenance below the marina design elevation, plus 1 foot of allowable overdredge.

Advanced maintenance dredging refers to sediment that will be dredged below the project elevation. This practice helps to ensure project elevations are met, minimizes operating and facilities maintenance costs, and reduces dredging frequency. It also helps to minimize air emissions (including greenhouse gases) and environmental disturbance because it extends the interval between dredging cycles. Allowable overdredge allows incidental excursions that may occur due to unanticipated variations in substrate, incidental removal of submerged obstructions, wind, waves, and other site conditions that may reduce the ability to accurately control the excavation elevation of the dredging equipment.

Other than a localized area adjacent to a City stormwater outfall that discharges along the south end of the property boundary, maintenance dredging has not been completed within the marina basin because it was last dredged in the 1960s. The focus of this program will be to restore the design elevation by removing high spots of sediment accumulation to allow for safe moorage and passage of vessels into and out of the marina (Figure 1).

2.1 Site History

MBYC was founded in 1946 and provides covered and uncovered moorage for a variety of recreational vessels. The last recorded marina-wide maintenance dredging event at the MBYC occurred in the 1960s, when the MBYC was dredged to a lake elevation of approximately +13.5 feet COE. The lake level is maintained by the United States Army Corps of Engineers between approximate elevation +20 and +22 feet COE annually; therefore, the design elevation of the MBYC corresponds to about 6.5 to 8.5 feet of water depth over each annual lake level cycle.

The only dredging that has occurred since the 1960s has been done by the City of Bellevue near a stormwater outfall that discharges at the south end of the marina pursuant to an easement obligation[1]. . The first event occurred in 1997 and included a testing program near the outfall (see Appendix A). This event resulted in removal of about 150 cy of material within a localized shoal area around the outfall structure, which was disposed of in an upland landfill since it was not eligible for

[1] The City of Bellevue manages this outfall and adjacent sediments and can be contacted regarding monitoring requirements and details of past dredging events. Contact information can be provided upon request.

open water disposal. MBYC is aware of two additional dredging events (2014 and 2017) conducted by the City adjacent to the outfall. No additional testing occurred as part of these events.

2.2 Existing Data Summary

A search was conducted in Washington State Department of Ecology's (Ecology) Contaminated Cleanup Site databases, Water Quality Permitting and Reporting Information System (PARIS), Ecology Well Viewer database, and the Environmental Information Management (EIM) database to identify contaminated sites, potential ongoing sources of contamination, and historical contamination. Additionally, data from the 1997 suitability determination for dredging near the City of Bellevue outfall are included in Appendix A.

2.2.1 Ecology Cleanup and Well Viewer Databases

The Ecology Toxic Cleanup Site database was reviewed and one adjacent cleanup site in Meydenbauer Bay was identified at Bellevue Marina (Cleanup Site ID: 13219, Facility ID: 12984) to the north of the MBYC marina. On December 22, 2009, during a geotechnical investigation, the City of Bellevue Utilities Department discovered soil with physical indications (odor) and noted petroleum contamination in a boring labeled "B-4." Soil was analyzed, and gasoline range hydrocarbons were detected at a concentration greater than the Model Toxic Control Act Method A cleanup level. The impacted soil from boring B-4 was approximately 15 inches below ground surface and located adjacent to the MBYC at 100 100th Avenue SE, Bellevue, Washington 98004. In April 2010, on behalf of the City, the discovery was filed with Ecology's Northwest Regional Office. Ecology sent an early notice letter in May 2017 to the City of Bellevue Parks (owner) indicating the listing as a suspected cleanup site. The Bellevue Marina is currently listed as awaiting cleanup.

The Ecology Reported Spills database indicated one recent spill has been reported in the immediate vicinity of the site (Figure A-1). The one spill occurred in January 2018 and released 20 gallons of vegetable oil into the water.

2.2.2 PARIS Database

No existing stormwater permits are issued for the MBYC or adjacent properties. Based on online utility maps from the City, there are two City managed stormwater discharge points locations, one City managed sewer gravity main, and one privately managed storm discharge point in the vicinity of the MBYC marina, as follows and as shown in Figure 2:

- City-managed storm discharge point north of Dock 3: 12-inch PVC pipe active during storm events
- City-managed sewer discharge point north of Dock 3: 10-inch ductile iron pipe that acts as an overflow for the pump station

- Privately managed storm discharge point near Dock 2: 21-inch pipe that discharges collected water from MBYC parking area and city street stormwater runoff
- City-managed storm discharge point south of Dock 1: 60-inch reinforced concrete gravity main

2.2.3 Ecology Well Viewer Database

The Ecology Well Report Viewer was reviewed and indicated three geotechnical soil borings have been completed by Cornerstone Geotechnical Inc., on the MBYC property in August 2008. The soil borings were completed via mud rotary methods to depths of 14, 19, and 24 feet below ground surface. The borings were collected to inform discussion on earthquake insurance and are not relevant to this project.

2.2.4 EIM Database

No available EIM data within the project boundary were listed on the Ecology EIM database.

Available EIM data, within the first quarter mile of the property boundary include two sediment grab samples. Location ID KCM-MDNBRSWMBCH (collected in 2010) and Location ID LKWA00834 (collected in 2000) had analyses of DMMP parameters including grain size, conventionals, metals, semivolatile organic compounds, pesticides, polycyclic aromatic hydrocarbons, and polychlorinated biphenyls (PCBs).

The sediment sample most near the MBYC marina was location ID LKWA00834. The sediment grab was from the top 10 centimeters of material and was primarily silt (61.8%), sand (33%), trace gravel (3.2%), and trace clay (2%). No analytes from KCM-MDNBRSWMBCH exceed DMMP SLs. Sample LKWA00834 had minor DMMP screening level exceedances of mercury, tributyltin, benzoic acid, pesticides (4,4-DDD, and 4,4-DDT), and total DMMP PCB Aroclors. Appendix A includes maps of the sample locations (Figure A-2) and EIM data export summary (Table A-1).

2.2.5 Invasive Species

A check was performed to determine whether the New Zealand mudsnail has been documented within the project area. Based on the review of the United States Geological Survey Nonindigenous Aquatic Species database, King County Services, and Washington Department of Fish and Wildlife, the New Zealand mudsnail has been identified in Lake Washington as a localized, low infestation. No confirmed New Zealand mudsnail sites were identified in Meydenbauer Bay.

Eurasian Milfoil and Brazilian Elodea are Class B invasive species and are widespread throughout Washington State. Their presence has been documented in Meydenbauer Bay. Each year, when permitted by the state, the bay is treated for eradication of both species using a licensed and

approved applicator. The chemical that is applied is Diquat. The last eradication event was scheduled for July 2022.

Inspection and cleaning procedures will be followed as described in Section 5.11 and Appendix C to prevent the potential spread of either species.

2.2.6 Eelgrass

Eelgrass is not known to exist in the area surrounding the site.

3 Project Team and Responsibilities

This section discusses the proposed project team and team member responsibilities for conducting the MBYC maintenance dredging sediment characterization.

3.1 Project Planning, Coordination, and Quality Assurance/Quality Control

Delaney Peterson will serve as the sediment characterization lead responsible for SAP development and quality assurance (QA) for the field sampling and laboratory programs. Ms. Peterson will be kept fully informed of field program procedures and progress during sample collection and laboratory activities during sample preparation. She will record any activities that vary from this SAP and develop appropriate resolutions for irregularities. Upon completing the sampling and analytical program, they will review laboratory QA/quality control (QC) results and incorporate findings into the final Sediment Characterization Report. Any QA/QC problems will be brought to the attention of the DMMP agencies as soon as possible to discuss issues related to the problem and to evaluate potential solutions.

3.2 Field Sample Collection

Stephen Strehl will serve as the field lead and will provide overall direction for field sampling as it relates to logistics, personnel assignments, and field operations. Mr. Strehl will supervise field collection of the sediment core samples and verify accurate positioning and recording of sampling locations, depths, and identification. He will also ensure conformity to sampling and handling requirements, including field decontamination procedures; perform physical evaluation and logging of the samples; maintain chain-of-custody of the core samples; and compile field data into the project database.

Gravity Marine Consulting (Gravity), or a similar subconsultant (pending availability), will provide the research vessel and captain to collect vibracore samples.

3.3 Physical and Chemical Analyses and Data Validation

Analytical Resources, LLC (ARL), will conduct physical and chemical analyses. ARL is National Environmental Laboratory Accreditation Program accredited and is accredited by the Washington State Department of Ecology. They will ensure that the submitted samples are handled and analyzed in accordance with DMMP marine (and freshwater if z-layer analyses are required) analytical testing protocols, QA/QC requirements, and the requirements specified in this SAP. ARL will prepare a laboratory data report containing all analytical and QA/QC results.

Laboratory Data Consultants will conduct EPA Stage 2B (USEPA 2009) validations, per the requirements in *Dredged Material Evaluation and Disposal Procedures User Manual* (DMMP User Manual; DMMP 2021).

3.4 Sediment Characterization Report

The Sediment Characterization Report will be prepared collaboratively by the Anchor QEA team to support the suitability determination. This report will summarize the sampling effort, analytical methods, QA/QC narrative, and analytical testing results. The content of this report is further described in Section 10.

4 Conceptual Dredging Plan

This section provides the conceptual dredging plan used to determine sampling rationale for dredged material and Z-layer sediment characterization.

4.1 Site Ranking

The project area has a general ranking of moderate by the DMMP agencies because it is a marina. This ranking means that sources exist in the vicinity of the project, or there are present or historical uses of the project site, with the potential for producing chemical concentrations within a range associated historically with some potential for causing adverse biological impacts.

4.2 Estimated Dredge Area

The project is proposed to occur within the marina, which receives deposition from Meydenbauer Creek, located just south of the marina (Figure 1). Maintenance dredging will be performed to the permitted elevation of +13.5 feet COE and will include 1-foot advance maintenance and a 1-foot overdredge allowance (to a maximum elevation of +11.5 feet COE; Figure 2). Design side slopes are 3 feet horizontal to 1 foot vertical (3H:1V) on the southern and western boundaries, while the northern and eastern boundaries have been designed to include a vertical cut.[2] Because the site has not been dredged since the 1960s, a conservative assumption has been made that the sediment is heterogeneous surface material.

4.3 Estimated Dredge Volumes

The maximum dredge volume for this project is estimated to be 18,500 cy. This estimate was based on bathymetry data surveyed by Gravity on May 12, 2022, and includes side slope and planned overdredge volumes, and a contingency volume to make certain the permitted dredge volume will exceed the actual dredge volume.

DMMP guidelines dictate the required number of DMMUs and maximum sediment volume represented by a single field sample. In a moderate ranked area, the maximum volume of heterogeneous sediment in a single surface DMMU is 16,000 cy and the maximum volume of sediment represented by each field sample is 4,000 cy (DMMP 2021). Therefore, two DMMUs with five core locations are required to characterize sediment in the planned dredge prism. An additional DMMU and associated sample location has been proposed to separately characterize the stormwater outfall area that is managed by the City of Bellevue. An additional sample (location C-4; see Figure 2) at the north end of the site near the two outfalls was also added at the request of DMMP. Therefore, a total of three DMMUs and seven core locations are proposed. Figure 2 shows the dredge prism,

[2] Vertical cuts are assumed on the northern and eastern boundaries due to adjacent structures. Additional volume has been include in the overall volume estimate to account for material that sloughs into the dredge prism.

DMMUs, and proposed sampling locations, and Figure 3 shows a representative cross section of the dredge prism.

4.4 Sampling Design

Seven sampling locations were selected to characterize the proposed dredged area. Table 1a provides the coordinates of the seven target sampling locations and sampling depths proposed from each core. Table 1b shows the sampling compositing scheme that will be used to create the representative DMMU sample composite generated for analysis. Sediment from the mudline down to +11.5 feet COE will be considered the dredged material. Sediment from +11.5 to +9.5 feet COE is the 2-foot Z-layer sample and represents the proposed post-dredge surface. Archives of each individual dredged material core segment (e.g., C-1-A) and Z-layer sample will be collected.

The seven sampling locations were selected in locations where the thickest dredge cuts are anticipated based on the survey data. The proposed locations require core lengths of approximately 5 to 6 feet maximum (to reach the Z-layer). Because the settlement from Meydenbauer Creek and Lake Washington sediments are primarily silt and sand (based on nearby sediment grab locations) difficulty achieving required coring depths is not anticipated for six of the seven locations[3]; however, if subsurface debris or larger grain size material are encountered during coring, it may be difficult to achieve adequate recovery or reach the Z-layer. If difficult coring conditions are encountered, the Z-layer may not be reached. If this situation occurs, a portion of the bottom 1-foot of the core will be sampled and archived for potential subsequent analysis. Sediment from the entire core should be included in the dredge prism sample. Coordination with DMMP will occur before any changes are made to the z-layer interval.

The Z-layer (or the archive from the bottom 1 foot of core) will only be analyzed and compared to the freshwater SMS if the dredged material has chemicals that exceed one or more marine SLs. If no chemicals exceed marine SLs, antidegradation requirements will be met and no further testing will be required.

[3] Sample location C-4 requested by DMMP is in or near a riprap slope of unknown extent. If riprap is encountered, the sample will be moved further offshore to a maximum distance of 30 feet from the current location.

5 Sampling Methods Requirements

This section addresses the sample collection and processing procedures that will be used to ensure data quality, including sample collection and sample processing. Specifically, this section describes scheduling, positioning, identification, collection, core processing, compositing, field QA, and waste management.

5.1 Sampling Schedule and Platform

Sampling will occur as soon as possible after this SAP is approved by DMMP agencies. Mobilization, field sampling, sample processing, and demobilization are anticipated to occur over 2 days.

Core samples will be collected using in-water vibracore collection techniques. Core tubes will be advanced to achieve the target depths provided in Table 1a. Core collection vessels will be operated by crews with extensive experience in vibracore operations.

5.2 Horizontal Positioning and Vertical Control

Horizontal positioning will be determined by an onboard differential global positioning system (DGPS) based on target coordinates shown in Table 1a. The DGPS will record sampling positions with a minimum 3-foot accuracy. The horizontal datum will be the North American Datum of 1983, Washington State Plane, North Zone, US feet. The DMMP agencies' point of contact (Kelsey van der Elst, Corps DMMO) will be consulted if there is a need to move a sampling location more than 10 feet from any station. Any stations that are moved will remain within the dredge prism.

The water depth at each sediment sampling location will be measured using a fathometer or lead-line during vibracoring. The water elevation at each station will be measured using Gravity's survey package, which includes a real-time kinematic (RTK) survey DGPS and survey-grade fathometer mounted on board the vessel above sea level. A survey reference marker will be identified from the Washington State reference marker network and used to calibrate the onboard RTK-DGPS for measuring water elevation. Gravity will conduct any necessary data corrections based on the location of the RTK-DGPS within the vessel. The water depth, water level (from RTK), and time of collection will be recorded on sediment core collection logs. The mudline elevation (feet COE) will be estimated by subtracting the water depth from the water level. For example, if the lead-line measurement is 5.5 feet at a sampling location and the recorded Lake Washington elevation is 20 feet COE, the mudline elevation at that location is calculated as follows: 20 feet COE – 5.5 feet = 14.5 feet COE.

5.3 Field Documentation

Field documentation will consist of a daily field log and sediment core collection and processing forms (Appendix B). All data entries will be made using an indelible-ink pen. Corrections to field forms will be made by drawing a single line through the error, writing in the correct information, and

then dating and initialing the change. The daily field log is intended to provide sufficient data and observations to enable readers to reconstruct events that occurred during the sampling effort. Examples of information to be recorded include field personnel, weather conditions, complications encountered, field communications, and other general details associated with the sampling effort. Collection and processing form requirements are described in Sections 5.9.1 and 5.9.2, respectively.

5.4 Station Locations

Figure 2 shows the proposed sampling locations. The seven locations were selected to achieve spatial representation within the dredge area. Table 1a presents the target coordinates and estimated mudline elevations of the proposed sampling locations.

5.5 Station and Sample Identification

Sediment core sample nomenclature identification is as follows:

- Each sampling location will be identified as the station number (e.g., C-1).
- Individual samples processed from the core will be identified by the same alphanumeric identification used to identify the sampling location, followed by the sample interval identifier (e.g., A or Z for Z-layer sample; C-1-Z for a sample collected from the Z-layer sample of C-1). The date will be appended (YYYYMMDD) to maintain database uniqueness.
- Composite samples will be identified by the dredge unit number followed by the sample interval identifier (A) to represent surface dredged material. For example, DU1-A would be used for a composite sample collected from DMMU1.

5.6 Equipment Decontamination Procedures

Sample containers, instruments, working surfaces, technician's protective gear, and other items that may contact sediment sample material must meet high standards of cleanliness. All equipment and instruments used that are in direct contact with the sediment collected for analysis must be made of glass, stainless steel, or high-density polyethylene (HDPE). All reusable sampling equipment will be cleaned prior to core collection (at each station) and prior to sample collection (each interval) during core processing. Decontamination of all items will follow Puget Sound Estuary Program (PSEP) protocols. The decontamination procedure is as follows:

- Scrub until free of visible sediment.
- Prewash and rinse with site water.
- Wash with a brush in a solution of distilled water and biodegradable phosphate-free liquid detergent (Liquinox) soap.
- Rinse three times with distilled water.
- Cover (no contact) all decontaminated items with aluminum foil.

5.7 Sample Containers for Analysis

The contract laboratory will provide certified, precleaned, U.S. Environmental Protection Agency (EPA)-approved containers for all chemistry samples. Sediment for bioassay testing will be placed in commercially available HDPE buckets that have been decontaminated as described in Section 5.6.

5.8 Field Quality Assurance

Field QA will include collecting additional sediment volume as required to ensure that the laboratory has sufficient sample volume to run the program-required analytical QA/QC samples (i.e., matrix spikes [MSs] and replicates) for analyses.

5.9 Sediment Core Collection

The subsequent subsections detail vibracore collection methods and vibracore processing methods.

5.9.1 Vibracore Collection Procedures

All core samples will be collected using a vibracore. A vibracore collects a continuous profile of sediments by using a high frequency vibrating coring device that penetrates the underlying sediments with minimal distortion. A vibracore is ideal for collecting long, relatively undisturbed cores from various sediment types. The vibracore will be fitted with a Lexan core tube and advanced to full penetration below the mudline.

The core tube will be lined with a clean plastic liner. The sediment will not contact the outer core tube. New liners will be used for each sampling location.

Vibracore samples will be collected in the following manner:

- The vessel will maneuver to the proposed sampling location.
- A 4-inch-diameter, thin-walled, 14-foot Lexan core tube with inner plastic liner will be secured to the vibratory assembly and deployed from the vessel.
- The cable umbilical to the vibrator assembly will be drawn taut and perpendicular as the core rests on the bottom sediment.
- The depth to sediment will be measured with a lead-line at the bow of the boat near the vibracore assembly.
- The core will be vibratory-driven into the sediment using two counter-rotating vibrating heads.
- A continuous core sample will be collected to target depth or until refusal.
- The depth of core penetration will be measured and recorded by the vessel captain using a tape measure attached to the vibracore head.
- The core barrel will be extracted from the sediment using the winch.

- While suspended from the A-frame, the assembly and core barrel will be sprayed off and then placed on the vessel deck.
- The core sample will be evaluated at the ends of the core tube, and the length of recovered sediment will be recorded by subtracting the head space from the total length of the core tube.

Acceptance criteria for sediment core samples are as follows:

- The core tube appears intact without obstruction or blocking.
- Recovery is greater than 75% of the drive length.
- Penetration is deep enough to collect all target depth intervals.

If sample acceptance criteria are not achieved, the sample will be rejected unless modified acceptance criteria (i.e., lower percent recovery after multiple attempts) are approved by the DMMP agencies.

Anchor QEA personnel will record field conditions and provide notes on a sediment core collection log (Appendix B). Logs will include the following information:

- Water depth at each station using a lead-line at point of sampling station
- Coordinates of each station, as determined by DGPS
- Date and time of collection of each sediment core sample
- Names of field personnel collecting and handling the samples
- Observations made during sample collection, including weather conditions, complications, ship traffic, presence of anthropogenic debris or New Zealand mudsnail, and other details associated with the sampling effort
- Sampling location identification
- Length and depth intervals of each core section
- Percent recovery for each core sample
- Qualitative notation of apparent resistance of sediment column to coring (how the core drove)
- Any deviation from the approved SAP

Once the core samples are deemed acceptable, the cutterhead will be removed, and a cap will be placed over the end of the tube and secured firmly in place with duct tape. The core tube will then be removed from the sampler, and the other end of the core will be capped and taped. The core tube will be labeled with duct tape and permanent black pen with the location identification and an arrow pointing to the top of core. Cores will be stored upright in a vertical position and secured to ensure they are stable until processing.

5.9.2 Vibracore Processing Procedures

Cores will be processed on board the sampling vessel on the same day as collection When processed, the entire core length contained within the polyethylene liner will be extracted from the core tube with the ends tied off and laid in a core processing tray. The liner will be cut open using a decontaminated stainless-steel box cutter. Using decontaminated stainless-steel wire core splitters or spatulas, the core will then be split lengthwise into two halves for sampling.

Prior to further sampling, Anchor QEA personnel will delineate sampling intervals, take color photographs, and record a sediment description of each core on a sediment core processing log (Appendix B). Logs will include the following information:

- Sample recovery
- Physical soil description in accordance with ASTM D 2488 and ASTM D 2487 – Unified Soil Classification System procedures including soil type, density/consistency of soil, and color
- Odor (e.g., hydrogen sulfide and petroleum)
- Visual stratification, structure, and texture
- Vegetation and debris (e.g., wood waste or fibers, paint chips, concrete, sand blast grit, and metal debris)
- Biological activity (e.g., detritus, shells, tubes, bioturbation, and live or dead organisms)
- Presence of oil sheen
- Contact with native material (and description of material), if applicable

Given the anticipated grain size characteristics, sample intervals will not be corrected for length based on core recovery.

Once the two sample intervals (i.e., dredge prism interval and z-layer interval)[4] are delineated as described in Table 1a, the sediment from each interval will be placed into a decontaminated stainless-steel bowl and mixed until homogenous and consistent in color and texture. Archives will be collected from individual cores. Core composites will be generated by placing a volume of sediment proportional to the length of each core into a large stainless-steel bowl and mixing until uniform in color and texture. Homogenized material from individual cores will be stored in the mixing bowls, covered with aluminum foil, and put on ice prior to compositing. To create composites, equal amounts of material from each sample interval will be composited together and homogenized until uniform in color and texture. The composited sediment will be spooned into laboratory-supplied jars for analyses. The sulfides samples will be collected from the homogenized core composites, placed in jars with 5 milliliters of 2-Normal zinc acetate per 30 grams, and shaken

[4] The field crew will be prepared to sample notable horizons if a layer with odor or some other unexpected characteristic is encountered. This should be discussed with DMMP prior to making changes.

vigorously to preserve the samples. Sample jars will be placed in zip-top bags and stored on ice in coolers in a secure location following chain-of-custody protocols described in Section 6.

5.10 Waste Management

All disposable sampling materials and personal protective equipment used in sample collection and processing, such as disposable coveralls, gloves, and paper towels, will be placed in heavy-duty garbage bags or other appropriate containers. Sediment remaining after core processing and sampling will be disposed of at the sampling location.

5.11 Vessel Inspection and Cleaning for Invasive Species

No confirmed New Zealand mudsnail (*Potamopyrgus antipodarum*) sites have been identified in Meydenbauer Bay. Inspection and cleaning procedures will be followed to prevent possible infection from the vessel being deployed for the project and to prevent the potential spread of any unidentified infections of New Zealand mudsnail or other invasive species. These procedures are detailed in Gravity's SOP SW-19: *Boat Inspection and Cleaning for Invasive Species,* located in Appendix C. A New Zealand mudsnail identification guide is provided in Appendix D. Additionally, any permit conditions related to inspection or cleaning procedures identified in the Washington Department of Fish and Wildlife Hydraulic Project Approval, or other permits and approvals, issued for the sampling or maintenance dredging activities will also be implemented.

6 Sample Handling and Custody

Samples are in one's custody if they are: 1) in the custodian's possession or view; 2) in a secured location (under lock) with restricted access; or 3) in a container that is secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s). Chain-of-custody procedures will be followed for all samples throughout the collection, handling, and analysis process. The principal document used to track possession and transfer of samples is the chain-of-custody form. Each sample will be represented on a chain-of-custody form the day that it is collected. All data entries will be made using an indelible-ink pen. Corrections will be made by drawing a single line through the error, writing in the correct information, and then dating and initialing the change. Blank lines and spaces on the chain-of-custody form will be lined-out and dated and initialed by the individual maintaining custody.

All samples will be transferred to the ARL sample custodian by Anchor QEA personnel. Upon transfer of sample possession to ARL, the person transferring custody of the sample container will sign the chain-of-custody form. Upon receipt of samples at the laboratory, the receiver will record the condition of the samples on a sample receipt form. Table 2 presents the sample handling and storage requirements to be followed by field and laboratory staff. The sample sizes in Table 2 provide sufficient material for the required laboratory QC samples.

7 Physical and Chemical Analyses

Table 3 presents the proposed analytes, evaluation guidelines, analytical methods to be used, and target quantitation limits (QLs) for evaluating sediment. All sample analyses will be conducted in accordance with DMMP- and Ecology-approved methods. Prior to analyses, all samples will be maintained according to appropriate holding times and temperatures for each analysis (Table 2).

ARL will report sample specific QLs and method detection limit (MDLs) for each target analyte in the laboratory data report. Values reported between the QL and MDL will be assigned a J-qualifier to denote that the concentration is estimated. ARL has established sediment methods that achieve QLs less than the DMMP and Sediment Management Standards screening levels (SLs), as shown in Table 3. Because dredged material is planned for disposal in a marine environment, it will be compared against DMMP Marine Guidelines, and material will also be analyzed for butyltins and dioxin/furans. If Z-layer samples are triggered for analyses after dredged material has been characterized, results will be compared against SMS Freshwater Guidelines because the newly exposed surface will be in a freshwater environment. For instances where nondetected QLs exceed SLs (i.e., matrix interference), the result will be evaluated to the MDL. If the MDL exceeds the SL and will impact the outcome of the evaluation, measures will be taken (e.g., additional extract cleanups, sample repreparation and reanalysis, use of a different method, etc.) to achieve an MDL below the SL.

In completing physical and chemical analyses for this project, the contract laboratory is expected to meet the following minimum requirements:

- Adhere to the methods outlined in this SAP, including methods referenced for each analytical procedure.
- Deliver PDF and electronic data in EQuIS format (per Anchor QEA database requirements).
- Meet reporting requirements for deliverables (package that meets DMMP reporting requirements).
- Meet turnaround times for deliverables.
- Implement QA/QC procedures, including laboratory QC requirements.
- Notify the project manager of any QA/QC problems when they are identified to allow for quick resolution. The project manager will then notify the DMMP agencies' point of contact if there are significant impacts to data quality.
- Allow laboratory and data audits to be performed, if deemed necessary.

8 Data Quality Control Procedures

The data quality objective (DQO) for this project is to ensure that data collected are of known and acceptable quality to achieve the project objectives described in this SAP. Laboratory QA/QC samples will be analyzed to measure collection and analytical method performance. The required frequencies for these analyses are provided in Table 4. Applicable quantitative goals for analytical data are provided in Table 5.

8.1 Special Training Requirements and Certifications

For sample preparation tasks, it is important that field crews be trained in standardized data collection requirements so that data collected are consistent among the field crew. All field staff will be fully trained in sediment core collection and sampling methods, decontamination protocols, field documentation, and chain-of-custody procedures.

In addition, the 29 Code of Federal Regulations 1910.120 Occupational Safety and Health Administration regulations require training to provide employees with the knowledge and skills to enable them to perform their jobs safely and with minimum risk to their personal health. All field crews will have completed the 40-hour HAZWOPER training course and 8-hour refresher courses, as necessary, to meet Occupational Safety and Health Administration regulations.

8.2 Laboratory Deliverables

For all analyses, the data reporting requirements will include those items necessary to complete data validation, including copies of all raw data (QA2 level). The ARL will be required, where applicable, to report the following:

- **Project Narrative:** This summary, in the form of a cover letter, will discuss problems, if any, encountered during any aspect of analysis. This summary should discuss, but not be limited to, QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered and their resolutions will be documented in as much detail as appropriate.
- **Chain-of-Custody Records:** Legible copies of the chain-of-custody forms will be provided as part of the data package. This documentation will include the time of receipt and condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented on a sample receipt form. The form must include all sample shipping container temperatures measured at the time of sample receipt.
- **Sample Results:** The data package will summarize the results for each sample analyzed. The summary will include the following information when applicable:
  - Field sample identification code and the corresponding laboratory identification code
  - Sample matrix
  - Date of sample extraction

  - Date and time of analysis
  - Weight and volume used for analysis
  - Final dilution volumes or concentration factor for the sample
  - Identification of the instrument used for analysis
  - QLs and MDLs
  - Analytical results with reporting units
  - Data qualifiers and their definitions
- **QA/QC Summaries:** This section will contain the results of the laboratory QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results. No recovery or blank corrections will be made by the laboratory. At a minimum, the following elements will be included/reported:
  - **Calibration Data Summary:** This summary will report the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent relative standard deviation, percent difference, retention time, and calibration r value for each analyte will be listed, as appropriate. Results for standards to indicate instrument sensitivity will also be documented.
  - **Internal Standard Area Count Summary**
  - **Method Blank Analysis:** Target compounds and concentrations
  - **Surrogate Spike Recovery:** Surrogates added, concentrations, percent recoveries, and control limits will be reported.
  - **Matrix Spike Recovery:** Analytes added, percent recoveries and relative percent difference (RPD) values for matrix spike duplicate (MSD) analyses.
  - **Matrix Duplicate:** RPD values or difference values for matrix duplicate analyses
  - **Laboratory Control Sample:** Analytes added, percent recoveries and RPD values for laboratory control sample duplicate analyses
  - **Relative Retention Time:** Relative retention times of each detected target analyte for primary and confirmational chromatographic analyses
- **Original Data:** Legible copies of the original data generated by the laboratory will include the following:
  - Sample extraction, preparation, extraction method, and cleanup logs
  - Instrument specifications and analysis logs
  - Calculation worksheets, if used
  - Full scan chromatograms for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials
  - Ion chromatograms for all detected analytes in gas chromatography/mass spectrometry analyses

- Full-scan chromatograms and quantitation reports for all gas chromatography and gas chromatography/mass spectrometry samples, standards, blanks, calibrations, spikes, replicates, and reference materials
- Enhanced spectra of detected compounds with associated best-match spectra for each sample

8.3 Laboratory Quality Control Procedures

Laboratory QC procedures, where applicable, include initial and continuing instrument calibrations, standard reference materials, laboratory control samples, laboratory replicates, MS/MSD samples, surrogate spikes, and method blanks. Table 4 lists the frequency of analysis for laboratory QA/QC samples, and Table 5 summarizes the DQOs for laboratory precision, accuracy, and completeness.

Results of the QC samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the sample group, Anchor QEA will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

8.4 Data Validation, Verification, and Management

Laboratory data will be provided in PDF and EQuIS electronic format and uploaded to Anchor QEA's project database. Once data are received from the laboratory, several QC procedures will be followed to provide an accurate evaluation of data quality. A Stage 2B data validation will be performed for all testing parameters. Data quality review will be completed by Laboratory Data Consultants in accordance with EPA National Functional Guidelines (EPA 2020a, 2020b, 2020c) by considering the following:

- Data completeness
- Holding times
- Method blanks
- Surrogate and labeled compound recoveries
- Detection limits
- Laboratory control samples
- Replicates
- MS/MSD samples
- Instrument tunes
- Initial and continuing calibrations
- Internal standard area recoveries
- Second column confirmation results

- Estimated maximum potential concentrations

Data will be validated in accordance with the project specific DQOs (Table 5), analytical method criteria, and ARL's internal performance standards based on its standard operating procedures and internal control limits. The results of the data quality review, including assigning qualifiers in accordance with the EPA National Functional Guidelines (EPA 2020a, 2020b, 2020c) and a tabular summary of qualifiers, will be generated by the database manager and submitted to the QA/QC manager for final review and confirmation of data validity.

Laboratory data, which will be electronically provided and loaded into Anchor QEA's project database, will undergo a check against the laboratory hard copy data. Data will be validated or reviewed manually, and qualifiers, if assigned, will be entered manually. The accuracy of all manually entered data will be verified by a second party. Data will be exported from EQuIS to Excel tables.

Field datasheets will be checked for completeness and accuracy prior to delivery to the database manager. Data generated in the field will be documented on hard copy, summarized in a spreadsheet, and provided to the database manager, who is responsible for data entry into the database. Manually entered data will be checked by a second party. Field documentation will be filed in the main project file after data entry and checking are complete.

9 Bioassay Testing

Chemical concentrations will be compared to the applicable DMMP screening guidelines. If chemicals of concern (COCs) are detected in the surface interval samples at or less than the SL, then bioassay testing is not required to determine material suitability for unconfined, open-water disposal. If COCs are detected above the DMMP SL or maximum level, bioassay testing may be performed as follows. If any COC exceeds a bioaccumulation trigger, a decision will be made in coordination with DMMP whether to pursue bioassay or bioaccumulation testing. This section includes procedures for bioassay testing. Bioaccumulation testing is not proposed in this SAP.

Sediment for bioassay testing will be collected from the same composite sediment homogenate submitted for bulk chemical analyses. Homogenized sediment will be placed into a plastic bag. The bag will then be adequately sealed with headspace removed. Samples will be shipped to EcoAnalysts in Port Gamble, Washington, and stored in the dark at 4°C ± 2°C and bioassay testing will be triggered as required. The grain size and conventional data for all DMMU samples undergoing bioassay testing will be provided to the DMMP before choosing the test organisms. The bioassay tests will be initiated within 8 weeks of sample collection. If Z-layer sample chemical analyses are required, testing may need to be expedited to evaluate chemical results in order to meet bioassay hold times. Chain-of-custody procedures will be maintained by the laboratories throughout bioassay testing.

9.1 Bioassay Laboratory Protocols

The tiered testing approach will be used. A decision will be made as to whether bioassay testing will be undertaken on the composite sample if one or more COCs are above the DMMP SL or maximum level. To the extent feasible, chemical results will be provided for bioassay decisions within 28 days of sample collection. The DMMP agencies will be kept informed of analytical progress to support bioassay decisions. Bioassay testing, if required, will be preplanned to initiate appropriate testing as soon as possible after the first chemical results become available and the decision is made to conduct bioassays. This includes obtaining test organisms and control and reference sediment in a timely manner and allowing extra time for saltwater acclimation. This approach will support the opportunity for any additional bioassay testing within the allowable 56-day holding period if such need arises.

Marine bioassay testing requires test sediment be matched and run with appropriate DMMP-approved reference sediment to factor out sediment grain size effects on bioassay organisms. Reference-area sediment will be collected as soon as possible before biological testing. Anchor QEA will follow DMMP guidance (DMMP 2021) and will coordinate with DMMP to locate a suitable reference sediment location. During reference sediment collection, sediments will be wet-sieved to find an adequate match. Wet-sieving uses a 63-micron (#230) sieve and a graduated cylinder; 100

milliliters of sediment is placed in the sieve and washed thoroughly until the water runs clear. The volume of sand and gravel remaining in the sieve is then washed into the graduated cylinder and measured. This represents the coarse fraction; the fines content is determined by subtracting this number from 100. Because of the wide heterogeneity of grain size in the reference areas, it may be necessary to perform wet-sieving in several places before a reference sediment with the proper grain size is found or reference sediments may be mixed to achieve the appropriate grain size. The sample analyzed by wet-sieving should be representative of the sediment that will be used for bioassays. Homogenization of the sediment prior to wet-sieving is recommended. Coordinates will be recorded at each sampling location. Reference sediments will be analyzed for total solids, total volatile solids, total organic carbon, grain size, ammonia, and sulfides.

Marine acute toxicity and chronic sublethal bioassays prescribed by the DMMP (amphipod, sediment larval, and *Neanthes arenaceodentata* growth) will be conducted if required on dredged material. All biological testing will comply with PSEP guidance as updated by DMMP (PSEP 1995). General biological testing procedures and specific procedures for each sediment bioassay are summarized in the following subsections.

9.2 General Biological Testing Procedures

9.2.1 Negative Controls

Negative control sediment is used to check laboratory performance. Negative control sediment is clean sediment in which the test organism normally lives that is expected to produce low mortality. The sediment larval test uses a negative seawater control rather than control sediment.

The amphipod, sediment larval, and juvenile infaunal growth (*Neanthes*) tests each have performance standards for negative controls, which are identified in Section 9.3 and Table 6.

9.2.2 Reference Sediment

The DMMP prescribes the use of bioassay reference sediment for test comparison and interpretations that closely match the grain size characteristics of the dredged material test sediment. The reference sediment is used to check for physical effects of the test sediment. Selection of a suitable reference site location will be approved by the DMMP agencies' point of contact. Reference sediment samples will target locations with percent fines (silt + clay) within about 10% of the project sample materials.

Bioassays have performance standards for reference sediment (see Section 9.3 and Table 6). Retesting may be required if these standards are not met.

Reference sediment will be collected using a Van Veen-type grab sampler in accordance with PSEP protocols (PSEP 1997). Reference sediment will be analyzed for total solids, total volatile solids, total

organic carbon, bulk ammonia, bulk sulfides, and grain size. The methods and QA guidelines for analyzing sediment conventionals in the test sediment will also be used in the reference sediment.

9.2.3 Positive Controls

A positive control will be run for each bioassay. Positive controls are chemicals known to be toxic to the test organism and indicate the sensitivity of the particular organisms used in a bioassay. An appropriate reference toxicant (Ref Tox) will be run with each batch of test sediment.

9.2.4 Ammonia and Sulfide Purging and Reference Toxicant Testing

To avoid nontreatment effects of bioassay test organisms from ammonia and sulfides, aqueous concentrations will be measured by the testing laboratory in the appropriate exposure medium (porewater or overlying water, depending on test organism) prior to initiating bioassay testing. Procedures to determine Ref Tox testing or purging will follow the methods outlined in DMMP's clarification paper (DMMP 2015) regarding ammonia and sulfide triggers. Decision-making regarding sample purging procedures will be coordinated with the DMMP agencies.

Unionized ammonia and hydrogen sulfide aqueous concentrations measured by the testing laboratory will be compared with the Reference Toxicant and Purging Triggers for Marine Bioassays (Table 9-4 in DMMP 2021). Relevant water quality parameters (temperature, pH, and salinity) will be measured in the aqueous medium to calculate unionized ammonia and hydrogen sulfide concentrations. If concentrations are less than the Ref Tox or purging triggers, bioassay testing may proceed normally. The ammonia Ref Tox test will be run if ammonia exceeds the trigger concentrations for the specified test organisms. If ammonia or sulfide concentrations exceed the purge trigger concentrations, sediments will be purged by the testing laboratory to lower concentrations to less than the trigger level. Purging will be conducted by the testing laboratory using established protocols involving aeration and/or overlying water replacement. Purging methods may be omitted in consultation with the DMMP agencies if COCs are subject to loss or alteration during purging. Once ammonia and sulfide concentrations are within the acceptable limits for each test organism, bioassay testing may proceed.

Bioassay testing reporting will include all ammonia and sulfides measurements, including water quality measurements and relevant calculations.

9.2.5 Saltwater Acclimation

Because freshwater sediment dredged material is planned for disposal in a marine site, marine bioassays will be conducted on dredged material sediment samples. Confounding factors caused by testing freshwater sediments in aerated saltwater with marine organisms can lead to toxicity independent of contaminant-related effects. The confounding factors include increased ammonia concentrations caused by disruption or elimination of microbial communities adapted to freshwater

conditions, as well as salinity and pH levels within sediments or overlying water that are outside the recommended ranges for the test organisms. Therefore, sediments will need to be acclimated to marine conditions prior to commencement of bioassay testing. Acclimation will follow considerations in the Sediment Acclimation and the Larval Bioassay Test Issue and Clarification Paper (DMMP 2020) and will be discussed with DMMP prior to sample collection. The length of time required for sediments to acclimate is unknown and to meet testing holding times, planning with DMMP and the bioassay laboratory will be initiated prior to sample collection.

9.2.6 Water Quality Monitoring

Salinity, temperature, pH, and dissolved oxygen will be measured daily for the amphipod and sediment larval tests. These measurements will be made every 3 days for the *Neanthes* bioassay test. Ammonia and sulfides will be determined at the beginning and end of the three tests. Monitoring will be conducted for test and reference sediment and negative controls (including seawater controls). Parameter measurements must be within the limits specified for each bioassay. Measurements for each treatment will be made on a separate chemistry beaker set up to be identical to the other replicates within the treatment group, including the addition of test organisms.

9.3 Marine Bioassay-Specific Procedures

Three standard DMMP sediment toxicity tests will be conducted on dredged material samples identified for toxicity testing. These tests are as follows:

- Acute 10-day amphipod mortality test (*Eohaustorius estuaries, Ampelisca abdita,* or *Rhepoxynius abronius*)
- Acute 48-hour bivalve larvae combined mortality and abnormality test (*Mytilus galloprovincialis* or *Dendraster excentricus*)
- Chronic 20-day juvenile survival and growth test (*Neanthes arenaceodentata*)

9.3.1 10-Day Amphipod Mortality Test

This test involves exposing the amphipod *Eohaustorius estuarius*, *Ampelisca abdita*, or *Rhepoxynius abronius* to test sediment for 10 days. In sediment with high percent fines (greater than 60%), *Ampelisca abdita* or *Eohaustorius estuarius* will be used. *Ampelisca abdita* is the preferred organism for testing sediments with high clay (greater than 20%) content, and *Eohaustorius estuarius* is the preferred test organism for clay less than 20%. *Rhepoxynius abronius* is only used for testing Puget Sound sediment with coarse grain size (less than 60% fines). The appropriate test species will be determined in consultation with the DMMP agencies based on the project area grain size data. The number of surviving amphipods at the end of the exposure period will be counted. Daily emergence data and the number of amphipods failing to rebury at the end of the test will be recorded as well. Performance standards and evaluation are shown in Table 6.

9.3.2 Sediment Larval Test

This test monitors larval development of a suitable echinoderm or bivalve species (*Mytilus galloprovincialis* or *Dendraster excentricus*) in the presence of test sediment. Either species will be used depending on availability and spawning conditions at the time of testing. If both species are unavailable, the laboratory may propose to use an alternate species. Any proposal to use an alternative species will be coordinated with the DMMP agencies.

The test is run until the appropriate stage of development is achieved in a seawater control. The larval test will be aerated. The test will be performed according to the procedures and QA/QC performance standards described in PSEP protocols (PSEP 1995) and the most recent protocols in DMMP (2021). The resuspension protocol will only be used if determined appropriate and in coordination with DMMP agencies for approval prior to implementation. At the end of the test, larvae from each test sediment exposure are examined to quantify abnormality and mortality. Performance standards and evaluation are shown in Table 6.

9.3.3 20-Day Juvenile Infaunal Growth Test

This test uses the polychaete *Neanthes* in a 20-day growth test. The growth rate of organisms exposed to test sediment is compared to the growth rate of organisms exposed to reference sediment. The test will be performed according to the procedures and QA/QC performance standards described in PSEP protocols (PSEP 1995), the protocol for juvenile *Neanthes* sediment bioassay (Johns et al. 1990), and the most recent protocols in DMMP (2021). Testing results will be reported on an ash-free dry-weight (AFDW) basis. The AFDW procedure eliminates weight from sediment in the gut, thereby providing a more accurate measurement of the change in biomass during the exposure period. Performance standards and evaluation guidelines are shown in Table 6.

9.3.4 Interpretation

Test interpretations consist of endpoint comparisons to controls and references on an absolute percentage basis, as well as statistical comparison to reference. Test interpretation will follow the guidelines established in the DMMP User Manual (DMMP 2021). Evaluation guidelines are listed in Table 6.

9.3.4.1 One-Hit Failure

When the response of any one bioassay test exceeds the bioassay-specific DMMP guidelines (Table 6) relative to the negative control and reference, the DMMU is judged to be unsuitable for unconfined open-water disposal.

9.3.4.2 Two-Hit Failure

If no one-hit failure occurs but the response of two bioassay tests are statistically significant compared to the reference sediment (and <70% of mean reference sediment growth rate for the *Neanthes* bioassay for nondispersive sites), the DMMU is judged to be unsuitable for unconfined open-water disposal.

9.4 Reporting

The bioassay laboratory will provide a written report that meets all the requirements in the DMMP User Manual (DMMP 2021).

9.5 Bioaccumulation Testing

Bioaccumulation testing is not proposed in this SAP. Given the holding time limitation and volume of sediment needed for the bioaccumulation tests, sediment will be recollected if bioaccumulation testing is required. If required, the procedures and methods will be described in an addendum to this SAP and submitted to DMMP agencies for approval prior to initiating additional sediment sampling and testing.

10 Sediment Characterization Report

Anchor QEA will prepare a Sediment Characterization Report documenting all activities associated with collecting, transporting, and analyzing samples. At a minimum, the final report will include the following:

- A summary of all field activities, including sampling equipment and protocols used
- Any deviations from the approved SAP
- A table summarizing:
  - Actual sampling locations in state plane coordinates (Washington North Zone) including a description of methods used to record positions
  - Measured water depths and mudline elevations at time of sampling of each location and real-time tide levels
  - Core penetrations and recoveries, sample depths, and sample compositing scheme
- A project map showing actual and target sampling locations with DMMU outlines
- A QA/QC narrative for chemical testing
- Field data collection sheets
- A summary table of sample analytical results with validation qualifiers, comparison to the applicable screening values in Table 3 with any exceedances highlighted
- Summary tables of bioassay results, QA data, and interpretation (if applicable)
- Appendices, including sample collection forms, chain-of-custody forms, photographs, analytical laboratory reports, bioassay laboratory reports, and validation reports.
- Electronic data in Ecology's EIM format will be submitted to DMMP agencies

- Comprehensive laboratory data package for Ecology (electronic only)

11 References

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EPA (U.S. Environmental Protection Agency), 2020a. *National Functional Guidelines for Organic Superfund Methods Data Review*. Office of Superfund Remediation and Technology Innovation. EPA-540-R-20-005. November 2020.

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PSEP (Puget Sound Estuary Program), 1995. "Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments." *Puget Sound Protocols and Guidelines*.

PSEP, 1997. *Recommended Guidelines for Measuring Organic Compounds in Puget Sound Water, Sediment, and Tissue Samples.* Final Report. Prepared for the U.S. Environmental Protection Agency.

Tables

Table 1a
Target Sampling Locations and Sampling Depths

Station ID	Coordinates[a]		Estimated Mudline Elevation (feet COE)[b]	Target Core Length[c] (feet)	Heterogeneous A-Interval Depths[c] (feet)	Z-Layer Sample Depths[d] (Elev. +9.5 to +11.5 feet COE)
	Northing	Easting				
C-1	225010.48'	1301059.86'	+13.7	5	0 to 2.2	2.2 to 4.2
C-2	224857.66'	1301143.33'	+14.0	5	0 to 2.5	2.5 to 4.5
C-3	224742.74'	1301344.62'	+15.1	6	0 to 3.6	3.6 to 5.6
C-4	225192.91'	1301195.35'	+15.5	6	0 to 4.0	4.0 to 6.0
C-5	225102.87'	1301340.66'	+13.5	5	0 to 2.0	2.0 to 4.0
C-6	224964.43'	1301424.85'	+14.0	5	0 to 2.5	2.5 to 4.5
C-7	224844.05'	1301470.31'	+14.4	5	0 to 2.9	2.9 to 4.9

Notes:

a. Coordinates are in North American Datum of 1983, Washington State Plane North, U.S. feet.

b. Depth intervals are approximate based on estimated mudline depths from most recent bathymetry. Actual depth intervals will be determined in situ based on measured mudline.

c. Individual sample intervals will be sampled and archived for potential future analyses.

d. Z-layer samples will be collected from each core and archived for potential future analysis pending results of dredged material. If a shorter core is obtained, and the Z-interval is not reached, the bottom 1-foot of the core will be sampled and retained as a separate sample.

COE: United States Army Corps of Engineers Lake Washington Datum

Table 1b
Sample Compositing Scheme

DMMU Volume	Cores in DMMU Sample Composite	Core Intervals in Sample Composite[a]	Sample Composite ID	Testing Parameters
DMMU1 10,670 cy	C-1	A	DU-1A	Marine DMMP[b,c]
	C-2	A		
	C-3	A		
DMMU2 6,480 cy	C-4	A	DU-2A	
	C-5	A		
	C-6	A		
DMMU3 1,350 cy	C-7	A	DU-3A	

Notes:

a. See Table 1a for sample intervals.

pesticides, polychlorinated biphenyls (PCBs), metals, sulfide, ammonia, total organic carbon, grain size, total volatile solids, and total solids.

c. Exceedances in the surface sample composite will trigger z-layer testing using the freshwater COC list.

cy: cubic yards

DMMP: Dredged Material Management Program

DMMU: Dredged Material Management Unit

Table 2
Sample Handling and Storage Guidelines

Parameter	Sample Size	Container Size and Type[a]	Holding Time	Preservative
Grain size	300 g	16-oz glass or HDPE	6 months	4°C ± 2°C
Total solids, total organic carbon, total volatile solids	30 g	8-oz glass or HDPE	14 days	4°C ± 2°C
			6 months	-18°C ± 2°C
Ammonia	25 g	4-oz glass	7 days	Cool/4°C
Total sulfides	50 g	2-oz glass	7 days	5 mL 2-Normal zinc acetate/dark/cool/4°C
Total metals	10 g	4-oz glass	6 months; 28 days for mercury	4°C ± 2°C
			2 years; 1 year for mercury	-18°C ± 2°C
SVOCs, PAHs, PCBs, pesticides, organotins, TPH	200 g	2 x 16-oz glass	14 days until extraction	4°C ± 2°C
			1 year until extraction	-18°C ± 2°C
			40 days after extraction	4°C ± 2°C
Dioxins/furans	10 g	4-oz amber glass	14 days until extraction	4°C ± 2°C
			1 year until extraction	-18°C ± 2°C
Chemistry archive for untested intervals	500 g	16-oz glass	1 year until extraction	Freeze/-18°C
Bioassays	500 g	Plastic bag	8 weeks	4°C ± 2°C; no headspace

Notes:

a. Sample containers may vary based on availability at the time of sample collection.

g: grams

HDPE: high-density polyethylene

mL: milliliter

oz: ounce

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl

SVOC: semivolatile organic compound

Table 3
Parameters for Analysis, Screening Levels, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Method Detection Limit	Quantitation Limit	Marine DMMP Guidelines			SMS Freshwater Sediment		SMS Marine Sediment		Marine SMS AET	
				Screening Level	Bioaccumulation Trigger	Maximum Level	Sediment Cleanup Objective	Cleanup Screening Level	Sediment Cleanup Objective	Cleanup Screening Level	Sediment Cleanup Objective	Cleanup Screening Level
Conventional Parameters (%)												
Grain size (PSEP or ASTM modified)[a]	PSEP/ASTM Mod	---	0.1	---	---	---	---	---	---	---	---	---
Total solids	SM2540G/PSEP	---	0.1	---	---	---	---	---	---	---	---	---
Total volatile solids	SM2540G/PSEP	---	0.1	---	---	---	---	---	---	---	---	---
Total organic carbon	Plumb (1981)/EPA 9060 Mod	---		---	---	---	---	---	---	---	---	---
Conventional Parameters (mg/kg dry weight)												
Ammonia	Plumb (1981)/SM 4500-NH3	---	0.4	---	---	---	---	---	---	---	---	---
Total sulfides	PSEP/SM 4500-S2	---	1.0	---	---	---	---	---	---	---	---	---
Metals (mg/kg dry weight)												
Antimony	EPA 6020B	0.10	0.20	150	---	200	---	---	---	---	---	---
Arsenic	EPA 6020B	0.038	0.20	57	507.1	700	14	120	57	93	57	93
Cadmium	EPA 6020B	0.040	0.10	5.1	--	14	2.1	5.4	5.1	6.7	5.1	6.7
Chromium	EPA 6020B	0.26	0.50	260	--	---	72	88	260	270	260	270
Copper	EPA 6020B	0.35	0.50	390	--	1,300	400	1200	390	390	390	390
Lead	EPA 6020B	0.052	0.10	450	975	1,200	360	> 1300[c]	450	530	450	530
Mercury	7471B	0.0053	0.025	0.41	1.5	2.3	0.66	0.8	0.41	0.59	0.41	0.59
Nickel	EPA 6020B	0.22	0.50	---	---	---	26	110	---	---	---	---
Selenium[b]	EPA 6020B	0.18	0.50	---	3	---	11	> 20[c]	---	---	---	---
Silver	EPA 6020B	0.022	0.20	6.1	--	8.4	0.57	1.7	6.1	6.1	6.1	6.1
Zinc	EPA 6020B	2.9	6.0	410	--	3,800	3200	> 4200[c]	410	960	410	960
Organometallic Compounds (µg/kg dry weight)												
Monobutyltin	Krone/8270E-SIM	1.9	4.1	---	---	---	540	> 4800[c]	---	---	---	---
Dibutyltin	Krone/8270E-SIM	1.7	5.8	---	---	---	910	130,000	---	---	---	---
Tributyltin (ion)	Krone/8270E-SIM	0.5	3.9	---	73	---	47	320	---	---	---	---
Tetrabutyltin	Krone/8270E-SIM	5.0	5.0	---	---	---	97	> 97[c]	---	---	---	---
PAHs (µg/kg dry weight)									**mg/kg OC**		**µg/kg dry weight**	
1-Methylnaphthalene[d]	EPA 8270E	5.3	20	---	---	---	---	---				
2-Methylnaphthalene[d]	EPA 8270E	4.5	20	670	---	1,900	---	---	38	64	670	670
Acenaphthene	EPA 8270E	5.2	20	500	---	2,000	---	---	16	57	500	500
Acenaphthylene	EPA 8270E	6.2	20	560	---	1,300	---	---	66	66	1,300	1,300
Anthracene	EPA 8270E	7.2	20	960	---	13,000	---	---	220	1,200	960	960
Benzo(a)anthracene	EPA 8270E	6.0	20	1300	---	5,100	---	---	110	270	1,300	1,600
Benzo(a)pyrene	EPA 8270E	4.2	20	1600	---	3,600	---	---	99	210	1,600	1,600
Benzo(g,h,i)perylene	EPA 8270E	14	20	670	---	3,200	---	---	31	78	670	720
Chrysene	EPA 8270E	6.1	20	1,400	---	21,000	---	---	110	460	1,400	2,800
Dibenz(a,h)anthracene	EPA 8270E	17	20	230	---	1,900	---	---	12	33	230	230
Fluoranthene	EPA 8270E	6.1	20	1,700	4,600	30,000	---	---	160	1,200	1,700	2,500
Fluorene	EPA 8270E	15	20	540	---	3,600	---	---	23	79	540	540
Indeno(1,2,3-cd)pyrene	EPA 8270E	15	20	600	---	4,400	---	---	34	88	600	690
Naphthalene	EPA 8270E	4.2	20	2,100	---	2,400	---	---	99	170	2,100	2,100
Phenanthrene	EPA 8270E	8.7	20	1500	---	21,000	---	---	100	480	1,500	1,500
Pyrene	EPA 8270E	5.7	20	2600	11,980	16,000	---	---	1,000	1,400	2,600	3,300

Table 3
Parameters for Analysis, Screening Levels, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Method Detection Limit	Quantitation Limit	Marine DMMP Guidelines			SMS Freshwater Sediment		SMS Marine Sediment		Marine SMS AET	
				Screening Level	Bioaccumulation Trigger	Maximum Level	Sediment Cleanup Objective	Cleanup Screening Level	Sediment Cleanup Objective	Cleanup Screening Level	Sediment Cleanup Objective	Cleanup Screening Level
Total benzo(b,j,k)fluoranthenes	EPA 8270E	10	40	3200	---	9,900	---	---	230	450	3,200	3,600
Total LPAH (U = 0)[e]	EPA 8270E	---	---	5,200	---	29,000	---	---	370	780	5,200	5,200
Total HPAHs (U = 0)[f]	EPA 8270E	---	---	12000	---	69,000	---	---	960	5,300	12,000	17,000
Total PAHs (U = 0)[g]	Calculated	---	---	---	---	---	17,000	30,000	---	---	---	---
Chlorinated Hydrocarbons (µg/kg dry weight)									**mg/kg OC**		**µg/kg dry weight**	
1,4-Dichlorobenzene	EPA 8270E	0.6	5.0	110	---	120	---	---	3.1	9	110	110
1,2-Dichlorobenzene	EPA 8270E	0.7	5.0	35	---	110	---	---	2.3	2.3	35	50
1,2,4-Trichlorobenzene	EPA 8270E	2.7	5.0	31	---	64	---	---	0.81	1.8	31	51
Hexachlorobenzene	EPA 8270E	0.7	5.0	22	168	230	---	---	0.38	2.3	22	70
Phthalates (µg/kg dry weight)									**mg/kg OC**		**µg/kg dry weight**	
Dimethyl phthalate	EPA 8270E	4.4	20	71	---	1,400	---	---	53	53	71	160
Diethyl phthalate	EPA 8270E	20	50	200	---	1,200	---	---	61	110	200	>1,200
Di-n-butyl phthalate	EPA 8270E	5.6	20	1,400	---	5,100	380	1000	220	1,700	1,400	1,400
Butyl benzyl phthalate	EPA 8270E	9.4	20	63	---	970	---	---	4.9	64	63	900
Bis(2-ethylhexyl) phthalate	EPA 8270E	5.5	20	1,300	---	8,300	500	22,000	47	78	1300	1900
Di-n-octyl phthalate	EPA 8270E	4.4	20	6,200	---	6,200	39	> 1100[c]	58	4,500	6,200	6,200
Phenols (µg/kg dry weight)												
Phenol	EPA 8270E	4.4	20	420	---	1,200	120	210	420	1,200	420	1,200
2-Methylphenol	EPA 8270E	6.7	20	63	---	77	---	---	63	63	63	63
4-Methylphenol	EPA 8270E	7.4	20	670	---	3,600	260	2000	670	670	670	670
2,4-Dimethylphenol	EPA 8270E	2.2	25.0	29	---	210	---	---	29	29	29	29
Pentachlorophenol	EPA 8270E	31.2	100	400	504	690	1200	> 1200[c]	360	690	360	690
Miscellaneous Extractables (µg/kg dry weight)									**mg/kg OC (unless noted)**		**µg/kg dry weight**	
Benzyl Alcohol	EPA 8270E	16	20	57	---	870	---	---	57 dry weight	73 dry weight	57	73
Benzoic Acid	EPA 8270E	39	200	650	---	760	2900	3800	650 dry weight	650 dry weight	650	650
Dibenzofuran	EPA 8270E	14	20	540	---	1,700	200	680	15	58	540	540
Hexachlorobutadiene	EPA 8270E	4.8	20	11	---	270	---	---	3.9	6.2	11	120
N-Nitrosodiphenylamine	EPA 8270E	5.3	20	28	---	---	---	---	11	11	28	40
Carbazole	EPA 8270E	4.3	20	---	---	---	900	1100	3.9	6.2	11	120
Pesticides (µg/kg dry weight)												
2,4'-DDD	EPA 8081B	0.20	1.0	---	---	---	---	---	---	---	---	---
2,4'-DDE	EPA 8081B	0.25	1.0	---	---	---	---	---	---	---	---	---
2,4'-DDT	EPA 8081B	0.19	1.0	---	---	---	---	---	---	---	---	---
4,4'-DDD	EPA 8081B	0.32	1.0	16	---	---	---	---	---	---	---	---
4,4'-DDE	EPA 8081B	0.14	1.0	9	---	---	---	---	---	---	---	---
4,4'-DDT	EPA 8081B	0.32	1.0	12	---	---	---	---	---	---	---	---
2,4'-DDD and 4,4'-DDD	Calculated	--	--	---	---	---	310	860	---	---	---	---
2,4'-DDE and 4,4'-DDE	Calculated	--	--	---	---	---	21	33	---	---	---	---
2,4'-DDT and 4,4'-DDT	Calculated	--	--	---	---	---	100	8100	---	---	---	---
Total DDT (U = 0)[h]	Calculated	---	---	---	50	69	---	---	---	---	---	---
Aldrin	EPA 8081B	---	---	9.5	---	---	---	---	---	---	---	---
beta-HCH	EPA 8081B	0.09	0.50	---	---	---	7.2	11	---	---	---	---
Dieldrin	EPA 8081B	0.12	1.0	1.9	---	1,700	4.9	9.3	---	---	---	---

Table 3
Parameters for Analysis, Screening Levels, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Method Detection Limit	Quantitation Limit	Marine DMMP Guidelines			SMS Freshwater Sediment		SMS Marine Sediment		Marine SMS AET	
				Screening Level	Bioaccumulation Trigger	Maximum Level	Sediment Cleanup Objective	Cleanup Screening Level	Sediment Cleanup Objective	Cleanup Screening Level	Sediment Cleanup Objective	Cleanup Screening Level
Endrin ketone	EPA 8081B	0.28	1.0	---	---	---	8.5	---	---	---	---	---
Heptachlor	EPA 8081B	0.05	0.50	1.5	---	270	--	--	---	---	---	---
cis-chlordane	EPA 8081B	0.1	0.5	---	---	---	---	---	---	---	---	---
trans-chlordane	EPA 8081B	0.3	0.5	---	---	---	---	---	---	---	---	---
cis-nonchlor	EPA 8081B	0.2	0.5	---	---	---	---	---	---	---	---	---
trans-nonachlor	EPA 8081B	0.2	0.5	---	---	---	---	---	---	---	---	---
oxychlordane	EPA 8081B	0.1	0.5	---	---	---	---	---	---	---	---	---
Total Chlordane (U = 0)[i]	EPA 8081B	---	---	2.8	37	---	---	---	---	---	---	---
PCBs (µg/kg dry weight)												
Aroclor 1016	EPA 8082A	1.6	4.0	---	---	---	---	---	---	---	---	---
Aroclor 1221	EPA 8082A	1.6	4.0	---	---	---	---	---	---	---	---	---
Aroclor 1232	EPA 8082A	1.6	4.0	---	---	---	---	---	---	---	---	---
Aroclor 1242	EPA 8082A	1.6	4.0	---	---	---	---	---	---	---	---	---
Aroclor 1248	EPA 8082A	1.6	4.0	---	---	---	---	---	---	---	---	---
Aroclor 1254	EPA 8082A	1.6	4.0	---	---	---	---	---	---	---	---	---
Aroclor 1260	EPA 8082A	0.6	4.0	---	---	---	---	---	**mg/kg OC**		**µg/kg dry weight**	
Total Aroclor PCBs (U = 0)	EPA 8082A	1.6	4.0	130	38 mg/kg OC	3,100	110	2500	12	65	130	1,000
Total Petroleum Hydrocarbons (mg/kg dry weight)												
Diesel range organics	NWTPHDx	2.3	5.0	---	---	---	340	510	---	---	---	---
Residual range organics	NWTPHDx	3.0	10	---	---	---	3600	4400	---	---	---	---
Dioxin/Furans (ng/kg dry weight)[j]												
Dioxins												
2,3,7,8-TCDD	EPA 1613B	0.15	1.0	---	---	---	---	---	---	---	---	---
1,2,3,7,8-PeCDD	EPA 1613B	0.17	1.0	---	---	---	---	---	---	---	---	---
1,2,3,4,7,8-HxCDD	EPA 1613B	0.17	1.0	---	---	---	---	---	---	---	---	---
1,2,3,6,7,8-HxCDD	EPA 1613B	0.18	1.0	---	---	---	---	---	---	---	---	---
1,2,3,7,8,9-HxCDD	EPA 1613B	0.22	1.0	---	---	---	---	---	---	---	---	---
1,2,3,4,6,7,8-HpCDD	EPA 1613B	0.56	2.5	---	---	---	---	---	---	---	---	---
OCDD	EPA 1613B	4.60	10	---	---	---	---	---	---	---	---	---
Furans												
2,3,7,8-TCDF	EPA 1613B	0.06	1.0	---	---	---	---	---	---	---	---	---
1,2,3,7,8-PeCDF	EPA 1613B	0.24	1.0	---	---	---	---	---	---	---	---	---
2,3,4,7,8,-PeCDF	EPA 1613B	0.22	1.0	---	---	---	---	---	---	---	---	---
1,2,3,4,7,8-HxCDF	EPA 1613B	0.28	1.0	---	---	---	---	---	---	---	---	---
1,2,3,6,7,8-HxCDF	EPA 1613B	0.20	1.0	---	---	---	---	---	---	---	---	---
1,2,3,7,8,9-HxCDF	EPA 1613B	0.19	1.0	---	---	---	---	---	---	---	---	---
2,3,4,6,7,8-HxCDF	EPA 1613B	0.17	1.0	---	---	---	---	---	---	---	---	---
1,2,3,4,6,7,8-HpCDF	EPA 1613B	0.21	1.0	---	---	---	---	---	---	---	---	---
1,2,3,4,7,8,9-HpCDF	EPA 1613B	0.24	1.0	---	---	---	---	---	---	---	---	---

Table 3
Parameters for Analysis, Screening Levels, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Method Detection Limit	Quantitation Limit	Marine DMMP Guidelines			SMS Freshwater Sediment		SMS Marine Sediment		Marine SMS AET	
				Screening Level	Bioaccumulation Trigger	Maximum Level	Sediment Cleanup Objective	Cleanup Screening Level	Sediment Cleanup Objective	Cleanup Screening Level	Sediment Cleanup Objective	Cleanup Screening Level
OCDF	EPA 1613B	1.10	2.5	---	---	---	---	---	---	---	---	---
Total TEQ (U = 0)	---	---	---	4.0	10	---	---	---	---	---	---	---
Total TEQ (U = 1/2 EDL)	---	---	---	4.0	10	---	---	---	---	---	---	---

Notes:

a. Grain size analysis will include the #10 and #230 sieves.

b. Because no screening level value exists for toxicity testing, selenium will only be evaluated for its bioaccumulation potential.

c. Greater than (>) values indicate that the upper bound of toxicity level is unknown, but is known to be above the concentration shown.

e. 1-Methylnaphthalene and 2-methylnaphthalene are included in the summation of total PAH for freshwater projects. 2-Methylnaphthalene is analyzed for marine projects but is not included in the summation for total LPAHs. 1-Methylnaphthalene is not analyzed for marine projects.

e. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.

f. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

g. Total PAHs consists of the sum of all PAHs listed.

h. Total DDT consists of the sum of 4,4'-DDD; 4,4'-DDE; and 4,4'-DDT.

i. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.

j. Dioxin/furan results will be reported to sample and analysis-specific estimated detection limits.

µg/kg: micrograms per kilogram
AET: Apparent Effects Threshold
ASTM: ASTM International
DDD: dichlorodiphenyldichloroethane
DDE: dichlorodiphenyldichloroethylene
DDT: dichlorodiphenyltrichloroethane
EPA: U.S. Environmental Protection Agency
HPAH: high-molecular-weight PAHs
LPAH: low-molecular-weight PAHs
mg/kg: milligram per kilogram
ng/kg: nanograms per kilogram
OC: organic carbon-normalized
PAHs: polycyclic aromatic hydrocarbons
PCBs: polychlorinated bipheynls
PSEP: Puget Sound Estuary Program
SMS: Sediment Management Standards
TEQ: toxic equivalency

Table 4
Laboratory Quality Assurance/Quality Control Requirements

Parameter	Laboratory Quality Control Elements								
	Initial Calibration	Continuing Calibration	Duplicates	Triplicates	Laboratory Control Sample	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
Grain size	Each batch[a]	NA	NA	Per batch	NA	NA	NA	NA	NA
Total solids/total volatile solids	Each batch[a]	NA	NA	Per batch	NA	NA	NA	NA	NA
Total organic carbon	Daily or each batch	1 per 10 samples	NA	Per batch	1 per 20 samples or 1 per batch	NA	NA	1 per 20 samples or 1 per batch	NA
Ammonia	Each batch	1 per 10 samples	NA	Per batch	1 per 20 samples or 1 per batch	NA	NA	1 per 20 samples or 1 per batch	NA
Total sulfides	Each batch	1 per 10 samples	NA	Per batch	1 per 20 samples or 1 per batch	NA	NA	1 per 20 samples or 1 per batch	NA
Metals	Daily	1 per 10 samples	Per batch	NA	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	NA
Organotins	As needed[b]	Every 12 hours[c]	NA	NA	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	Every sample
SVOCs/PAHs	As needed[b]	Every 12 hours	NA	NA	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	Every sample
Pesticides	As needed[b]	1 per 10 samples[c]	NA	NA	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	Every sample
PCBs	As needed[b]	1 per 10 samples[c]	NA	NA	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	Every sample
TPH	As needed[b]	1 per 10 samples[c]	NA	NA	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	1 per 20 samples or 1 per batch	Every sample
Dioxins/furans	As needed[b]	Every 12 hours		NA	1 per 20 samples or 1 per batch	NA	NA	1 per 20 samples or 1 per batch	Every sample[d]

Notes:
a. Calibration and certification of drying ovens and weighing scales are conducted bi-annually.
b. Initial calibrations are considered valid until the continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.
c. Continuing calibrations at the beginning and end of each batch and every 10 samples.
d. Isotope dilution with labeled compounds are required in every sample.
NA: not applicable
PCBs: polychlorinated biphenyls
PAHs: polycyclic aromatic hydrocarbons
SVOCs: semivolatile organic compounds

Table 5
Data Quality Objectives

Parameter	Precision	Accuracy	Surrogates	Completeness
Grain size	± 20% RSD	NA	NA	95%
Total solids/total volatile solids	± 20% RSD	NA	NA	95%
Total organic carbon	± 20% RSD	75%–125% R	NA	95%
Ammonia	± 20% RSD	75%–125% R	NA	95%
Total sulfides	± 20% RSD	75%–125% R	NA	95%
Total metals	± 20% RPD	75%–125% R	NA	95%
Organotins	± 35% RPD	50%–150% R	Laboratory limits	95%
PAHs/SVOCs	± 35% RPD	50%–150% R	Laboratory limits	95%
Pesticides	± 35% RPD	50%–150% R	Laboratory limits	95%
PCBs	± 35% RPD	50%–150% R	Laboratory limits	95%
Total petroleum hydrocarbons	± 35% RPD	50%–150% R	Laboratory limits	95%
Dioxins/furans	± 30% RPD	50%–150% R	Method limits	95%

Notes:

NA: not applicable

PAHs: polycyclic aromatic hydrocarbons

PCBs: polychlorinated biphenyls

PS-SRM: Puget Sound sediment reference material

R: recovery

RPD: relative percent difference

RSD: relative standard deviation

SRM: standard reference material

SVOCs: semivolatile organic compounds

Table 6

Bioassay Performance Standards and Evaluation Guidelines

Bioassay	Negative Control Performance Standard	Reference Sediment Performance Standard	Dispersive Disposal Site Interpretation Guidelines		Nondispersive Disposal Site Interpretation Guidelines	
			1-hit rule	2-hit rule	1-hit rule	2-hit rule
Amphipod Mortality	$M_C \leq 10\%$	$M_R - M_C \leq 20\%$	$\lvert M_T - M_C \rvert > 20\%$			
			$M_T - M_R > 10\%$	NOCN	$M_T - M_R > 30\%$	NOCN
Larval Development	$N_C / I \geq 0.70$	$N_R / N_C \geq 0.65$	$N_T / N_C < 0.80$			
			$N_R/N_C - N_T/N_C > 0.15$	NOCN	$N_R/N_C - N_T/N_C > 0.30$	NOCN
Neanthes Growth	$M_C \leq 10\%$ and	$M_R \leq 20\%$ and	$MIG_T / MIG_C < 0.80$			
			$MIG_T/MIG_R < 0.70$	NOCN	$MIG_T/MIG_R < 0.50$	$MIG_T/MIG_R < 0.70$

Notes:

C: negative control

I: initial count

M: mortality

MIG: mean individual growth rate (milligrams/individual/day)

N: normal larvae

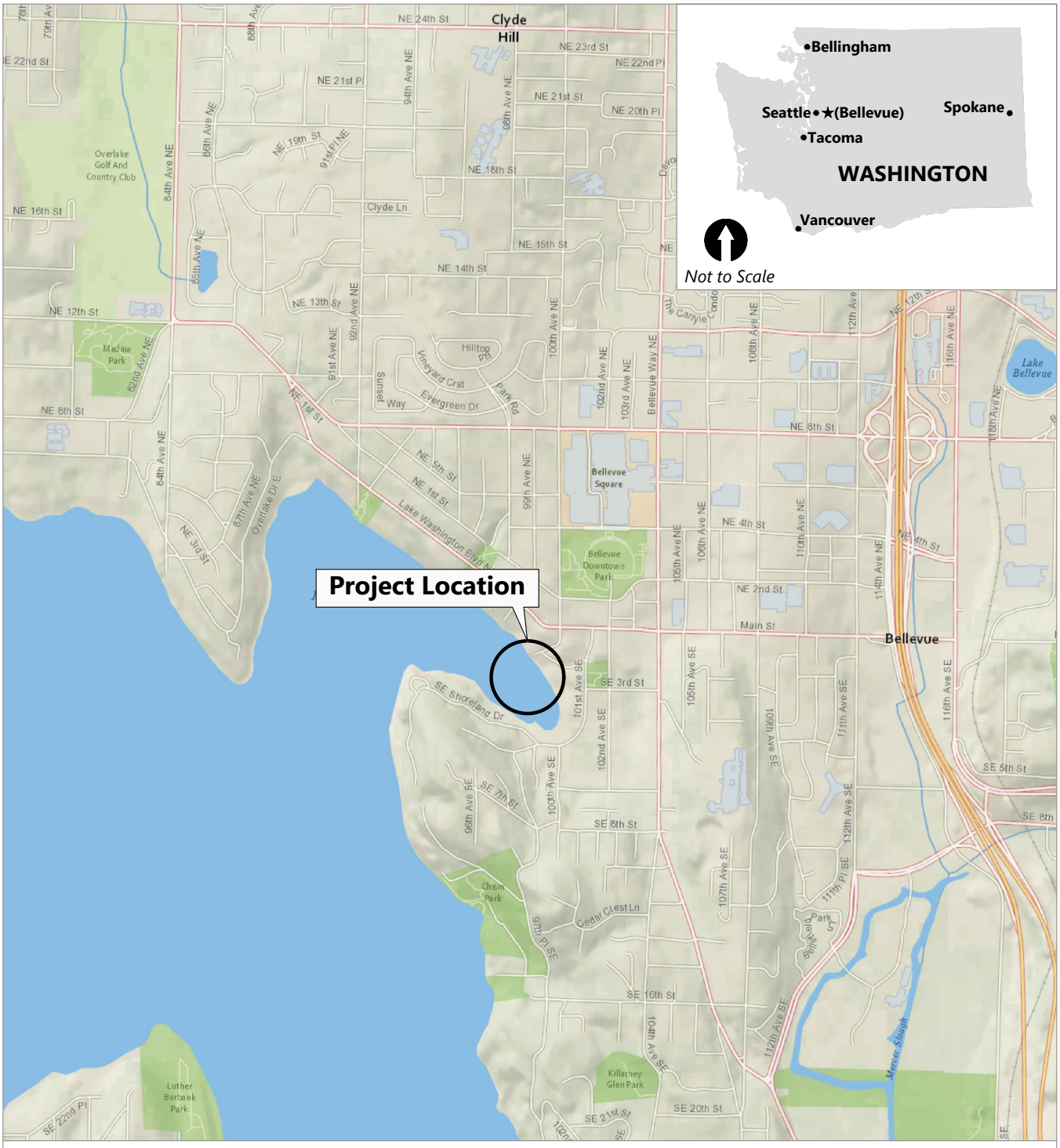
NOCN: no other conditions necessary

R: reference sediment

SD: statistically significant difference

T: test sediment

Figures



SOURCE: National Geographic World Map - National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
HORIZONTAL DATUM: Washington State Plane North Zone, NAD83, U.S. Survey Feet

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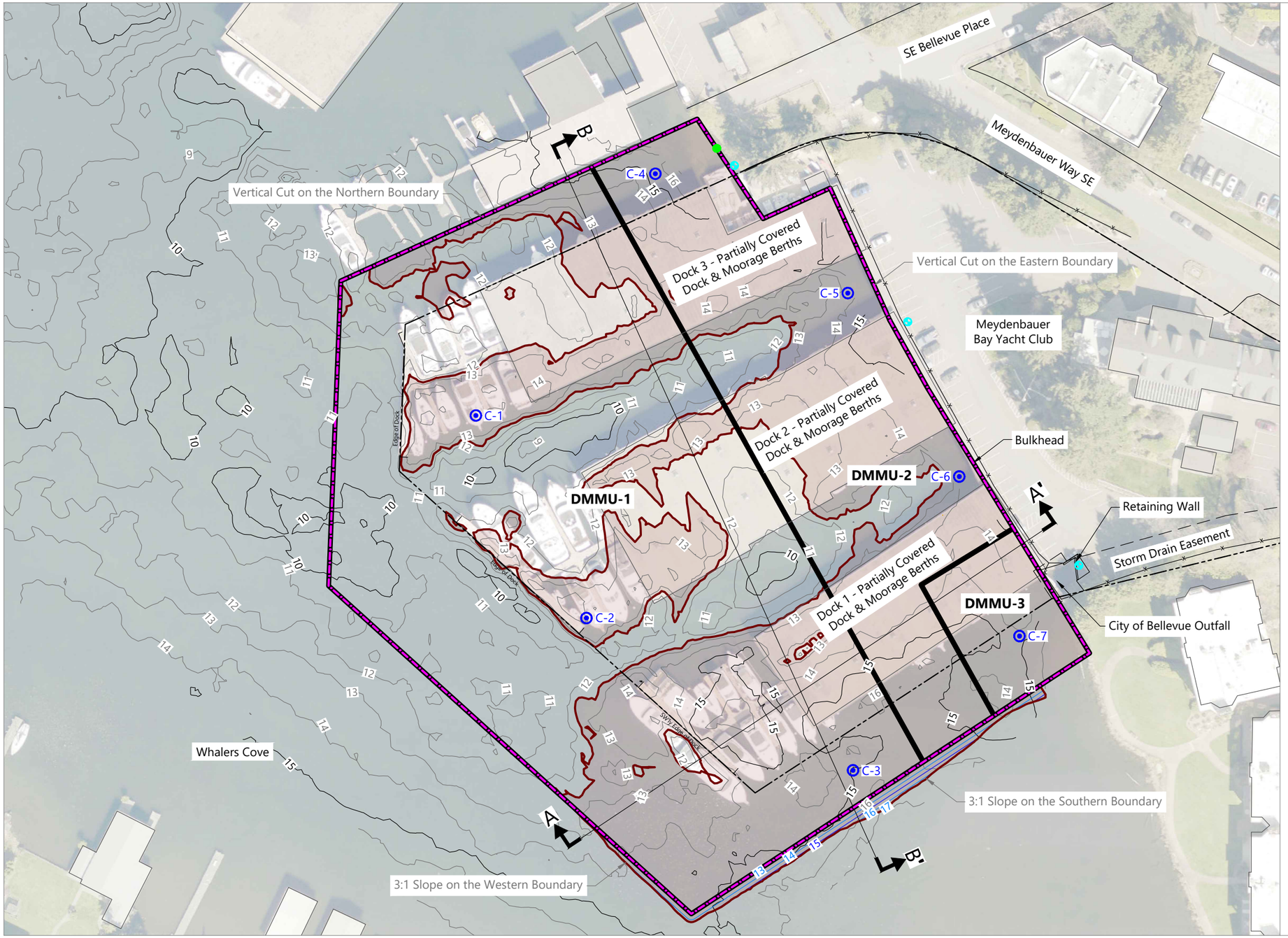
Filepath: K:\Projects\2595-Meydenbauer Yacht Club\MBYC Maintenance Dredging Eval\2595-RP-002 (Vicinity Map-SAP).dwg Figure 1

ANCHOR QEA

Figure 1
Vicinity Map

Sampling and Analysis Plan
MBYC Maintenance Dredging Evaluation



LEGEND:

- Meydenbauer Bay Yacht Club Property Line
- Project Area
- DMMU Boundary
- Storm Drain Easement
- 6' Chain Link Fence
- Existing Contours (1' & 5' Intervals)
- Proposed Contours (1 & 5' Intervals)
- +12.5' Dredge Prism Extent
- Proposed Sediment Sampling Location
- Storm Drain Discharge Point
- Sewer Overflow Discharge Point
- Cross Section Location

SOURCE: Aerial photograph from King County, dated 2021. Property survey conducted by True North Land Surveying, dated July 12, 2022. Hydrographic survey conducted by Gravity Marine on May 12, 2022.
HORIZONTAL DATUM: Washington State Plane North Zone, NAD83, U.S. Survey Feet
VERTICAL DATUM: Corps of Engineers Lake Washington

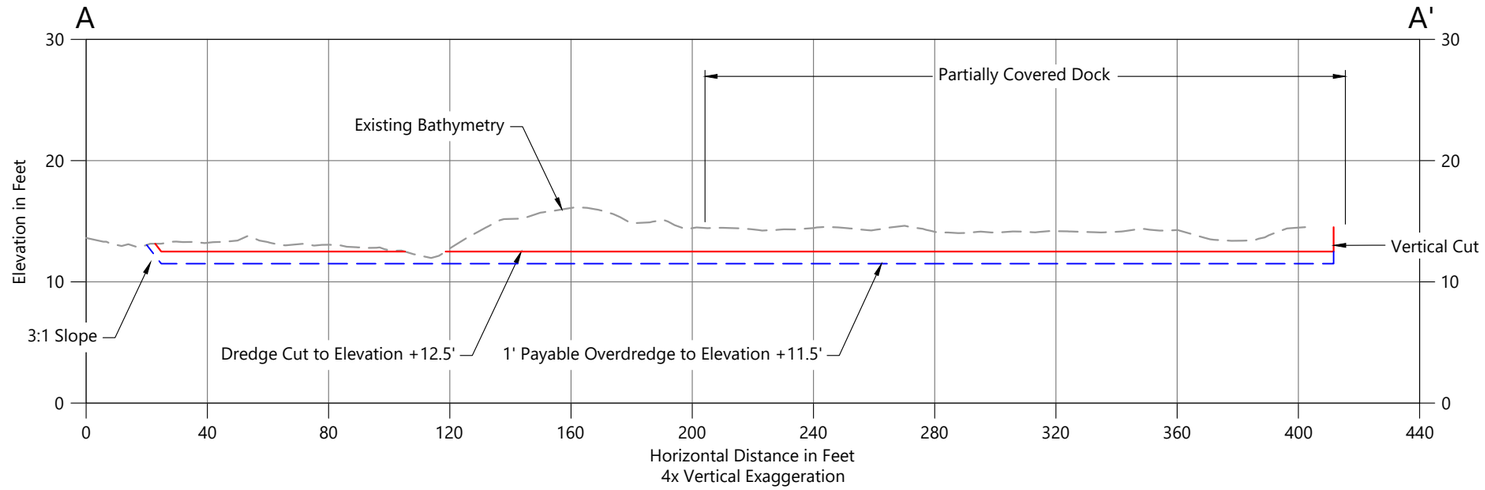
0 80
Feet

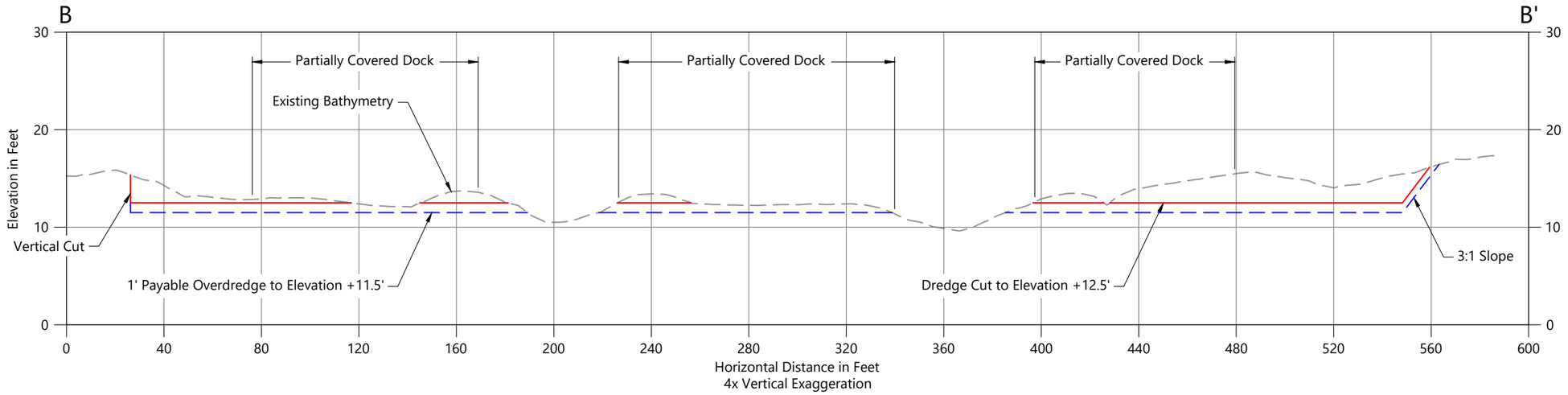
Publish Date: 2023/01/18 10:19 AM | User: jbigsby
Filepath: K:\Projects\2595-Meydenbauer Yacht Club\MBYC Maintenance Dredging Eval\2595-RP-003 (Dredge Design-12.5' Plan & Sections-SAP).dwg Figure 2

ANCHOR QEA

Figure 2
Conceptual Dredge Prism and Sample Locations

Sampling and Analysis Plan
MBYC Maintenance Dredging Evaluation





HORIZONTAL DATUM: Washington State Plane North Zone, NAD83, U.S. Survey Feet
VERTICAL DATUM: Corps of Engineers Lake Washington

0 50
Feet

Publish Date: 2023/01/18 10:19 AM | User: jbigsby
Filepath: K:\Projects\2595-Meydenbauer Yacht Club\MBYC Maintenance Dredging Eval\2595-RP-003 (Dredge Design-12.5' Plan & Sections-SAP).dwg Figure 3

ANCHOR QEA

Figure 3
Conceptual Dredge Prism Cross Sections

Sampling and Analysis Plan
MBYC Maintenance Dredging Evaluation

Appendix A
Historical Data

Filepath: \\fuji\Anchor\Projects\Meydenbauer Yacht Club\Maintenance Dredging Eval\4_Deliverables\SAP\Appendix A - Historical Data

ANCHOR QEA

Figure A-1
Reported Spill Locations

Sampling and Analysis Plan
Meydenbauer Yacht Club Maintenance Dredging Evaluation

Source: Washington State Department of Ecology, 2022. Environmental Information Management System. Location Data Summary. Accessed August 18, 2022. Available at: https://apps.ecology.wa.gov/eim/search/default.aspx.

Table A-1
Meydenbauer Bay Yacht Club EIM Data Export

			Task	KingLakeSeds	LKWA00
			Location ID	KCM-MDNBRSWMBCH	LKWA00834
			Sample ID	L51549-10	L18812-3
			Sample Date	8/24/2010	9/13/2000
			Depth	0 - 10 cm	0 - 10 cm
			Sample Type	N	N
			Matrix	SE	SE
			X		-122.211907161978
			Y		47.6102464564289
	DMMPSL2021	DMMPBT2021	DMMPML2021		
Conventional Parameters (mg/kg)					
Acid volatile sulfide				--	**88**
Ammonia as nitrogen				**1 J**	**55**
Phosphate (orthophosphate)				1 U	--
Phosphorus				**291**	**691**
Sulfide				--	55 U
Conventional Parameters (pct)					
Total organic carbon				0.051 U	**7**
Total solids				**86**	**18.1**
Conventional Parameters (SU)					
pH				**7**	--
Grain Size (pct)					
Pebble				**14**	--
Gravel				**34**	**3 J**
Granule (very fine gravel)				**2**	--
Sand				**65**	**33**
Sand, very coarse				**18**	--
Sand, coarse				**34**	--
Sand, medium				**22**	--
Sand, fine				**8**	--
Sand, very fine				**1**	--
Silt				1 U	**62**
Silt, coarse				0 U	--
Silt, medium				1 U	--
Silt, fine				1 U	--
Silt, very fine				1 U	--
Clay				1 U	**2 J**
Clay, coarse				1 U	--
Clay, medium				1 U	--
Clay, fine				1 U	--
Total fines (Reported, not calculated)				1 U	--
Metals (mg/kg)					
Antimony	150		200	0 UJ	1 UJ
Arsenic	57	507.1	700	**2**	**15**
Beryllium				**0 JT**	0 U
Cadmium	5.1		14	**0 JT**	**1**
Chromium	260			**10**	**48**
Copper	390		1300	**9**	**65**
Lead	450	975	1200	**2**	**184**
Manganese				**163**	**269**
Mercury	0.41	1.5	2.3	**0 JT**	**1**
Nickel				**17**	**41**
Selenium		3		0 U	2 U
Silver	6.1		8.4	**0 JT**	**1 J**
Thallium				**0 JT**	0 U
Zinc	410		3800	**35**	**190**
Organometallic Compounds (µg/kg)					
Butyltin (n-Butyltin)				--	**98**
Dibutyltin				--	**85**
Tetrabutyltin				--	2 U
Tributyltin		73		--	**100 J**
Volatile Organics (µg/kg)					
Bis(2-ethylhexyl)adipate				23 U	--
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	11		270	--	150 U
Semivolatile Organics (µg/kg)					
1,2,4-Trichlorobenzene	31		64	0 U	4 UJ
1,2-Dichlorobenzene	35		110	0 U	4 UJ
1,2-Diphenylhydrazine				--	290 U
1,3-Dichlorobenzene				0 U	4 UJ
1,4-Dichlorobenzene	110		120	0 U	4 UJ
2,2'-Oxybis (2-chloropropane)				--	290 UJ
2,4,5-Trichlorophenol				--	610 U
2,4,6-Trichlorophenol				--	610 U
2,4-Dichlorophenol				--	150 U

Table A-1
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			Depth	0 - 10 cm	0 - 10 cm
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			X		-122.211907161978
			Y		47.6102464564289
	DMMPSL2021	DMMPBT2021	DMMPML2021		
2,4-Dimethylphenol	29		210	2 U	150 U
2,4-Dinitrophenol				--	290 U
2,4-Dinitrotoluene				--	61 U
2,6-Dinitrotoluene				--	61 U
2-Chloronaphthalene				--	88 U
2-Chlorophenol				--	290 U
2-Methylphenol (o-Cresol)	63		77	5 U	150 U
2-Nitroaniline				--	610 U
2-Nitrophenol				--	150 U
3,3'-Dichlorobenzidine				--	150 UJ
3-Nitroaniline				--	610 UJ
4-Bromophenyl-phenyl ether				--	61 U
4-Chloro-3-methylphenol				--	290 U
4-Chloroaniline				--	-- **R**
4-Chlorophenyl phenyl ether				--	88 U
4-Methylphenol (p-Cresol)	670		3600	9 U	150 U
4-Nitroaniline				--	610 UJ
4-Nitrophenol				--	290 U
Aniline				--	-- **R**
Benzidine				--	-- **R**
Benzoic acid	650		760	182 UJ	**660**
Benzyl alcohol	57		870	5 U	150 U
Bis(2-chloroethoxy)methane				--	150 U
Bis(2-chloroethyl)ether				--	88 UJ
Bis(2-ethylhexyl)phthalate	1300		8300	**11 JT**	**630**
Butylbenzyl phthalate	63		970	9 U	88 U
Coprostanol (Cholestan-3-ol (3B, 5B))				--	1500 U
Diethyl phthalate	200		1200	9 U	150 U
Dimethyl phthalate	71		1400	9 U	61 U
Di-n-butyl phthalate	1400		5100	13 UJ	150 U
Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)				--	290 U
Di-n-octyl phthalate	6200		6200	9 U	88 U
Hexachlorobenzene	22	168	230	0 U	4 UJ
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	11		270	1 U	--
Hexachlorocyclopentadiene				--	150 UJ
Hexachloroethane				2 U	150 UJ
Isophorone				--	150 U
Nitrobenzene				--	150 U
n-Nitrosodimethylamine				--	610 UJ
n-Nitrosodi-n-propylamine				--	150 U
n-Nitrosodiphenylamine	28		130	9 U	150 U
Pentachlorophenol	400	504	690	23 U	150 U
Phenol	420		1200	9 U	610 U
Polycyclic Aromatic Hydrocarbons (µg/kg)					
2-Methylnaphthalene	670		1900	5 U	240 U
Acenaphthene	500		2000	5 U	61 U
Acenaphthylene	560		1300	5 U	88 U
Anthracene	960		13000	5 U	88 UJ
Benzo(a)anthracene	1300		5100	5 U	**280**
Benzo(a)pyrene	1600		3600	5 U	**360**
Benzo(b)fluoranthene				5 U	**560 J**
Benzo(g,h,i)perylene	670		3200	5 U	**280 J**
Benzo(k)fluoranthene				5 U	**330**
Carbazole				5 U	150 U
Chrysene	1400		21000	5 U	**490**
Dibenzo(a,h)anthracene	230		1900	5 U	240 U
Dibenzofuran	540		1700	5 U	150 U
Fluoranthene	1700	4600	30000	5 U	**710 J**
Fluorene	540		3600	5 U	88 U
Indeno(1,2,3-c,d)pyrene	600		4400	5 U	**270 J**
Naphthalene	2100		2400	5 U	240 UJ
Phenanthrene	1500		21000	5 U	**180 J**
Pyrene	2600	11980	16000	5 U	**580**
Total Benzofluoranthenes (b,j,k) (U = 0)	3200		9900	5 U	**890 J**

Table A-1
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			Matrix	SE	SE
			X		-122.211907161978
			Y		47.6102464564289
	DMMPSL2021	DMMPBT2021	DMMPML2021		
Total HPAH (DMMP) (U = 0)	12000		69000	5 U	**3860 J**
Total LPAH (DMMP) (U = 0)	5200		29000	5 U	**180 J**
Pesticides (µg/kg)					
4,4'-DDD (p,p'-DDD)	16			1 U	**33**
4,4'-DDE (p,p'-DDE)	9			1 U	**8**
4,4'-DDT (p,p'-DDT)	12			1 U	**13 J**
Aldrin	9.5			1 U	7 U
Chlordane				--	**110**
Chlordane, alpha- (Chlordane, cis-)				1 U	--
Chlordane, gamma-				1 U	--
Chlorpyrifos				--	94 UJ
Diazinon				--	55 U
Dieldrin	1.9		1700	1 U	7 U
Disulfoton				--	55 U
Endosulfan				--	7 U
Endosulfan sulfate				1 U	7 U
Endosulfan, alpha- (I)				1 U	--
Endosulfan, beta (II)				1 U	--
Endrin				1 U	7 U
Endrin aldehyde				1 U	7 UJ
Heptachlor	1.5		270	1 U	7 U
Heptachlor epoxide				1 U	7 U
Hexachlorocyclohexane (BHC), alpha-				1 U	7 U
Hexachlorocyclohexane (BHC), beta-				1 U	7 U
Hexachlorocyclohexane (BHC), delta-				1 U	7 U
Hexachlorocyclohexane (BHC), gamma- (Lindane)				1 U	7 U
Malathion				--	150 UJ
Methoxychlor				6 U	37 U
Parathion				--	150 UJ
Phorate				--	94 U
Toxaphene				12 U	72 U
Sum 4,4 DDT, DDE, DDD (U = 0)		50	69	1 U	**54 J**
Total Chlordane (DMMP) (U = 0)	2.8	37		1 U	--
Herbicides (µg/kg)					
2,2-Dichloropropionic acid (Dalapon)				--	35 UJ
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)				--	27 U
2,4,5-TP (Silvex)				--	33 U
2,4-D (2,4-Dichlorophenoxyacetic acid)				--	14 U
2,4-DB (2,4-D derivative)				--	19 U
Dicamba				--	32 U
Dichloroprop				--	18 U
Dinoseb				--	13 U
Mecoprop (MCPP)				--	16 U
Mephanac (MCPA)				--	15 U
PCB Aroclors (µg/kg)					
Aroclor 1016				2 U	72 U
Aroclor 1221				3 U	72 U
Aroclor 1232				3 U	72 U
Aroclor 1242				2 U	72 U
Aroclor 1248				2 U	72 U
Aroclor 1254				2 U	**150**
Aroclor 1260				2 U	72 U
Total DMMP PCB Aroclors (U = 0)	130		3100	3 U	**150**
PCB Aroclors (mg/kg-OC)					
Total DMMP PCB Aroclors (U = 0)		38		5.882 U	**2.143**
Polybrominated diphenyl ethers (ng/kg)					
PBDE-017				0 U	--
PBDE-028				0 U	--
PBDE-047				**0 J**	--
PBDE-066				0 U	--
PBDE-071				0 U	--
PBDE-085				0 U	--
PBDE-099				**0**	--
PBDE-100				0 U	--

MEMORANDUM

DATE: November 28, 1995

TO: Paul Benko

FROM: Carl Kassebaum

SUBJECT: Meydenbauer Bay Outfall Project Analysis

1.0 Introduction

Purposes of this report are:

1. Review available information and sediment testing studies to assess the extent of sediment build-up in front of the outfall as a result of its discharges.
2. Evaluate the sediment build-up in relationship to the City/Yacht Club easement.
3. Provide summary of findings and conclusions.

2.0 Background and Study Efforts Undertaken to Date

Following is a brief history of events and summary of study efforts undertaken:

1. On July 10, 1981, a storm drainage easement was executed between the Meydenbauer Bay Yacht Club and the City of Bellevue. Key conditions in the easement are:

> *"Grantee accepts responsibility for sediment discharged from the energy dissipator and deposited off-shore to the extent that said sediment may adversely impact Grantor's customary use of its shorelands and boat moorage facilities. If and when sedimentation originating from the new pipeline energy dissipator system should cause the lake bottom of Grantor's shorelands to rise by more than two inches, on average, then Grantee will remove said sediment, or at Grantee's option Grantee may remove more than said accumulation from said shoreland."*

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"Topographic stations shall be located at the entrance to each of said moorage slips and at locations approximately twenty feet away from each slip entrance."

"In no case can the increase exceed three inches at any given station unless there is no impact on the use of that moorage slip."

"In no case shall Grantee be liable for any adverse impacts caused by changes in the lake surface elevation, or for any sedimentation which occurred prior to construction of the pipeline and dissipator system for any sediment deposited in any location which originates from any source other than the new pipeline energy dissipator system."

"Any and all sediment removal from the lake shall be contingent on the City's ability to obtain necessary federal, state, and local permits."

2. The outfall was built in 1982 and began functioning the same year. During the 1980's the City initiated a) stringent source control policies in the Central Business District (CBD), b) Business Partners for Clean Water Program, and c) required installation of water pollution systems on all new developments and redevelopments with high pollution potential. Because of all the above measures and ongoing programs, runoff today contains substantially less contaminates and solids than in 1982.

3. In February of 1982 prior to installation of the outfall, the Yacht Club measured spot elevations off the south side of the Yacht Club at various locations. Follow-up data were collected by the Yacht Club from these same locations in February of 1983, April 1985, January 1987, January 1990, May 1992, and April 1994.

4. At the end of January 1990, the Yacht Club supplied spot elevation data to the City through the January 1990 event. The Yacht Club requested, based on the data and the easement agreement, that the City institute action to remove sediment as stipulated in the easement agreement. In response, the City instituted action and applied for permits to dredge the area in front of the Yacht Club. At that time, the City did not verify to what extent sediment may have built up at the outfall discharge. The May 1992 and April 1994 spot elevation data was supplied to the City on July 19, 1995.

5. To complete the above permitting process, the City was required to undertake sediment testing of the material to be dredged. Based on Seattle-King County Department of Public Health requirements, sampling was undertaken for Total Petroleum Hydrocarbons (TPH) and heavy metals. Sediment testing was undertaken by Sweet-Edwards/EMCON, Inc (EMCON) on April 19 and November 6, 1991. Results were compiled and reported in January 1992. Based on the results which indicated great expense and permitting difficulty in implementing the project, the City decided to allow for more review and project study.

6. On August 23, 1995, the sediment was tested by Hartman Associates, Inc. (HAI) according to the Puget Sound Dredged Disposal Analysis (PSDDA) criteria to

determine whether the material may be suitable for open water disposal, and to verify location and extent of the outfall sediment.

3.0 Review and Analysis of Various Data Gathering Efforts

Yacht Club Lake Bottom Spot Elevation Surveys

The Yacht Club hired Bush, Roed & Hitchings, Inc. (BRHI) to collect spot elevation data. We understand that BRHI collected samples by lowering a disk over the side until it rested on the bottom. The depth was then measured to the water surface and the depth reported in relationship to the Puget Sound datum where Mean Lower Low Water = 0.0 feet.

The BRHI sampling locations and results for all sampling events are described by Figure 1 (Plan View), Figures 2 and 3 (Cross Sections), and Table 1.

Based on our review and analysis of the data, we have the following observations.

1. We understand that the surveyor contacted the U.S. Corps of Engineers by phone to identify the lake level at the Hiram Chittenden Locks at the time of sampling. Depending on wind and wave conditions, outfall and creek discharges, and other local conditions inside Meydenbauer Bay, Lake Washington, Lake Union, and the Ship Canal, the actual water height at Meydenbauer Bay could have been substantially different than at the Locks. Based on these factors, the vertical measurement accuracy of the BRHI surveys is significantly greater than +/- 2 inches and probably equal to or greater than +/- one half foot.

2. The impact of aquatic vegetation is unknown on the measurements. However, it is expected that millfoil in the area will affect measurements that are undertaken during the months of late March through October. It is expected that the disk, when lowered over the side, will be held up above the actual lake bottom to some extent if it is resting on aquatic vegetation. The 1985, 1992, and 1994 survey events all were undertaken during the March-October time frame.

3. Review of Figures 2 and 3 indicate that the measurements over time are tightly bunched. Assuming measurement accuracy of +/- one half foot, all measurements inside of the +/- one half foot range, as depicted by the dashed lines, could be anywhere within this range. With the exceptions of location A at 5 feet and 28 feet from the dock, location C at 5 feet from the dock, and location E at 28 feet from the dock, the measurement accuracy boundaries are always overlapping. Assuming the +/- one half foot measurement accuracy, build up of material can only be confirmed at the A locations. The individual C and E locations are not consistent; results are unclear.

4. The spot elevations were located at the edge of the slips directly out from the finger piers, not at the entrance to the slips as specified by the easement agreement. Specifically, the easement wording states that

"Topographic stations shall be located at the entrance to each of said moorage slips and at locations approximately twenty feet away from each slip entrance."

Sediment Sampling in 1991

In 1991 sediment samples were collected by EMCON using a gravity corer and 2-foot long butyl acrylate tubes. Sample recovery was poor because of the loose nature of the sediment. Numerous attempts were made to recover adequate amount of sediment to test. In some locations, the sediment was so loose that no recovery was possible. Chemical analyses were only performed on recovered samples.

Due to the weight and force on the gravity corer striking the bottom and the very loose nature of the surface sediments, it is estimated that the actual core sediment samples were taken at a depth of at least 2 or more feet below the actual sediment surface. Sample recovery that was representative of the upper loose material may not have been achieved due to the thrust cone pressure of the core device.

The sediment samples recovered were described as having high water content and to be of fine grained texture. The chemical testing results indicate that the sediment contains elevated concentrations of heavy metals and total petroleum hydrocarbons (TPH), and that the recovered core section surface and depth sample results were comparable.

Cost estimates for dredging and disposal were extremely high (e.g., greater than $200,000 for 300 yards of material). Based on the costs and the complex permitting processes, the City determined that additional study and analysis was required.

Sediment Testing for PSDDA Analyses in 1995

On August 23, 1995, sediment was collected by Pentec Environmental Inc. (Pentec) on behalf of HAI from three locations as identified as #1, #2, and #3 in Figure 4. At locations #1 and #2 a 7-foot-long, 4-inch square tube was placed on the sediment surface and pushed, only with the diver's force, almost entirely into the sediment. From this, approximately 2.0 to 2.3 feet of material was recovered. This procedure was repeated twice at locations #1 and #2 to collect sufficient material for testing. Equal amount of material from each of the two cores at each location (total of 4 cores) was then composited into one sample for chemical analysis.

A grab sample of material was collected at location number 3. This material consisted of sandy material.

The Pentec sampling observations and sample collection efforts are detailed in Attachment A.

From the visual analysis by the diver and the physical/chemical analyses of the sediment samples, the following observations are made:

1. The surface sediments at locations 1 and 2 are extremely loose; the material is of soupy consistency. It flows and moves easily. Based on the inspection of the sediment cores and diver experience, the approximate depth of this fluffy loose material is definitely greater than one half foot and probably is greater than one foot in depth.

2. The total recovery of material in the seven-foot-long core was approximately 2.0 to 2.3 feet. Of this, the material was approximately equally distributed (e.g., one foot of overlying very soft organic material, and one foot of underlying peat material). Assuming direct correlation and compression of the sample, in-situ loose material could extend down approximately 3 feet before the underlying peat is encountered.

3. The overlying soft sediment was very organic; this is indicative of decay and build-up of organic plant material, presumably millfoil. Visual inspection of the bottom by the diver and inspection of the sediment samples indicates ongoing natural organic plant decay and build-up. Other sedimentation processes were not noted.

4. Diver survey of the area indicated extensive millfoil beds throughout most of the area. The beds completely cover much of the bottom and extend to within 1 to 2 feet of the surface. In order to collect sediment samples numbered 1 and 2, millfoil was first removed by the diver by hand from the area of sample collection, and then the sampler was guided into the sediment at the location which had been cleared. Based on the extensive growth, it appears that the millfoil could be causing problems with boat operations in the area.

5. The diver survey indicated sand build-up in front of the outfall as identified by Figure 4. No aquatic vegetation was growing at this location.

6. The diver survey indicated a sudden (e.g., not gradual change) demarcation between the sandy area and the silty soft sediment area extending outward from that point.

7. Chemistry analysis results indicated that the sediment tested is not suitable for open water disposal.

4.0 Evaluation

Evaluation of information derived from the data gathering efforts discussed above:

1. Depth measurements are very difficult to accomplish accurately at this site because:

   a) The surface material is very soft. Any mechanical system of measurement such as the disk used by BRHI will sink into the top of this sediment to some degree. The smaller and heavier the disk, the deeper it will sink. The larger and lighter the disk, the higher it will tend to rest. Similar difficulties would be encountered with electronic bathymetric measurement from side

scan sonar or radar. The actual density point at which the electronic echo is returned would be difficult to interpret.

b) Millfoil and aquatic plants will intercept the measuring device or interfere with the electronic echo. In either case, artificially shallow water depth readings would tend to occur.

2. The sample locations (e.g., at the end of the floats) may have resulted in an exaggerated data set. Specifically, because the sediment is so soft on the surface, it is speculated that boat prop wash is a major dynamic process at the site. Boats coming in and out of the slips will tend to wash sediment away from the center of the slip with subsequent deposition occurring underneath or in line with the floats where the depth measurements were taken.

3. A major design purpose for construction of the Meydenbauer Bay trunk-line was to direct peak storm water runoff events away from Meydenbauer Creek and thus reduce flooding events along the creek. The 60 inch trunk-line acts as a high flow bypass line. Low and normal flow runoff events are controlled by the diversion structure at N.E. 2nd and 105th N.E. Low and normal flow events have sufficient energy (i.e., flow velocity) in the collection system to suspend and move fine sand, silt and clay sized particles. However, sufficient energy is not generated during these events to move the larger sand sized particles. Consequently, the fine sand, silt and clay particles are largely directed to Meydenbauer Creek.

During the course of a large storm, the following steps occur.

Step 1: Initially at the beginning of the storm as water starts to accumulate in the system, almost all flows are directed to Meydenbauer Creek. Exception is that a small percentage of the lower basin, including Bellevue Square, discharges directly to the bypass line. Corresponding to this part of the storm is the initial washing or cleansing of the streets, parking lots, and other runoff surfaces. Since most of the drainage basin is in the CBD, including Bellevue Square, soil erosion and associated organic debris discharge is minimal. Sources of materials entering the system from the CBD are from road sanding, oils and greases from automobiles, and dust. Sufficient water volumes and energy occurs at this early phase to wash the fine materials (fine sands, silts, clays, and dust) into the system and eventually to Meydenbauer Creek. However, there is not sufficient energy to move sand particles completely through the collection system. These larger particles are temporarily trapped in catch basins.

Step 2: As flows increase, water is diverted to the Meydenbauer Bay trunk-line. Because of the increased flow energy, the sands in the system become suspended and are discharged at the Meydenbauer Bay outfall. The visible oil sheen which occasionally occurs with this discharge is believed to be a result of runoff from streets and parking

lots. Fine particles are largely not discharged during this portion of the storm. To the extent they are discharged, these particles will remain in suspension for a long period of time, eventually settling over a very large area.

The deposition of these fines will be in relationship to the intensity of the storm. If wave and wind action in the Bay is great, deposition will be widespread. The greater the energy in the Bay, the greater the area of deposition.

4. Review of the spot elevation data (Figures 2 and 3) indicates that previous to construction of the outfall and continuing to the present day, the water depth as measured at the G and H floats is consistently shallower than at the B through E floats. Reason for this is unknown. However, standard outfall (e.g., an outfall which discharges during all storm runoff regardless of storm size) deposition patterns would have resulted in the filling of this hole. For standard outfalls, the water depth immediately adjacent the outfall would be most shallow. Depths would then become progressively deeper at distances progressively greater from the outfall discharge point. The deeper the depth, the finer the material being deposited; sandy material next to outfall, grading into fine sands, then silts, and finally clays.

5. The 1990 and 1995 sediment sampling results tend to indicate that the area in which the sediments were tested may have been contaminated prior to outfall construction. This is based on the finding that the 1990 samples found equivalent concentrations of chemicals in the deeper and surface portions of the cores, and confirmation of equivalent chemical concentrations for the entire core in the 1995 sampling. The 1995 sampling identifies the subsurface layer as peat material, which is indicative of a natural system which was in place prior to construction of the outfall. The 1995 sampling, which collected a sample down to approximately 6 feet of depth did not result in sufficient dilution or differing results from the 1990 sampling.

6. The outfall has deposited sediment in greater than two inches depth immediately in front of the outfall and extending out approximately 75 feet. This material is sandy, heavier material that settles quickly.

7. The surface organic sediment extending out beyond the sandy area is very soft and loose. Dredging of this material would create a hole to which the soft surface soft material as well as the subsurface peat material would tend to flow into and fill up. Any dredging activity would likely need to be repeated quickly again; the benefit of the dredging would be short lived and economically difficult to justify.

8. Based on diver observations, it appears that millfoil could be causing problems with boat operations in the area.

5.0 Conclusions

Based on the data gathered during the sampling processes and evaluation of other information as discussed above, the following conclusions are provided.

1. Sandy sediment, greater than two inches in depth and extending out approximately 75 feet, has been deposited in front of the outfall. Support evidence includes:

   - The diver survey confirms that this material consists largely of sand and that there is a sudden (e.g., not gradual change) demarcation between the sandy area and the silty soft sediment area extending outward from that point.

   - Assuming vertical accuracy of +/- one half foot for the Yacht Club lake bottom survey, the measurements at location A at 5 feet and 28 feet from the dock conclusively demonstrate sediment build-up of greater than 2 inches.

   - The 60 inch trunk-line acts as a high flow bypass line for the Meydenbauer drainage basin. Sand captured in catch basins during low flow storm events is suspended and diverted to the trunk-line during the high flow events and subsequently discharged at the Meydenbauer Bay outfall.

2. There is insufficient basis to establish that there is greater than two inches of material build-up, due to the outfall, extending beyond the sandy area immediately in front of the outfall. Support evidence includes:

   - Assuming vertical measurement accuracy of +/- one half foot for the Yacht Club lake bottom survey, the measurement variability ranges consistently overlap. Differences in measurements cannot be assured because of the vertical range accuracy overlap.

   - Visual inspection of the bottom by the diver and inspection of the sediment samples indicates ongoing natural organic plant decay and build-up. The overlying soft sediment is very organic and is indicative of decay and build-up of organic plant material, presumably millfoil. Other sedimentation processes were not noted.

   - The diver survey confirms that there is a sudden (e.g., not gradual change) demarcation between the sandy area and the silty soft sediment area extending outward from that point. Had there been significant discharges of solids other than sands, the sediment should become progressively finer at greater and greater distances from the outfall; sandy material next to outfall, grading into fine sands, then silts, and finally clays.

   - Water depth measurements at the G and H floats demonstrate consistently shallower depths than at the B through E floats, even prior to outfall construction. Had there been significant discharges of solids other than

sands from the outfall, the deposition patterns should have resulted in the filling of this hole, not its continuance.

6.0 Recommendations

1. The City should continue with the permitting process to dredge and dispose of the sandy sediment in front of the outfall, and provide ongoing maintenance in this area in accordance with the easement agreement. The City should undertake additional chemical analyses to determine the proper disposal action.

2. Dredging of the soft loose sediment beyond the sandy sediment deposits is not recommended. Dredging of this material would create a hole to which the soft surface material as well as the subsurface peat material would tend to flow into and fill up. Any dredging activity would likely need to be repeated quickly again; the benefit of the dredging would be short lived and economically difficult to justify.

CC: Linda Dawson
Cliff Whitmus

ATTACHMENT A
MEYDENBAUER OUTFALL SEDIMENT CHARACTERIZATION

SAMPLE COLLECTION FOR PSDDA IN 1995

Cores for analysis of sediment characteristics were collected on August 23, 1995, at each of two different locations near the Meydenbauer Outfall located at the Meydenbauer Yacht Club, Bellevue, Washington. One additional sample of surface sediment was collected near the outfall by scooping material up with a glass sample container. Sampling locations are shown on Figure 4; sampling location, coordinates, and sample collection data are provided in Table 1.

Before sampling, the core tube and all parts of the sampler that came in contact with the sample were decontaminated following Puget Sound Estuary Program (PSEP 1991) protocols. The decontamination procedure deviated from PSEP protocols by not using an acid rinse and a solvent rinse; the rinse used was distilled water. Pentec acknowledged and accepted the potential added risk of sample contamination. The decontamination procedure was as follows:

- Pre-wash rinse with tap water.
- First wash with solution of tap water and Alconox soap (brush).
- Second rinse with tap water.
- Second wash with solution of tap water and Alconox soap (brush).
- First rinse with distilled water.
- Second rinse with distilled water.
- Coverage (no contact) of all decontaminated items with aluminum foil. Ends of core tubes were sealed with decontaminated stainless-steel-lined silicone rubber caps.

An attempt to use the Pentec Technologies, Inc., MudMole™ pneumatic sediment corer to collect the cores failed because of extremely soft sediment conditions. The weight of the sediment corer caused the core tube to sink at an uncontrolled rate into the bottom.

To collect the cores, it was necessary to remove the driver head from the sediment sampler. The diver then pushed the 4-inch square, 7-ft long, aluminum core tube vertically into the bottom by hand as far as possible. After the core tube was pushed in, the core was extracted by hand. A hinged stainless steel core

catcher retained the sediment during extraction. The extremely soft nature of the sediment allowed penetrations of 5 to 6 ft with this method.

Extensive milfoil beds were found in the project area. These beds completely cover much of the bottom and extend to within 1 to 2 ft of the surface over much of the area. The diver attempted to locate an area free of milfoil at the sampling locations. If this was not possible, milfoil was removed by hand to clear an area for the core tube to be inserted. This technique avoided the risk of the plant material plugging the end of the core tube which could have reduced sediment recovery.

After extracting the core from the bottom, the water overlaying the sediment was carefully decanted. Distance from the top of the core tube to the surface of the retained sediment was measured with a decontaminated stainless steel ruler. This measurement was subtracted from the length of the core tube to calculate the amount of retained sediment. A sample label was affixed to the core tube and documentation regarding the sample entered onto the appropriate forms. The top and bottom of the core tube were sealed to prevent contamination before extruding the sediment from the core tube. The bottom of the core tube was capped with a stainless-steel-lined silicone rubber cap. To seal the top of the core tube, a stainless-steel-lined silicone plug was inserted into the core tube and pushed down until it contacted the surface of the sediment. The plug was then expanded to seal the core tube at the surface of the sediment.

Sediment core locations were documented using a differential global positioning system (DGPS) and were recorded to the nearest foot in the Washington State Plane coordinate system using North American Datum 1983 (NAD 83). Coordinates in latitude and longitude (NAD 83) are calculated to the nearest second. Water depths were measured with a diver's depth gauge.

The cores were extruded into stainless steel trays, photographed, and the qualitative sample characteristics documented.

LOCATION 1

Two cores were collected at this location in an open area several feet across which was found in the milfoil bed. These cores were labeled Cores 3 and 4. Penetration was 6 ft and 5 ft, respectively, with a recovery of 2.0 ft for each of the cores. The core tubes penetrated easily the first 3 ft, after which increasing resistance was felt. The sediment was a dark brown silt with a high percentage of organic material. An oil sheen was noted near the top of both cores. Organic fiber increased near the bottom of

the cores, appearing to be peat bog, which made up the bottom 0.9 and 0.5 ft of Cores 3 and 4, respectively. This peat material was of a light brown color. Core 3 had a slight hydrogen sulfide odor. Volatile and sulfide compound samples were taken from Core 4 immediately after the core was extruded.

Two archive samples were collected of material composited from these two cores. The first of these samples consisted of sediment collected from above the dividing line between the peat layer and the upper sediment. The second sample was made up of material taken from below the dividing line.

LOCATION 2

Two cores were collected at this location and labeled Cores 1 and 2. A very dense mat of milfoil covered the entire bottom at this location. The diver removed the milfoil growth by pulling it out by hand to expose sediment prior to collecting the core sample. Core 1 had a penetration of 6 ft and a recovery of 2.3 ft. The core tube penetrated easily the first 3 ft, after which increasing resistance was felt. An oil sheen was noted near the top of the core. The sediment was similar to that collected from Location 1, consisting of a dark brown silt with a high organic material content. The bottom 1.0 ft of the core was a lighter brown material with a greater amount of organic fiber content that appeared to be peat.

Core 2 was similar in appearance to Core 1. Penetration was 6 ft with a 2.3 ft recovery. An oil sheen was present near the top of the core. The bottom 0.8 ft of the core was a lighter color and appeared to be peat.

Two archive samples were collected of material composited from these two cores. The first of these samples consisted of sediment collected from above the dividing line between the peat layer and the upper sediment. The second sample was made up of material taken from below the dividing line.

LOCATION 3

A visual diving survey was conducted of the area near the outfall. The bottom of this area consists of a gray, firm sand that extends for an estimated 75 ft from the outfall. No milfoil was seen in this area. The edge of this sand deposit transitions quickly into soft sediments with a high organic content with no apparent gradation of transitional grain sizes. The sandy sediment appeared to contain very little organic material. This gray sandy material was not visible in any of the core samples collected at Location 1 or Location 2. A sample of this sediment was collected by scooping the surface material up using a glass sample container. This sample was frozen for possible future analysis.

COMPOSITING

Equal amounts of sediment for the four cores collected at Location 1 and Location 2 was placed into a mixing bowl and homogenized to make one composite sample for chemical analysis.

REFERENCE

Puget Sound Estuary Program (PSEP). 1991. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments. Prepared for US Environmental Protection Agency—Region 10, Seattle.

TABLE 1

Meydenbauer Bay Yacht Club Dredging
City of Bellevue

24-Oct-95
Bottom Elevations relative to MLLW at the Hiram M. Chittenden Locks

Pier	Distance from Bulkhead	6-Feb-82		12-Feb-83		6-Apr-85		10-Jan-87		21-Jan-90		3-May-92		5-Apr-94	
		5-feet	28-feet	5-feet	28-feet	5-feet	28-feet	5-feet	28-feet	5-feet	28-feet	5-feet	28-feet	5-feet	28-feet
A	15	13.6	13.2	13.6	13.6	13.8	13.8	14.1	13.9	14.4	14.1	14.5	14.2	15.1	14.5
B	50	13	12.9	13.2	12.6	13.2	13.2	13.1	12.9	13.2	13.2	13.2	12.5	13.2	13.1
C	85	12.7	12.8	12.9	12.7	12.8	13	13.1	12.9	13.5	13.1	13.5	13	13.8	13.6
D	120	13.3	13.5	13.4	13.5	13.4	13.7	13.4	13.8	13.5	13.7	13.5	13.9	13.7	14
E	150	13.2	12.5	13.1	12.6	13.2	12.7	13.3	13	13.5	13.1	13.5	13.3	13.7	13.5
F	185	13.3	13.6	13.3	13.4	13.3	13.6	13.6	13.9	13.9	14	13.9	14.1	14.2	14.5
G	220	14.1	14	14	14	14	14	14	14.3	14	14.9	14.1	14.5	14.3	14.7
H	305	14.3	14.2	14.1	13.9	14.1	13.8	14.2	14.1	14.6	14.1	14.6	14	14.7	14.7
I*	335	13.8		13.5	13.4	13.6	13.9	13.1	14	13.6	14.1	13.4	14	13.5	14.2

* Distance from pier is 0-feet instead of 5-feet.

Table 2 Sampling location, coordinates, and sample collection data from the Meydenbaurer Outfall, August 1995.

Station Name	Rep.	Sample Number	Coordinates: State Plane NAD 83 Northing	Coordinates: State Plane NAD 83 Easting	Coordinates: Latitude	Coordinates: Longitude	Water Depth (ft)	Penetration (ft)	Recovery (ft)	Percent Recovery	Sample Date
1	3	18100300001	224850	1301408	47 °36 '29 "	122 °12 '28 "	7	5.0	2.0	40	8/23/95
	4	18100300001						6.0	2.0	33	8/23/95
2	1	18100300001	224767	1301286	47 °36 '28 "	122 °12 '30 "	7	6.0	2.3	38	8/23/95
	2	18100300001						6.0	2.3	38	8/23/95
3	1	18100300002	224889	1301470	47 °36 '30 "	122 °12 '27 "	NR	0.1	**	**	8/23/95

00181\0003\tables\meyb_lo

NR = Not recorded.
** = Surface scoop sample, archived.

Appendix B
Field Collection Forms

Daily Log

ANCHOR QEA

PROJECT NAME: **DATE:**

SITE ADDRESS: **PERSONNEL:**

WEATHER: **WIND FROM:**

N	NE	E	SE	S	SW	W	NW	LIGHT	MEDIUM	HEAVY

SUNNY	CLOUDY	RAIN	?

TEMPERATURE: ° F . ° C

[Circle appropriate units]

TIME	COMMENTS

Signature: _____

Sediment Core Collection Log

Job:	**Station ID:**
Job No.:	**Attempt No.:**
Field Staff:	**Date:**
Contractor:	**Logged By:**
Vertical Datum:	**Horizontal Datum: NAD83 WA State Plane North, feet**

Field Collection Coordinates:

Lat/Northing: Long/Easting:

A. Water Depth

DTM Depth Sounder:

DTM Lead Line:

B. Water Level Measurements

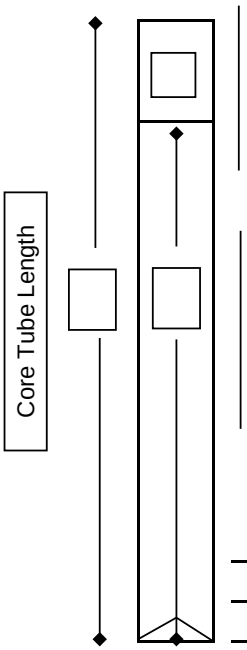
Time:

Height:

Source:

C. Mudline Elevation

Recovery Measurements (prior to cuts)



Core Collection Recovery Details:

Core Accepted: Yes / No

Core Tube Length:

Drive Penetration:

Headspace Measurement:

Recovery Measurement:

Recovery Percentage:

Total Length of Core To Process:

Sections To Process:

A:

B:

C:

D:

Drive Notes:

Core Field Observations and Description:

Sediment type, moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota

Notes:

Sediment Core Processing Log

ANCHOR QEA

Job:	Station ID:
Job No.:	Date/Time:
No. of Sections:	Core Logged By:
Drive Length:	Attempt No.:
Recovery:	Type of Core ☐ Mudmole ☐ Vibracore ☐ Diver Core
% Recovery:	Diameter of Core (inches)
Notes:	

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch

Chain of Custody Record & Laboratory Analysis Request

Laboratory Name:
Date:
Project Name:
Project Number:
Project Manager:
Phone Number:
Shipment Method:

Line	Field Sample ID	Collection Date/Time	Matrix	No. of Containers	Test Parameters: Total Solids	Total Volatile Solids	Total Organic Carbon	Ammonia	Sulfide	Metals/Mercury	SVOCs/PAHS	Pesticides	PCB Arcolors	Grain Size	Archive	Bioassay Archive							Comments/Preservation
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							
13																							
14																							
15																							
16																							
17																							
18																							

Notes: Do not freeze bioassay archive sample.

Relinquished By:	Company: Anchor QEA, LLC
Signature/Printed Name	Date/Time

Received By:	Company:
Signature/Printed Name	Date/Time

Relinquished By:	Company:
Signature/Printed Name	Date/Time

Received By:	Company:
Signature/Printed Name	Date/Time

Distribution: A copy will be made for the laboratory and client. The Project file will retain the original.

Appendix C
Boat Inspection and Cleaning for Invasive Species

STANDARD OPERATING PROCEDURE (SOP) SW-19

BOAT INSPECTION AND CLEANING FOR INVASIVE SPECIES

SCOPE AND APPLICATION

This SOP describes the protocol for procedures that have been developed to help prevent the spread of aquatic invasive species, especially quagga and zebra mussels and milfoil, on Gravity Environmental Consulting's trailered watercraft. When properly used, these procedures also preserve fishing, protect the aquatic environment, and save millions of dollars in water supply and electric-power generating equipment maintenance. It protects water bodies from the many destructive invasive species that hitchhike on boats. Finally, it enables Gravity to comply with state and federal laws prohibiting the spread of invasive species.

These instructions include inspection of every part of the equipment that has been in contact with the water. Including the processes to discover, remove, and kill, all invasive species. Microscopic, free-floating larvae can be found anywhere there is standing water remaining on your vessel or trailer. Attached juveniles the size of sand grains, older juveniles as large as shotgun shot, or adults up to an inch in length, might be found anywhere on Gravity boats. Therefore, the inspection must be detailed and thorough.

When a water body is known to be infected with mussels or Milfoil:

- Boats entering the water are not required to be inspected and cleaned.
- **Boats leaving the water must be inspected and cleaned according to these procedures.**

When a water body is known to NOT be infected with mussels:

- **Arriving boats need to be inspected according to these procedures before entering the water. If ANY milfoil, mussel adults, juveniles or larvae are discovered, a complete cleaning of all equipment according to these procedures is *required*.**
- Boats leaving the water require no inspection and cleaning.

Western water bodies known to contain quagga mussels include Lake Mead, Lake Mohave, Lake Havasu, and the Colorado River Drainage below these lakes. Water bodies located in the following states and Canadian provinces are known to contain quagga and/or zebra mussels. Alabama, Arizona, Arkansas, California, Connecticut, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada New York, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, as well as, Ontario, Canada and Quebec, Canada.[1]

SUMMARY OF METHOD

Boats leaving a water body known to be infected: Immediately upon securing the craft to the trailer, remove it from the water and drive to the area designated for boat inspection and cleaning.

Boats arriving at a water body known to NOT be infected: Drive to the area designated for boat inspection.

PROCEDURES

All boats that have been in water known to be infested for over 24 hours and
Boats and equipment where mussel juveniles have been discovered – that sandpaper feel:

Completely wash with a pressurized power sprayer using water of **140° F** or hotter. Contact with water at this temperature will kill quagga and zebra mussel juveniles and larvae in a few seconds. Qualified mussel researchers have established 104° F will work. However, hotter water works better and temperatures of 140°F and higher are common for the many power sprayers available.

- *Completely spray the entire exterior of the craft and the trailer.* Perform the wash slowly and carefully. The idea is to "cook 'em" with heat and "remove 'em" with the pressurized water. Spray all small nooks and crannies where mussel larvae may be lodged.
- No soap, detergent or chemicals are necessary.
- Be careful not to remove decals, paint or labels from the boat while spraying.

Using a power sprayer carwash, even one with hot water, is NOT adequate. One of the largest expenses in that business is energy to heat the water, regardless of the fuel used. Thus, there is considerable incentive to maximize profits by minimizing water heating. Some carwashes do not have any water heaters and only provide cold water washes. There is no assurance that carwashes use water of at least 104° F. Live mussel juveniles and larvae could be washed into storm drains that empty into the nearest stream. In addition to not cleaning the boat, this would spread mussels into waterways and reservoirs. This situation indicates using carwashes to control mussels is not advised.

Equipment

Fishing waders are a proven means of spreading invasive species. Everything from whirling disease to mud snails to quagga and zebra mussels are transported by waders. First, separate all individual components such as insoles, socks, booties, ankle guards, and laces. Then wash everything inside and out to remove dirt, plants and other visible substances. Be sure the treads are completely clean. Finally, soak them in a bucket or bathtub full of hot water. Allow sufficient soaking time for all components to reach the water temperature; thick felt soles take time. Repeat the soak with fresh hot water. Another option would be to soak them in a

potassium chloride solution made as described below. Completely dry all components and reassemble the waders.

Ropes, lines and cords and fish nets and all nets. Thoroughly wash them to remove dirt, plants and other visible substances. Then soak them in a bucket full of hot water from your house. Allow sufficient soaking time for all components to reach the water temperature. Repeat the soak with fresh hot water. Another option would be to soak them in a potassium chloride solution made as described below. Completely dry them, ideally in the sun on a hot day.

Drying Kills Mussels

Mussels are tough, and it's often difficult to know what exact conditions kill them. Thus, it's beneficial to know basic concepts. High temperatures, low humidity, and prolonged time are all injurious to mussels and increase the likelihood of death. *Boaters are advised to do everything possible to expose their equipment to hot and dry conditions for as long as possible.* Multiple researchers have shown that any dry exposure longer than 21 days will kill all mussels. Notice that these procedures contain specific actions that foster these conditions. They also prevent mildew with attendant cost and health issues, and your equipment lasts longer. It's recommended to leave boats outside in the sun, after opening and exposing compartments and wet locations.

Boats leaving a water body known to be infected:
After inspection and cleaning according to these procedures, allow the boat and trailer to air-dry for at least 7 days. Longer is better.

Boats arriving at a water body known to NOT be infected:

Drain ALL water from the boat, especially the live well. Drain all water from the bilge, motor well, (Figure 2) water-holding compartments, and water-skiing ballast tanks and bladders. See detailed instructions below for ballast tanks.

Completely drain all water from the motor cooling system. Some motors, like outboards, drain freely and easily. Other motors, like some inboards and stern-drives, can only be drained using special equipment and procedures. Follow the motor manufacturers instructions or obtain the services of a qualified service technician. This is exactly the same as draining the motor at the end of boating season to prevent freezing in the engine cooling system. Failure to do this can result in mussels growing inside the engine block and in the lines carrying cooling water to and from the motor. The consequences can be overheating, resulting in serious damage to the motor, in addition to transporting the mussels.

Thoroughly inspect the boat, trailer and all equipment for mud, plants and mussels.

Completely remove these contaminants. In addition to looking – inspect by gently running your hand along the entire surface of the equipment. Take time and carefully feel for juvenile mussels; when you locate them, it will feel like sandpaper.

Specifically, check the following areas.

Trailer
Trailer frame Rollers & bunks License plate Lights Wiring
Axles Springs Fenders Hangers
Pockets & hollow spaces Trailer tires & wheels

Water Craft Exterior
Entire hull Trim tabs: top & bottom of hinges Thru-hull fittings Transducers
Pitot tube Cavitation Plates Ropes & Lines Anchors
Depth sounders Water intakes Water outlets Lights

Motors
Entire exterior housing Propeller Propeller shaft
Propeller shaft support Propeller guards Propulsion systems
Lower unit Gimbal area Water intakes & outlets

Boat Contents
ALL nets Float belts Personal floatation devices Float cushions
Rope lockers Equipment lockers Waterfowl decoys and camouflage blinds

When adult quagga or zebra mussel shells are found attached to any surface — remove and KILL THEM. There must be no reservation nor hesitation. These are the invasive creatures that cause so much environmental damage and cost so much money. They must be completely removed from wherever they are found and destroyed. Adults are indicated by shells of any visible size. They are the highest risk since they are the toughest to kill and they reproduce very rapidly. There has been much research on how to kill them using chemicals, radiation, heat and other methods that are complex and difficult to implement. *Therefore, simply crush them to death by stepping on them or hitting them with a rock, hammer or whatever is available.* Wear eye protection, gloves and protective clothing. Dispose of the remains in a dumpster. Depending on the degree of contamination, killing all adult mussels could be a substantial amount of work.

Specific Instructions Common to All Water Craft

All boats that have been in water known to be infested for over 24 hours and
Boats and equipment where mussel juveniles have been discovered – that sandpaper feel:

Completely wash with a pressurized power sprayer using water of **140° F** or hotter. Contact with water at this temperature will kill quagga and zebra mussel juveniles and larvae in a few

seconds. Qualified mussel researchers have established 104° F will work. However, hotter water works better and temperatures of 140°F and higher are common for the many power sprayers available.

- *Completely spray the entire exterior of the craft and the trailer.* Perform the wash slowly and carefully. The idea is to "cook 'em" with heat and "remove 'em" with the pressurized water. Spray all small nooks and crannies where mussel larvae may be lodged.
- No soap, detergent or chemicals are necessary.
- Be careful not to remove decals, paint or labels from the boat while spraying.

Using a power sprayer carwash, even one with hot water, is NOT adequate. One of the largest expenses in that business is energy to heat the water, regardless of the fuel used. Thus, there is considerable incentive to maximize profits by minimizing water heating. Some carwashes do not have any water heaters and only provide cold water washes. There is no assurance that carwashes use water of at least 104° F. Live mussel juveniles and larvae could be washed into storm drains that empty into the nearest stream. In addition to not cleaning the boat, this would spread mussels into waterways and reservoirs. This situation indicates using carwashes to control mussels is not advised.

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Boats leaving a water body known to be infected:
After inspection and cleaning according to these procedures, allow the boat and trailer to air-dry for at least 7 days. Longer is better.

Boats arriving at a water body known to NOT be infected:

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Diving Gear Additional Instructions

Diving gear is a well-proven means of spreading invasive species, including quagga and zebra mussels. Divers swim in ideal mussel habitat and easily pick up larvae and juveniles. Thoroughly wash <u>everything</u> inside and out to remove dirt, plants and other visible substances. This includes masks, wetsuits, booties and gloves. Also wash air tanks, air lines, regulators, and flippers. Finally, soak all equipment in a bucket or bathtub full of hot water from your house. Allow sufficient soaking time for all components to reach the water temperature. Repeat the soak with fresh hot water. Completely dry all equipment, ideally in sunlight.

Additional Information

***Chlorine** may be used to kill mussels, but only under carefully controlled circumstances.*

- Chlorine is toxic, corrosive, and a strong oxidizer; it is extremely reactive. Only properly trained personnel, wearing protective equipment, should use chlorine. Work must be done in specifically designated areas and every one else should be kept out.
- Chlorine can be detrimental to the environment and harmful to water bodies in sufficient concentrations. Control chlorine runoff through evaporation or proper disposal.
- Chlorine has been used for years to kill mussels. Still, treatment should be conducted only as long as necessary to prevent damage. Use only the minimum concentration necessary. These apply to whatever boat system is being treated.

Appendix D
New Zealand Mudsnail Identification Guide

New Zealand mudsnails (NZMS)

(Potamopyrgus antipodarum)

IDENTIFICATION GUIDE FOR KING COUNTY, WA

How and when to use this guide: The highly invasive New Zealand mudsnail (NZMS) has been identified in 10 King County stream systems (Big Soos, Kelsey, May, McAleer, Thornton, Longfellow, Pipers, Mapes, Sunset, and Maple Leaf creeks) as of summer 2017. We ask that everyone doing freshwater field work turn over a rock or two to look for NZMS to help expand our understanding of its presence in King County.

This identification guide is intended to help distinguish between the NZMS and native snails similar in size and appearance.

A hand lens and flashlight will be helpful for seeing some features.

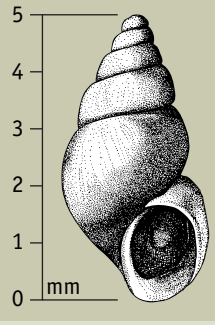
IDENTIFIABLE AND DISTINGUISHING FEATURES OF NZMS AND NATIVE SNAILS

Hold snail with tip up and opening facing you. Please note that measurements are approximate and will vary.

Invasive non-native species

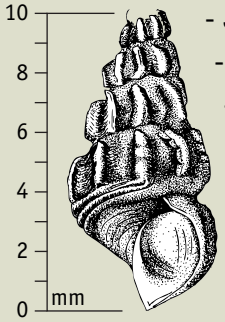
New Zealand mudsnail (NZMS)

Potamopyrgus antipodarum



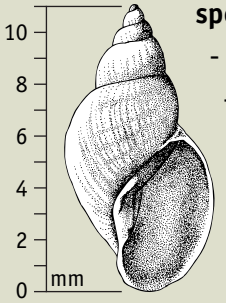
- Usually less than 6 mm long
- Elongate shells with 5 to 8 whorls
- Right opening
- Variable shell color; gray to brown
- Has operculum (opening lid)

Juga sp., no common name



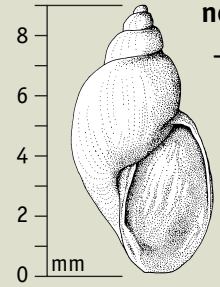
- Juvenile similar in size to NZMS
- Right opening
- Reddish-brown shell
- Thin spiral incised lines and raised folds
- Has operculum
- Only known from Soos Creek basin and Mill Creek

Pondsnails, *Stagnicola* and similar species in family *Lymnaeidae*



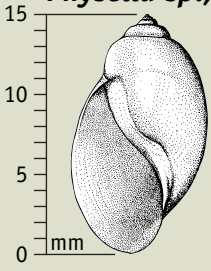
- Broader shell relative to length
- D-shaped right opening with twisted inner lip
- No operculum

Galba sp., formerly *Fossaria*, no common name



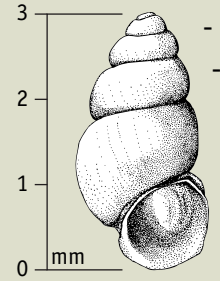
- Thin, broader shell relative to length
- Oval right opening half of the entire shell length
- No operculum

Physella sp., no common name



- Thin, fairly transparent shell
- Left oval opening that is ¾ the length of the shell
- No operculum

Pristine pyrg (*Pristinicola hemphilli*)



- Very narrowly conical shell
- Clear to white coloration
- Oval, elongate right opening
- Lives in springs, unlikely to make large populations in streams or lakes
- Has operculum

If you find NZMS, please identify the location and take pictures.
Contact Kate Macneale at **kate.macneale@kingcounty.gov** or **206-477-4769** to report potential King County infestations.

over→

New Zealand mudsnail Identification Guide *continued*

Snails found in local streams (left to right) NZMS, Pristinicola, Galba, Physella, Juga (juvenile), Stagnicola

These boots were worn while walking in the mud at the edge of Capitol Lake in Olympia. Over 120 NZMS were found while cleaning the boots.

Gear decontamination tips for avoiding the spread of aquatic invasive species

- Avoid going in the water unless necessary for the work to be done.
- Do not wear felt soles on boots or waders; use hard soles only.
- Plan field trips to move from least to most likely areas of contamination; go from upstream to downstream along a water course.
- Scrub, clean, rinse, and examine all gear on-site before moving to a new water body.

Scrub

No Felt Boots

Drain

Rinse

When entering areas of known infestation, add one of the following decontamination procedures to the basic cleaning procedure:

- Dedicate equipment only to that site and use it nowhere else.
- Freeze for 8 hours (14 °F /-10 °C).
- Soak in hot water for at least 5 minutes (140 °F / 60 °C).
- Soak in 2% solution of Virkon Aquatic formulation for 20 minutes.
- Allow to dry in a warm, non-humid environment for at least 72 hours.

Resources

For more information including up-to-date King County infestation sites, please visit: *www.kingcounty.gov/mudsnails*

Search **"New Zealand mudsnail"** on the internet for additional information about NZMS and field gear decontamination.

Alternative formats available
206-477-9333 TTY Relay: 711

Thank you

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King County
Department of Natural Resources and Parks
Water and Land Resources Division
Science and Technical Support Section

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