14 July 2016

DND CFB ESQUIMALT F/G JETTY OPTIMIZATION PROJECT AND COLWOOD SOUTH REMEDIATION PROJECT

Environmental Management Plan

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REPORT

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Notice to Readers

This report was prepared for Canada in accordance with terms and conditions of the task authorization contract #EZ899-150978/002/PWY, dated February 16, 2015.

The inferences concerning the Site conditions contained in this report are based on information obtained during the assessment conducted by Golder personnel, and are based solely on the condition of the property at the time of the Site reconnaissance, supplemented by historical and interview information obtained by Golder, as described in this report.

This report was prepared, based in part, on information obtained from historic information sources. In evaluating the subject Site, Golder has relied in good faith on information provided. We accept no responsibility for any deficiency or inaccuracy contained in this report as a result of our reliance on the aforementioned information.

The findings and conclusions documented in this report have been prepared for the specific application to this project, and have been developed in a manner consistent with that level of care normally exercised by environmental professionals currently practicing under similar conditions in the jurisdiction.

With respect to regulatory compliance issues, regulatory statutes are subject to interpretation. These interpretations may change over time, these should be reviewed.

If new information is discovered during future work, the conclusions of this report should be re-evaluated and the report amended, as required, prior to any reliance upon the information presented herein.

Table of Contents

TABLES

FIGURES

APPENDICES

List of Abbreviations

AOA ..... Archaeological overview assessment
AIA ..... Archaeological impact assessment
BGID ..... Below-grate inlet device
BMP ..... Best management practice
CCME ..... Canadian Council of Ministers of the Environment
CEAA ..... Canadian Environmental Assessment Act
CFB ..... Canadian Forces Base
COPC ..... Contaminant of potential concern
COSEWIC ..... Committee on the Status of Endangered Wildlife in Canada
CRD ..... Capital Regional District
CSR ..... Contaminated Sites Regulation
CSRP ..... Colwood South Remediation Project
DFO ..... Fisheries and Oceans Canada
DND ..... Department of National Defence
EED ..... Environmental Effects Determination
EIR ..... Environmental incident report
EM ..... Environmental monitor
EMBC ..... Emergency Management British Columbia
EMA ..... *Environmental Management Act*
EMP ..... Environmental management plan
EPP ..... Environmental protection plan
FGOP ..... F/G Jetty Optimization Project
FSEMS ..... Formation Safety Environment Management System
H_2S ..... Hydrogen sulphide
MMO ..... Marine Mammal Observer
MOE ..... Ministry of Environment
MSDS ..... Material safety data sheet
NRAO ..... Numerical Remedial Action Objective
PAH ..... Polycyclic aromatic hydrocarbons
PCB ..... Polychlorinated biphenyl
PEL ..... Probable effects level
POD ..... Point of Discharge
PWGSC ..... Public Works and Government Services Canada
QHM ..... Queens Harbour Master
QP ..... Qualified Professional
SARA ..... *Species at Risk Act*
SEED ..... Section 67/68 Environmental Effects Determination
SEL ..... Sound exposure level
SSAP ..... Substrate Sampling and Analysis Plan
SPL ..... Sound pressure level
SQG ..... Sediment quality guideline
TBT ..... Tributyltin
TSS ..... Total suspended solids
WHMIS ..... Workplace Hazardous Materials Information System
WQMP ..... Water quality monitoring plan

List of Units

dB.....decibels
kg ..... kilograms
L ..... litres
NTU.....nephelometric turbidity units

1.0 INTRODUCTION

1.1 Overview

This Environmental Management Plan (EMP) was prepared by Golder Associates Ltd. (Golder) for Public Works and Government Services Canada (PWGSC) on behalf of the Department of National Defence (DND) for the F/G Jetty Optimization Project (FGOP) and Colwood South Remediation Project (CSRP). The EMP is based on potential environmental effects and mitigation measures identified in the *Canadian Environmental Assessment Act, 2012* (CEAA, 2012) Section 67 Environmental Effects Determination (EED) for the Projects dated July 7, 2016.

The contents of this EMP are organized as follows:

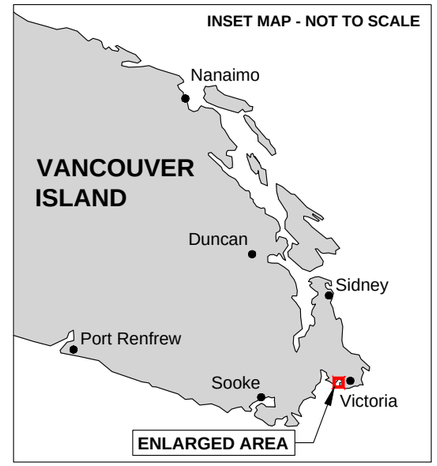
- **Section 1.0: Introduction** – Provides an overview of the Projects and the purpose and organization of the EMP.
- **Section 2.0**: **Environmental Setting** – Provides a summary of the physical, biological and social/cultural setting of the Project Areas.
- **Section 3.0**: **Roles and Responsibilities** – Describes roles, responsibilities, and reporting relationships of DND, PWGSC, the Environmental Monitor (EM), and the Contractor(s) for implementing environmental management and mitigation measures.
- **Section 4.0: Regulatory Setting** – Outlines environmental legislation, regulation, acts, and best management practices (BMPs) applicable to the work.
- **Section 5.0: Environmental Incidents** – Defines environmental incidents and outlines reporting and notification protocol to PWGSC, DND and relevant regulatory agencies.
- **Section 6.0: Environment Monitoring Program** – Describes the environmental monitoring and reporting activities that will be undertaken to assess and document that the environmental management goals set for the Projects are being met.
- **Section 7.0: Environmental Requirements** – Summarizes measures that will be undertaken for protection of environmental resources.

This EMP is intended to be read in conjunction with applicable environmental approvals, authorizations, and permits, as well as contract requirements for the Projects.

1.2 Project Description

DND, which administers Esquimalt Harbour, has implemented a remediation program in Esquimalt Harbour, as part of a long-term strategy to address sediments that have been contaminated by historical industrial activities. The remediation and risk management of sediment contamination at D Jetty (herein referred to as the "D Jetty Project Area") and between F and G Jetties (herein referred to as the "F/G Jetty Project Area") at DND Colwood in Esquimalt Harbour are the focus of these Projects (Figure 1).

KEY MAP



LEGEND

REMEDIATION FOOTPRINT

REFERENCE(S)

1. PROJECT FOOTPRINT PROVIDED BY ANCHOR QEA; DRAWING DFG Remediation Areas_20160630.dwg.
2. IMAGERY DOWNLOADED FROM SLR CONSULTING EXAVAULT; ACCESSED 2016-02-03; 2015 AIR PHOTOS, 10 cm RESOLUTION.

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PROJECT
F/G JETTY OPTIMIZATION PROJECT
AND COLWOOD SOUTH REMEDIATION PROJECT
ENVIRONMENTAL MANAGEMENT PLAN

TITLE
KEY PLAN

PROJECT NO.	PHASE	REV.	FIGURE
1657898	3000	0	1

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As a result of historical activities in Esquimalt Harbour, areas of sediment contamination exceeding the Canadian Council of Ministers of the Environment (CCME) probable effects level (PEL) sediment quality guidelines (SQGs) are present within the Project Areas (CCME 1999). The primary contaminants of potential concern (COPCs) resulting from historical activities in the harbour include arsenic, copper, lead, zinc, mercury, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins, furans and organochlorine pesticides.

Sources of historical contamination in the general vicinity of D Jetty and F/G Jetty include (Anchor 2016a):

- On-land storage and transmission of fuels to F Jetty;
- Major leaks from pipelines, including a discharge from F Jetty into the harbour (1988 – 1990);
- Transmission of oily water from F Jetty, and subsequent on-land storage and treatment of wastewater;
- Ship fueling activities at F Jetty, which may have impacted the marine environment;
- Sand blasting activities at D Jetty and disposal of sand blast residues both on land and to the marine environment; and
- Typical vessel cleaning and berthing activities at D Jetty, including vessel cleaning and material jettisoned into the harbour.

The remediation and risk management of sediment contamination for these Projects consists of the following components:

- Mobilization and demobilization;
- Structure removal, relocation and reinstatement;
- Dredging and residuals management;
- Barge dewatering;
- In-water transportation;
- Offloading, stockpiling, processing and potential treatment of contaminated sediment;
- Upland transportation and disposal; and
- Backfill and material placement.

1.2.1 Description of Proposed Project Activities

Dredging is proposed for the FGOP and the CSRP and will involve removal of seafloor debris and contaminated sediments. Previous sediment investigations identified seafloor contaminants in exceedance of CCME PEL sediment quality guidelines (Anchor 2013). Temporary increases in turbidity and total suspended solids (TSS) are anticipated for project activities such as dredging, backfill and material placement and other in-water works. The measures to mitigate temporary increases in turbidity and TSS, along with other project specific mitigation

measures are further described in a separate *Canadian Environmental Assessment Act, 2012* (CEAA, 2012) Section 67 EED report. Removal of contaminated sediment will result in an overall improvement to benthic habitat. The most current engineering design for dredging, available at the time of preparation of this habitat offsetting review, is provided in the draft 100% design specification report developed by Anchor (2016a).

1.2.1.1 Mobilization and Demobilization

Mobilization activities proposed for the FGOP and CSRP include establishment of office facilities onsite and other temporary structures. Materials and equipment staging is proposed to be on-site, in an area such as the gravel parking area at the DND Colwood, at an upland location, or on barges within the F/G Jetty and D Jetty Project Areas. The staging area will be identified prior to work commencement and use will be limited to parking, office space, equipment staging and loading and unloading purposes only. No stockpiling or storage of dredged sediment or debris will occur at the staging area without written approval from the Departmental Representative. Demobilization activities include dismantling and removing all temporary facilities, clean-up of the F/G Jetty work site and any contractor off-site offload facility (Anchor 2016a).

Mobilization for the CSRP will be limited to the establishment of site offices, storage and other temporary facilities at the onsite staging area on D Jetty. Demobilization activities includes dismantling and removing all temporary facilities, clean-up of the D Jetty work site and if applicable, the contractor off-site offload facility (Anchor 2016a).

1.2.1.2 Structure Removal, Relocation and Reinstatement

Prior to dredging the utilities associated with the gas float and associated structures located within the F/G Jetty Project Area will be disconnected and the structures will be removed. Existing timber pilings will be removed using vibratory methods and after extraction, sediment and other objects attached to the surface of these piles will be cleaned off within the dredge area. Demolished structures will be disposed off-site or temporarily relocated to an identified area off-site (to be determined) until dredging is complete. Structures will be reinstalled in their existing locations and configurations. In the event the timber pilings are damaged upon removal, new timber pilings will be installed. It is expected that 50% of the pilings removed may require replacement due to damage from degradation and/or extraction. Pile driving and removal will be conducted using marine based floating equipment. Pile installation will occur using vibratory pile driving methods or an alternative equivalent method if submitted to the Departmental Representative for review (Anchor 2016a).

Structure removal proposed for the D Jetty Project Area includes removal of floating camel/tire fenders and attachments, wharf safety ladders and attachments, and miscellaneous jetty attachments and components. These structures will be removed prior to dredging and where possible will be salvaged, cleaned, stored off-site and replaced once dredging is complete. Structures that are deemed unsuitable for reinstatement will be disposed off-site. Removal of pilings associated with the fender system on the north side of D jetty is also proposed to facilitate dredging closer to the structure and backfill and material placement under the jetty. Pilings will be removed using vibratory methods. Where possible, pilings will be salvaged, cleaned, stored off site and reinstalled once dredging activities are complete. Pilings that are deemed unsuitable for reinstatement will be replaced with new timber piles of equivalent dimensions. Pile driving is proposed using marine/ barge-based floating equipment. Pile installation will occur using vibratory pile driving or impact pile driving methods (Anchor 2016a).

1.2.1.3 Dredging and Residuals Management

Dredging and re-dredging of targeted dredge pockets may be required to adequately remove contaminants and/or residuals from the F/G Project Area. The proposed dredge area for the FGOP includes 5,600 m^2 with a dredge volume of 10,100 m^3. The proposed F/G Jetty dredge area contacts approximately 35 m of shoreline and extends offshore to a depth of -6.5 m chart datum (CD). Dredging rock outcrops is not considered feasible and is not required to meet remedial objectives. Dredging will be undertaken using mechanical dredging methods and dredged material and debris will be placed on a barge in preparation for disposal (Anchor 2016a).

A preliminary dredge area of 7,700 m^2 with a dredge volume of 14,300 m^3 has been identified for the CSRP and extends offshore to a depth of approximately -12 m chart datum. No dredging will occur under D Jetty, and a dredge offset area around the jetty will be established. Dredging will be undertaken using a bucket type and size of the Contractor's choosing provided that water quality requirements of the EMP and permit conditions are met (Anchor 2016a).

1.2.1.4 Barge Dewatering

No passive dewatering will be permitted in Dredge Units (DUs) 4 and 5 on the north side of D-Jetty based on water quality modelling undertaken for the Projects. For the remainder of the DUs at D Jetty and at F/G Jetty, passive dewatering will occur. Dewatering will occur on the work site using filter media, such as filter fabric, to remove suspended solids from any barge effluent discharge with a discharge limit of 75 mg/L. The contractor shall collect, store, treat as necessary and discharge of effluent from barges in a manner that meets the water quality requirements of the EMP. Passive barge dewatering is proposed only within the remediation area boundaries (Anchor 2016a).

1.2.1.5 In-Water Transportation

Contaminated materials shall be transported from the worksite to the contractor's off-site offloading and processing facility using barges. Haul barges must be watertight to prevent passive dewatering of dredged sediment during in water transportation (Anchor 2016a).

1.2.1.6 Offloading, Stockpiling, Processing and Potential Treatment of Contaminated Sediment

Offloading of dredged sediments and debris is expected to occur at a staging area within the contractor's designated off-site offloading and processing facility. Dredged sediments and debris will be offloaded at an off-site offload facility determined by the contractor. It is expected that the offloading will occur directly from the material barge onto a staging area within the contractor off-site offload facility, where material will be processed (Anchor 2016a). Dredged sediment will be processed at a processing facility at the contractor off-site offloading and processing facility to segregate suspected explosive items and explosives of concern and to monitor for antiquities. Processed sediment has the potential to be reloaded onto a barge and shipped to a different upland area for disposal.

1.2.1.7 Upland Transportation and Disposal

Equipment used for activities occurring upland, at the contractor's off-site offloading and processing facility, will be decontaminated after working in potentially contaminated work areas and prior to subsequent work and will be transported by truck or rail for disposal. Wastewater generated from upland equipment decontamination activities shall be contained, sampled and disposed of in accordance with federal, provincial and municipal regulations (Anchor 2016a).

1.2.1.8 Backfill and Material Placement

Following the completion of the dredging activities at F/G Jetty, backfill material will be placed to match pre-construction elevations and grades. Structural backfill will be placed for gas float structures prior to pile reinstatement. General backfill and surface backfill will be placed in areas to restore the seabed elevation to the pre-dredge bed elevation. Compaction of backfill after placement is not required (Anchor 2016a).

Once dredging activities at D Jetty are complete backfill will be placed in the dredge prism footprint. Structural backfill for the fender system will be placed prior to reinstatement of the fender piling system. Substrate cover will be placed in underpier areas. A residuals management cover (RMC) is proposed for the remainder of the dredge area (Anchor 2016a).

1.2.2 Project Areas

The Project Areas for the purposes of this EMP includes the on-site upland staging areas, dredging areas, material placement areas, upland offloading and processing facility (location to be determined), waters in between the dredging areas and upland offloading areas where vessels will travel (route to be determined), the processing facility (location to be determined), the treatment facility (location to be determined if needed) and the transportation route from the upland offloading and processing facility to the disposal facility (route and location to be determined).

The upland staging areas, dredging areas and material placement areas for the D Jetty Project and the F/G Jetty Project are shown in Figure 2. The upland staging areas will be onsite at DND Colwood. The contractor upland offloading and processing facility is defined as the contractor-provided off-site upland site where contaminated sediment and debris that has been generated from the work site is offloaded, stockpiled (if applicable), dewatered, rehandled, and transferred onto trucks or rail cars (if rail access is available) for disposal at a disposal facility (Anchor 2016a). The contractor off-site offloading and processing facility will be selected by the contractor.

LEGEND

- REMEDIATION FOOTPRINT
- ON-SITE UPLAND STAGING AREA

NOTE(S)

1. SURFACE CONTOURS SHOWN IN 1 m (MINOR) AND 5 m (MAJOR) INTERVALS. ELEVATIONS SHOWN RELATIVE TO CHART DATUM.

REFERENCE(S)

1. PROJECT FOOTPRINT PROVIDED BY ANCHOR QEA; DRAWING DFG Remediation Areas_20160630.dwg
2. IMAGERY DOWNLOADED FROM SLR CONSULTING EXAVAULT; ACCESSED 2016-02-03; 2015 AIR PHOTOS, 10 cm RESOLUTION.
3. SURFACE CONTOURS EXTRACTED FROM DIGITAL DATA DOWNLOADED FROM SLR CONSULTING'S EXAVAULT ESQUIMALT HARBOUR REMEDIATION PROJECT FTP SITE. ACCESSED 2016-03-03.
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   - 3.2. UPLAND: FILENAME: "COL_ENV.DWG" SURFACE CONTOURS ADJUSTED TO CHART DATUM USING A CONVERSION VALUE OF 1.885 m.

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PROJECT
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TITLE
SITE PLAN

PROJECT NO.	PHASE	REV.	FIGURE
1657898	3000	0	2

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1.3 Objective of the EMP

The overall objective of the EMP is to provide a framework through which potential environmental effects will be managed during implementation of the Projects. Specifically, the EMP identifies:

- Regulatory obligations that will govern implementation of the Projects.
- Roles and responsibilities of DND, PWGSC, the Environmental Monitor (EM), and the Contractor(s) that will undertake the work.
- Mitigation measures, BMPs, established protocols, and measurable environmental requirements that will be applied to these Projects.
- Monitoring plans to be undertaken to verify that the work is carried out in accordance with regulatory and contractual obligations, and to document DND's exercise of due diligence.

The EMP addresses project effects identified in the EED report (Golder 2016a), as well as those identified through subsequent engineering design, and allows for a process of continuous improvement and adaptive management if additional effects are identified as the Projects progress.

In the event of a discrepancy between the EMP and the provisions of any legislation, regulations, or municipal bylaws, the more stringent provisions resulting in the higher protection of the environment, the lower discharge of contaminants, and the higher degree of environmental protection and safety will prevail.

1.4 Water Quality Monitoring Plan (WQMP)

A Water Quality Monitoring Plan (WQMP) has been developed (Appendix A) and will be implemented during the Projects to verify water quality predictions for dredging and discharge of barge dewatering effluent, and to provide a feedback mechanism for implementing management actions. Specifically, the WQMP:

- Outlines the scope of monitoring that will be undertaken during project activities.
- Identifies appropriate parameters and assessment criteria.
- Presents decision criteria and high-level management actions.
- Presents data compilation and quality assurance/quality control (QA/QC) measures.
- Provides reporting procedures for the water quality monitoring program.

1.5 Environmental Protection Plan (EPP)

Prior to the commencement of the Projects, the Contractor will prepare an Environmental Protection Plan (EPP) that demonstrates how they will satisfy the requirements set out in this EMP. The Contractor will retain a Qualified Environmental Professional to prepare the EPP. The EPP will include the following information:

- Organization chart and names of persons responsible for EPP implementation and compliance.
- Training requirements.
- Site and activity-specific measures that will be implemented, equipment that will be used, and maintenance that will be undertaken.
- Contingency procedures in the event that environmental protection goals are not being met.
- Drawings, for example, showing work and storage areas.

The EPP will include, at a minimum, the following component plans:

- Dust and Emissions Control Plan.
- Spill Prevention and Response Plan.
- Water Quality Protection Plan.
- Stormwater Pollution Prevention Plan.
- Silt Curtain Control Plan.
- Sediment and Erosion Control Plan.
- Substrate Sampling and Analysis Plan.
- In-Air Noise, Light and Odour Plan.
- Non-Hazardous Waste Storage and Disposal Plan.
- Hazardous Materials Storage and Disposal Plan.

The EPP will be part of submissions by the contractor and will be reviewed by PWGSC/DND to make sure it meets the intent of the EMP. The contractor will address any deficiencies in the EPP.

2.0 ENVIRONMENTAL SETTING

This section provides a summary of the environmental resources in and adjacent to the Project Areas. A more detailed description is provided in the EED report (Golder 2016a).

2.1 Physical

Esquimalt Harbour is a sheltered body of water that covers an area of 3.38 km^2 and with 15 km of shoreline. The harbour entrance, Royal Roads passage, connects to the Strait of Juan de Fuca. Esquimalt Harbour lies in the Coastal Douglas Fir Biogeoclimatic Zone which experiences warm dry summers and mild wet winters (Nuszdorfer *et. al.* 1991). Based on Canadian Tide and Current Tables, Esquimalt Harbour's mean tide is 1.8 m (relative to chart datum) with a reported large tide of 3.1 m.

TSS and turbidity measurements collected in Esquimalt Harbour over a two month period (October to December 2010) indicate that Esquimalt is relatively clear (i.e. turbidity was less than 6.4 NTU for 95% of the measurements collected), although turbidity spikes of up to 400 NTU may occur possibly related to vessel prop-wash and wind and wave events (Golder 2011).

Subtidal habitat within the F/G Jetty area contained a mix of soft sediment, mixed substrate and boulder/bedrock. The nearshore portion of the proposed dredge boundary was characterized by intertidal bedrock, boulder and riprap substrate with three pockets of intertidal cobble, gravel and sand substrate. The intertidal area transitioned to either subtidal cobble, gravel and sand or sand, silt and mud substrate. At the northern portion of the proposed dredge boundary, subtidal sand, silt and mud substrate transitioned to cobble, gravel and sand substrate and bedrock, boulder and riprap substrate. Boulder substrate was documented nearshore, within the proposed Project Area and a rocky area was documented near the northern extent of the F/G Project Area (Figure 3). Shell and wood debris was observed in nearshore areas, primarily in the area of the gasoline float and approach structure (Balanced 2012a; Golder 2016a).

Subtidal habitat within the D Jetty area consisted of soft sediment with areas of mixed coarse substrate (Anchor 2016b, Anchor 2016c, Klohn Crippen Berger 2016; Golder 2016a); boulder substrate was observed outside but adjacent to the D Jetty Project Area along the D Jetty wall. The area under the jetty was primarily composed of subtidal cobble, gravel and sand substrate which continued from the jetty in some patches and transitioned to subtidal sand, silt and mud substrate further offshore. Shell and wood debris were abundant in a few small patches (<5 m2) throughout the survey area. Anthropogenic debris (e.g. metal, rope) was observed near the jetty within the survey area (Golder 2016a).

2.2 Biological

There was an overall low diversity and abundance of macroalgae throughout the Project Areas (Golder 2016b), which is likely a result of the time of year when the surveys were conducted. Macroalgae are generally more productive during the spring and summer seasons than during the winter and these surveys likely did not capture the full extent of macroalgae abundance and distribution. No evidence of canopy-forming kelps (e.g. bull kelp [*Nereocystis luetkeana*]) were found within the Project Areas during the habitat surveys (Golder 2016b). Encrusting coralline (*Lithothamnion* sp.) algae was the dominant taxa (75 to 100%) within subtidal rocky habitat at D Jetty.

The dominant taxa within the intertidal zone at F/G Jetty was rockweed (*Fucus* sp.), which occurs at 25 to 50% areal cover (Golder 2016b).

In general, hard substrates (boulder/bedrock/riprap) contained the greatest abundance and diversity of invertebrate species compared to mixed and soft sediment substrates (Balanced 2012a,b; Golder 2016b). Motile invertebrates were generally more abundant on mixed and soft sediment substrates while sessile invertebrates were more abundant on hard substrates. Adjacent to the D Jetty Project Area, northern abalone, a SARA schedule 1 threatened species, was observed within boulder habitat beneath the Jetty in the shallow subtidal zone ranging from 1.0 to 2.5 m below chart datum. Suitable abalone habitat adjacent to the D Jetty Project Area was mapped parallel to the east side of the jetty structure and consisted primarily of boulder habitat covering an estimated area of 241 m^2 (Figure 3).

Fish species observed in the Project Areas include: juvenile rockfish (*Sebastes* sp.), juvenile Pacific herring (*Clupea pallasi*), longfin sculpin (*Jordania zonope*), mosshead scuplin (*Clinocottus globiceps*), pile perch, copper rockfish (*Sebastes caurinus*), rock prickleback (*Xiphister mucosus*), kelp greenling, pile perch, rock sole, and unidentified sculpins. Pacific herring have historically spawned in areas of Esquimalt Harbour including the shoreline around the Project Areas. Millstream Creek flows into the northwest portion of Esquimalt Harbour and is known to have contained the following anadromous species: coho salmon (*Oncorhynchus kisutch*), anadromous coastal cutthroat trout (*O. clarkii clarkii*) and steelhead (anadromous rainbow trout) (*O. mykiss*). Mapster salmon escapement data indicated coho salmon were present in 2007 when the stream was last inspected (DFO 2016b). The last record for anadromous cutthroat trout was in 1977 and the last record for steelhead was in 1994 (MOE 2016); therefore, it is unknown if these species still exist in Millstream Creek.

Pacific herring may also spawn, incubate and rear in the CSRP and FGOP in-water work areas. DFO's herring spawning map for Section 193 indicate that herring have spawned in Esquimalt Harbour and in the vicinity of the CSRP and FGOP in-water work areas (Golder 2016a [Annex E]) (DFO 2015). Cumulative spawning in the vicinity of the CSRP and FGOP in-water work areas is classified as a 'low' (DFO 2015). The last spawning event in the vicinity of the CSRP and FGOP in-water work areas was recorded in 1993 according to the text version of the spawning records (DFO 2015).

Aquatic mammals that may occur in or adjacent to the D Jetty and F/G Jetty Project Areas include harbour seal (*Phoca vitulina richardsi*), California sea lions (*Zalophus californianus*) Steller sea lions (*Eumetopias jubatus*), resident and transient killer whales (*Orcinus orca*), harbour porpoise (*Phocoena phocoena*) and dall's porpoise (Phocoenoides dalli). Harbour seals were observed on several occasions within the Project Areas during habitat surveys in 2016. California sea lions and Steller sea lions have been observed in Esquimalt Harbour, although their occurrence in these waters is considered rare. Steller sea lions are a SARA schedule 1 species of special concern. Killer whales are known to infrequently occur in Esquimalt Harbour. No killer whales were observed in Esquimalt Harbour during Golder field surveys in 2016; however, pods of two to three killer whales were observed within Esquimalt Harbour by Queen's Harbour Master staff in January 2014 and September 2013 (QHM pers. comm. with DND, 2014; Golder 2016b [Annex A]). Southern resident killer whales are a SARA schedule 1 endangered species. Transient killer whales are listed under SARA schedule 1 as threatened. Harbour porpoises are listed under SARA schedule 1 as special concern.

Various migratory and non-migratory bird species may forage in and adjacent to the Project Areas including geese, swans, ducks, loons, cormorants, great blue heron (*Ardea herodias fannini)*, bald eagle (*Haliaeetus leucocephalus)*, peregrine falcon (*Falco peregrinus anatum* or *Falco peregrinus pealei*), gulls and kingfishers (Golder 2016a). Listed bird species that may forage in the Project Areas are outlined in Table 1 in Appendix B. Birds that may nest in and adjacent to the Project Areas include ospreys *(Pandion haliaetus*) and barn swallows (*Hirundo rustica*). Osprey nests are known to occur adjacent to the Project Areas. Two osprey nests have been documented at DND Colwood within 100 m of the Project Areas: one adjacent to D Jetty and one near the F/G Jetty Project Area (pers. comm. Tracy Cornforth, June 21, 2016). The location of these nests are displayed on Figure 3. The nest near D Jetty was occupied in 2014, but the one near the F/G Jetty Project Area was a relocated nest and has never been occupied (pers. comm. Tracy Cornforth June 21, 2016). Osprey nests are protected year round, and nesting ospreys are protected from “molestation” under the provincial *Wildlife Act*. Barn swallows, a COSEWIC threatened species and a migratory bird under the *Migratory Birds Convention Act*, may nest under jetties within the Project Areas.

LEGEND

- REMEDIATION FOOTPRINT
- ON-SITE STAGING AREA
- BOULDER/BEDROCK/RIPRAP
- BOULDER

MAPPED HABITAT:

- ABALONE
- OSPREY NEST

REFERENCE(S)

1. PROJECT FOOTPRINT PROVIDED BY ANCHOR QEA; DRAWING DFG Remediation Areas_20160630.dwg.
2. IMAGERY DOWNLOADED FROM SLR CONSULTING EXAVAULT; ACCESSED 2016-02-03; 2015 AIR PHOTOS, 10 cm RESOLUTION.

0 50 100
1:3,000 METRES

CLIENT
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

CONSULTANT
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YYYY-MM-DD	2016-07-07
DESIGNED	V. LAWRENCE
PREPARED	R. WIGGINS
REVIEWED	V. LAWRENCE
APPROVED	B. WERNICK

PROJECT
F/G JETTY OPTIMIZATION PROJECT
AND COLWOOD SOUTH REMEDIATION PROJECT
ENVIRONMENTAL MANAGEMENT PLAN

TITLE
ENVIRONMENTAL FEATURES

PROJECT NO.	PHASE	REV.	FIGURE
1657898	3000	0	3

2.3 Social and Cultural

Esquimalt Harbour is administered by DND and is governed by the *Canada Marine Act*, the Natural and Man Made Harbour Navigation and Use Regulations (pursuant to the *Canada Marine Act*), and Esquimalt Harbour - Practices and Procedures (DND 2016). The harbour is open to the public within the limitations set out in an Order in Council regarding Controlled Access Zones that provide for security zones around warships berthed or moving in the harbour. Vessels entering or departing Esquimalt Harbour are requested to contact Queens Harbour Master (QHM) Operations (DND 2010).

Four types of vessels enter and exit Esquimalt Harbour, including naval ships accessing DND Jetties, commercial traffic accessing the Esquimalt Graving dock, pleasure craft of all sizes, and recreational and commercial crab harvesting vessels (Golder 2016a).

Crab harvesting is only allowed outside of the controlled access zones and water lease areas. Fishing is not permitted in the harbour (QHM, pers comm. 2016). Anchoring is prohibited anywhere in the harbour except in the northern most part of the Inner Harbour. Ships at anchor must register with QHM Operations and cannot remain at anchor for longer than two weeks.

Esquimalt Harbour is surrounded by three Municipalities, the City of Colwood (Colwood), the Town of View Royal (View Royal), and the Township of Esquimalt (Esquimalt). The Project Areas are located adjacent to Colwood.

The Projects are located within the traditional territories of the Songhees Nation and Esquimalt Nation. Under the Douglas Treaty, the Esquimalt and Songhees Nations have fishing and hunting rights which are practiced in Esquimalt Harbour (INAC 2016a,b). In meetings with DND, First Nations have indicated that they have ongoing subsistence and cultural uses in the harbour. Both the Esquimalt and Songhees Nations assert Aboriginal rights and interests within the harbour area.

Both First Nations are concerned with the treatment of archaeological resources in the region, including ancestral remains which are often present in sites in this area.

There are no recorded precontact archaeological sites located within these Project Areas; however, the precontact archaeological site DcRu-136 is located immediately adjacent to the F/G Jetty Project Area (Golder 2015, Golder 2016c) (Figure 4). In addition, the archaeological overview assessment determined that there were locations with potential to contain undocumented precontact archaeological sites and heritage wrecks within the F/G Jetty Project Area, including along formerly exposed surfaces of seabed which have been inundated by post-glacial sea-level change (Figure 4).

LEGEND

- REMEDIATION FOOTPRINT (JUNE, 2016)
- DREDGE UNITS (JUNE, 2016)
- FORMER REMEDIATION FOOTPRINT
- ARCHAEOLOGICAL SITE DcRu-136
- AREA OF ARCHAEOLOGICAL POTENTIAL

NOTE(S)

1. SURFACE CONTOURS SHOWN IN 1 m (MINOR) AND 5 m (MAJOR) INTERVALS. ELEVATIONS SHOWN RELATIVE TO CHART DATUM.

REFERENCE(S)

1. PROJECT FOOTPRINT PROVIDED BY ANCHOR QEA; DRAWING "DFG Remediation Areas_20160630.dwg."
2. IMAGERY DOWNLOADED FROM SLR CONSULTING EXAVAULT; ACCESSED 2016-02-03; 2015 AIR PHOTOS, 10 cm RESOLUTION.
3. FORMER PROJECT FOOTPRINT PROVIDED BY ANCHOR QEA: DRAWING EH_DUs_20140110.DWG.
4. SURFACE CONTOURS EXTRACTED FROM DIGITAL DATA DOWNLOADED FROM SLR CONSULTING'S EXAVAULT ESQUIMALT HARBOUR REMEDIATION PROJECT FTP SITE. ACCESSED 2016-03-03.
   - 4.1. BATHYMETRY: FILENAME: "COLWOOD_15031.TIF". THE SURFACE WAS USED AS-IS.
   - 4.2. UPLAND: FILENAME: "COL_ENV.DWG" SURFACE CONTOURS ADJUSTED TO CHART DATUM USING A CONVERSION VALUE OF 1.885 m.
5. DcRu-136 SITE BOUNDARY OBTAINED FROM REMOTE ACCESS TO ARCHAEOLOGICAL DATA (RAAD).
6. AOA REPORT: GOLDER. 2015. ARCHAEOLOGICAL OVERVIEW ASSESSMENT OF SIX PROPOSED REMEDIAL DREDGING AREAS IN ESQUIMALT HARBOUR, CFB ESQUIMALT, ESQUIMALT, BC. FINAL REPORT PREPARED FOR DCC, MARCH 31, 2015.

0 25 50
1:750 METRES

CLIENT
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-07-07
DESIGNED	C. MOORE
PREPARED	R. WIGGINS
REVIEWED	C. MOORE
APPROVED	B. WERNICK

PROJECT
F/G JETTY OPTIMIZATION PROJECT
AND COLWOOD SOUTH REMEDIATION PROJECT
ENVIRONMENTAL MANAGEMENT PLAN

TITLE
ARCHAEOLOGICAL POTENTIAL

PROJECT NO.	PHASE	REV.	FIGURE
1657898	3000	0	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\gal\Victoria\CAD-GIS\Client\PWGSC\esquimalt_harbour\09_projects\1545562_marinehabitat\02_PRODUCTION\3000_EMP\DWGs | File Name: 1657898-3000-EMP-54.dwg

3.0 ROLES AND RESPONSIBILITIES

This section describes the roles and responsibilities of DND, PWGSC, the EM, and the Contractor for implementing, inspecting, and reporting on the effectiveness of the environmental mitigation measures. The team organization and communication structure is illustrated in Figure 5.

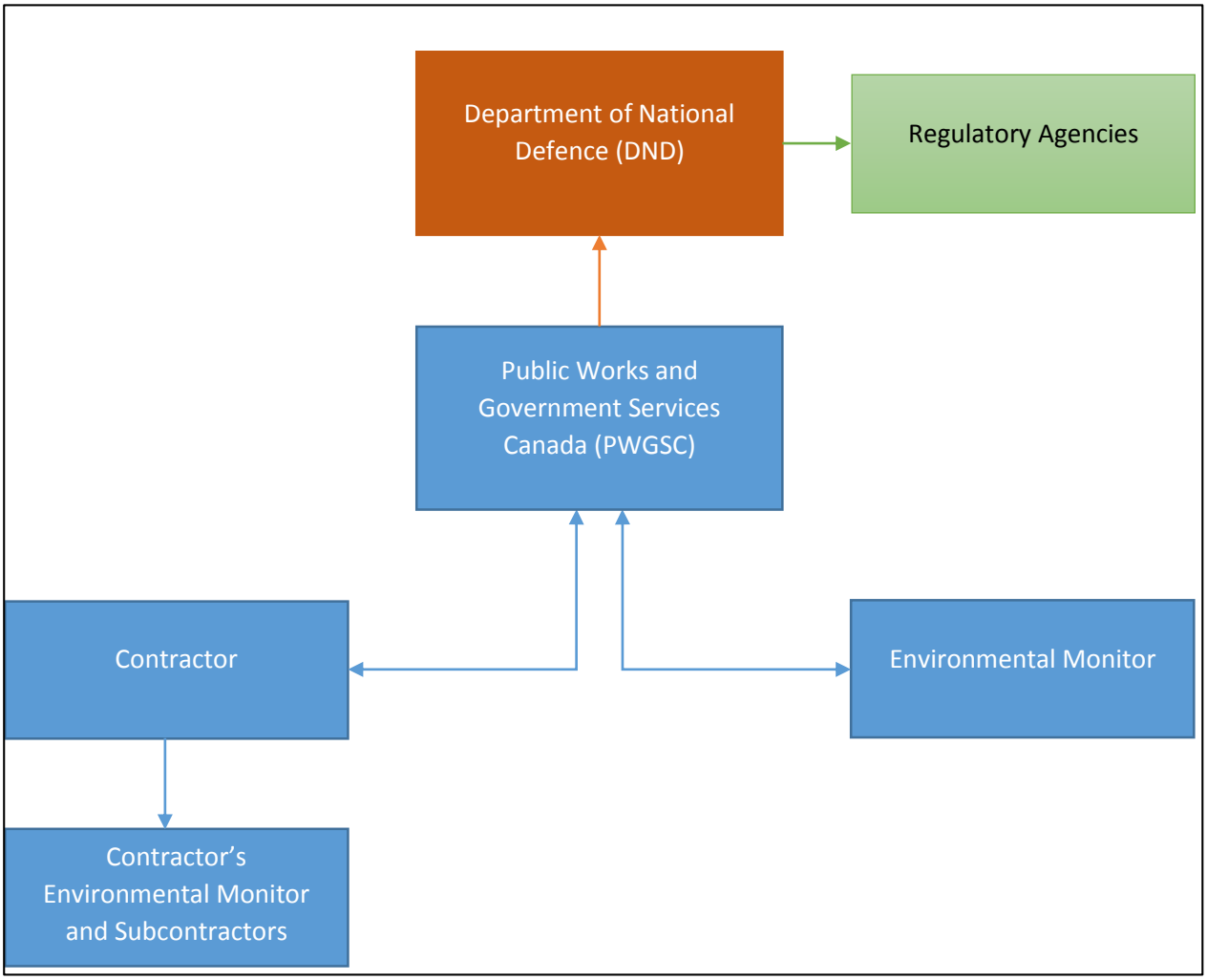

Figure 5: Project Environmental Team Organizational and Communication Structure

3.1 Department of National Defence (DND)

DND is the proponent of the Projects and is the overall authority. DND is responsible for the overall compliance with federal and provincial legislation. All communications with DND are to go through PWGSC. All communications with outside regulatory agencies are to go through DND.

3.2 Public Works and Government Services Canada (PWGSC)

PWGSC is DND's representative for the Projects, and is responsible for day to day compliance with environmental mitigation measures, permits, approvals, and authorizations. The Contractor(s) and EM will communicate with PWGSC about environmental aspects of the Projects. All communications to DND will go through PWGSC.

3.3 Contractor(s)

The Contractor(s) will be responsible for the actions of its agents, employees, and subcontractors, and thus will undertake all reasonable actions to have environmental protection measures in place and working effectively throughout the Project Areas. The contractor(s) will:

- Adhere to requirements set out in regulatory authorizations, approvals and permits, and contract requirements, including this EMP.
- Undertake effective communication with work crews and subcontractors such that environmental responsibilities and requirements are understood prior to the commencement of work, and are implemented during the work. This will include disseminating information from orientation and other meetings to personnel not in attendance at those meetings.
- Retain an environmental specialist with appropriate skills to prepare the EPP(s) and evaluate performance against the requirements outlined in regulatory approvals, authorizations, and permits, as well as environmental protection goals provided in this EMP and the contract requirements.
- Use equipment and implement work procedures and controls to prevent and/or reduce work-related disturbance to environmental, social, heritage, archaeological, and cultural resources.
- Take preventative and corrective measures in response to non-conformance with regulatory permits and approvals, the contract requirements including this EMP.
- Immediately respond to emergencies and incidents (defined in Section 5.0).

3.4 Environmental Monitor(s)

PWGSC will retain an EM to confirm that environmental management measures and controls are implemented in accordance with regulatory approvals, authorizations and permits, environmental components of the contract requirements, including this EMP, and the EPP prepared by the Contractor. Environmental monitoring tasks will be conducted by or under the supervision of a Qualified Professional (QP). For the purposes of this EMP, a QP is defined[1] as an applied scientist specializing in the area of biology, who:

- Is registered in British Columbia with an appropriate professional organization; and
- Through suitable education, experience, accreditation and knowledge, may reasonably be relied upon to provide advice regarding environmental management of the Projects.

It is anticipated that various personnel will be necessary to undertake different monitoring components for the Projects (e.g. surface water quality, marine mammal, and archaeological monitoring) and the experience of the personnel used should reflect those needs. The environmental monitoring program for these Projects is outlined in Section 6.0.

[1] The definition of a QP is adapted from the Municipal Wastewater Regulation (pursuant to the BC *Environmental Management Act*).

4.0 REGULATORY SETTING

This section provides a summary of federal and provincial environmental legislation and municipal (current to June 2016). This legislation provides the framework for the procedures described in Section 7.0 of this EMP. This section is not necessarily exhaustive or all inclusive; it is the Contractor's responsibility to understand the regulatory context governing their activities and to act accordingly. Should clarification of any environmental issue be required, the Contractor should consult the original regulation or legislative document.

4.1 Selected Federal Legislation

The following is a list of selected federal laws, acts and regulations that apply or may apply to the Projects.

Legislation	Application to the Projects	Authorization, Approval or Permit Issued
Canadian Environmental Assessment Act, 2012	These Projects as proposed are not a CEAA 2012 "designated project" and an environmental assessment as described in CEAA 2012 is not required; however, these Projects are located on federal land and meets the definition of a project under Section 66 of CEAA (2012).	A CEAA Section 67 Environmental Effects Determination (EED) report has been prepared for these Projects.
Navigation Protection Act	Regulates and protects all navigable waters in Canada, this includes any navigable water included on the List of Scheduled Waters within the *Navigation Protection Act* which includes Esquimalt Harbour. No work will be built or placed in, on, over, under, through or across any navigable water unless approved or exempted under this act.	DND to provide information on discussions with Transport Canada. Notice to the Minister not required as works are classified as "designated works" under the *Navigation Protection Act*
Fisheries Act (1985, amended 2013)	Section 35 – Prohibits causing serious harm to fish that are part of or support a commercial, recreational or Aboriginal fishery unless the activity is authorized under the Act.	Mitigation measures will be implemented to avoid causing serious harm.
Fisheries Act (1985, amended 2013)	Section 36 - Prohibits the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water. Performance objectives have been developed in the WQMP (Appendix A) to help meet the intent of this section.	General prohibition – no authorization issued.
	Section 38(4) – Duty to notify an inspector, fishery officer or prescribed authority, of an occurrence that results in serious harm to fish not authorized under the Act, or a serious and imminent danger of such an occurrence. Section 38(5) – Duty to notify to an inspector, fishery officer or prescribed authority, of the deposit or imminent danger of deposit, of a deleterious substance in waters frequented by fish, and detriment to fish habitat or fish or to the use by humans of fish results or may reasonably be expected to result from the occurrence.	General provisions – no authorization issued

Legislation	Application to the Projects	Authorization, Approval or Permit Issued
	Section 38(6) – Duty to take all reasonable measures consistent with public safety and with the conservation and protection of fish and fish habitat to prevent any occurrence referred to in subsection (4) or (5) or to counteract, mitigate or remedy any adverse effects that result or may reasonably be expected to result from the occurrence. The *Deposit out of the Normal Course of Events Notification Regulations* specify the BC Provincial Emergency Program, now called Emergency Management BC (EMBC), as the 24-hr emergency telephone service for notification. The reportable levels specified in the provincial *Spill Reporting Regulation* pursuant to the *Environmental Management Act* do not necessarily define a "deleterious substance". The requirements of these sections are to be considered in the development of a spill response plan.	
Marine Mammal Regulations (2011) (pursuant to the *Fisheries Act*)	Section 7 – Prohibits the disturbance of marine mammals except when fishing for marine mammals under the authority of these Regulations. Section 10 – Requires a person who kills or wounds a marine mammal to make a reasonable effort to retrieve the animal and prohibits abandoning the animal. Marine mammals may occur in and adjacent to the Project Areas.	General prohibition – no authorization issued.
Species at Risk Act	SARA contains prohibitions that make it an offence to: ▪ kill, harm, harass, capture, or take an individual of a species listed in Schedule 1 of SARA as endangered, threatened or extirpated; ▪ possess, collect, buy, sell or trade an individual of a species listed in Schedule 1 of SARA as endangered, threatened or extirpated; ▪ damage or destroy the residence (e.g. nest or den) of one or more individuals of a species listed in Schedule 1 of SARA as endangered, threatened or extirpated, if a recovery strategy has recommended the reintroduction of that extirpated species. Applicable species known to occur adjacent to the Project Areas include the northern abalone.	Mitigation measures will be followed to avoid contravening the act.
Migratory Birds Convention Act (MBCA)	Section 5.1/ 5.2 – Prohibits the deposit by a person or vessel of a substance, or combination of substances, that is harmful to migratory birds, in waters or an area frequented by migratory birds, or in a place from which the substance may enter such waters or area. Migratory birds may forage in the Project Areas.	General prohibition – no authorization issued.
Migratory Birds Regulations (pursuant to the MBCA)	Section 6 – Prohibits the disturbance, destruction or removal of a nest or related shelter, or egg of a migratory bird, or possession of a live migratory bird, or a carcass, nest or egg of a migratory bird. Barn swallows may nest under structures to be removed in the Project Areas.	General prohibition – no authorization issued.
Canadian Environmental Protection Act, 1999	The Act is aimed at preventing pollution and protecting the environment and human health, including the prohibition of the disposal of wastes and other matter at sea within Canadian	The dredged material has not been evaluated for disposal at sea and is

Legislation	Application to the Projects	Authorization, Approval or Permit Issued
(CEPA)	jurisdiction unless the disposal is permitted with conditions issued by the Minister, such as the "Disposal at Sea Regulations".	expected to be disposed of at a suitable upland facility.
Canada Marine Act	The Act establishes the means of management of ports and harbour facilities such as through the establishment of ports and harbour authorities. The Queen's Harbour Master is the designated Authority for Esquimalt Harbour.	General provisions – no authorization issued.
Canada Shipping Act	Promotes safety in marine transportation and recreational boating; protects the marine environment from damage due to navigation and shipping activities; and through the "Collision Regulations" prescribes regulations for vessels on or in any Canadian waterway.	General provisions – no authorization issued.
Transportation of Dangerous Goods Act	Regulates the transport of all dangerous goods in Canada, whether by rail, road, air, or water, and establishes safety standards and documentation to be complied with such that all containers, packages, and means of transport are clearly marked with prescribed safety marks. The Act also establishes requirements regarding emergency response assistance plans. Any hazardous materials associated with the Projects will be transported in accordance with this *Act*.	General provisions – no authorization issued.

4.2 Applicable Provincial Legislation

The following is a list of selected provincial laws, acts and regulations that apply or may apply to the Projects.

Legislation	Application to the Projects	Authorization, Approval or Permit Issued*
Wildlife Act	Section 34 - A person commits an offence if the person, except as provided by regulation, possesses, takes, injures, molests or destroys: (a) a bird or its egg, (b) the nest of an eagle, peregrine falcon, gyrfalcon, osprey, heron or burrowing owl, or (c) the nest of a bird not referred to in paragraph (b) when the nest is occupied by a bird or its egg. Several osprey nests are located adjacent to the Project Areas. Loud noises from equipment may be considered 'molestation' if this causes the birds to abandon active nests. Barn swallows may nest under structures to be removed in the Project Areas.	General prohibition – no authorization issued.
Environmental Management Act (EMA)	Prohibition against the introduction of waste into the environment in such a manner or quantity as to cause pollution, unless the introduction of that waste is conducted in accordance with a permit, approval, order, or regulation. EMA also prohibits causing pollution which is defined in the Act as "…the presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment."	General prohibition – no permit or approval for dredging. A permit or authorization is required for the discharge of waste (effluent) from

Legislation	Application to the Projects	Authorization, Approval or Permit Issued*
	Dredging is not included as a prescribed activity per the Waste Discharge Regulation; an effluent permit is not required for the dredging or barge dewatering activities. This general prohibition is addressed by the water quality protection measures developed for the Projects as outlined in the WQMP (Appendix A). Upland processing facilities for these Projects would be considered "contaminated sites contaminant management activities" per Schedule 1 of the regulation and therefore would require an authorization if the activity includes discharges of waste to the environment (e.g. effluent).	upland processing facilities.
Hazardous Waste Regulation (pursuant to EMA)	Hazardous wastes are wastes that could harm human health or the environment if not properly handled and disposed of. The Hazardous Waste Regulation includes the identification, handling, transport, disposal and treatment of hazardous wastes.	General provisions – no authorization issued.
Contaminated Sites Regulation (CSR) (pursuant to EMA)	The CSR provides a process for identifying and tracking the movement and deposition of soils from contaminated sites. BC CSR Schedule 7 is currently applicable to the assessment of soils/sediments being relocated or disposed on provincial land. However, under the upcoming Stage 10 amendments it is proposed that Schedule 7 will be repealed combined with revision of the text of various sections of Part 8 of the CSR to allow use of the soil standards of the new proposed Schedule "X" as applicable to the receiving site, in determining when a Contaminated Soil Relocation Agreement might be required to relocate soil to a receiving site. The CSR is also relevant to the characterization, transportation and disposal of the dredged materials to provincial lands.	Depending on the upcoming Stage 10 amendments to the CSR, Soil relocation agreement may be needed to transport material to non-permitted facility located on provincial land.
Spill Reporting Regulation (pursuant to EMA)	The regulation defines a "spill" as an unauthorized release or discharge of a listed substance into the environment in an amount exceeding the listed quantity and specifies reporting to EMBC. The requirements of the Regulation are to be considered in the development of a spill response plan	General provisions – no authorization issued.
Heritage Conservation Act	The Act encourages and facilitates the protection and conservation of heritage property in BC, including all archaeological sites on provincial Crown or private land that predate AD 1846. The Act prohibits, except as authorized by a permit or order, removal of heritage objects from BC, and the damage, desecration or alteration of specified sites and objects. Archaeological potential was identified to be high in the Project Areas.	General provisions – no permit issued.

4.3 Selected Regional and Municipal Legislation

The following is a list of selected municipal bylaws that apply or may be applied to the Projects. This list will be updated when the disposal facility to reflect by-laws in the relevant municipality.

Legislation	Application to the Projects	Authorization, Approval or Permit Issued*
City of Colwood Noise Bylaw, No. 38 (2001)	The *Bylaw to Regulate Noise within the City of Colwood* prohibits the disturbance of the quiet, peace, rest, enjoyment, comfort or convenience of the neighbourhood or of persons in the vicinity, and stipulates the following construction hours: ▪ 07:00 to 19:00 h daily; ▪ 08:00 to 17:00 h to operate any drills and/or compressors for blasting; ▪ No construction activity is allowed on Sunday or statutory holiday, such as construct, erect, reconstruct, alter, repair or demolish any building or thing, or excavate or fill in any manner which causes disturbance.	General provisions – no authorization issued.
City of Colwood Bylaw No. 1134	The Bylaw to Regulate Traffic, Parking and the use of Highways, Boulevards, Sidewalks and Public Land in the City of Colwood designates truck routes for heavy trucks (over 8,600 kg) (Schedule F to the bylaw). A heavy truck may drive on a highway other than a designated truck route to deliver cargo.	General provisions – no authorization issued.
The Township of Esquimalt Property, Unsightly Properties and Nuisance Bylaw No. 2826 (2014)	The Township of Esquimalt Property, Unsightly Properties and Nuisance Bylaw regulates the maintenance of property, unsightly property, and nuisance, including noise. The nuisance section of bylaw includes specific provisions regarding noise: Generally, no person will make noise, cause, allow, or permit a noise or sound in the street, park, plaza, or similar place which disturbs or tends to disturb the quiet, peace, rest, enjoyment, comfort, or convenience of persons in the neighbourhood or vicinity. For greater certainty, these activities are prohibited, between the hours of 10:00pm and 7:00am on Monday to Friday and between the hours of 10:00pm and 9:00am on Saturday, Sunday, or Holidays.	General provisions – no authorization issued.
Township of Esquimalt Streets and Traffic Regulation Bylaw No. 2607 (2005) and amendments.	The Bylaw identifies roads that are not acceptable for trucks over 10,000 kg within Esquimalt and prohibition of “extraordinary traffic”. This Bylaw would be applicable if trucks over 10,000 kg are going to be used for the Projects and will be transiting through Esquimalt.	General provisions – no authorization issued.
Capital Regional District (CRD) Bylaw No. 2922 (Consolidated)	The “Bylaw to regulate the discharge of waste into sewers connected to a sewage discharge facility operated by the Capital Regional District” specifies the conditions under which a waste discharge permit or authorization for discharges to CRD sanitary sewers may be issued. In the event that the Contractor wishes to discharge waste, such as barge dewatering effluent, the Contractor will apply for permits / authorizations for such a discharge.	Permit/Authorization Required

4.4 Applicable Best Management Practice and Guideline Documents

The following is a list of applicable best management practice documents that apply to the Projects.

Best Management Practice / Guidelines	Application to the Projects
Fisheries and Oceans Canada's (DFO's) Measures to Avoid Causing Harm to Fish and Fish Habitat http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html	Provides advice that will help to avoid causing serious harm to fish and fish habitat.
DFO's "Guidelines to Protect Fish and Fish Habitat from Treated Wood Used in Aquatic Environments in the Pacific Region" (Hutton and Samis 2000).	The document provides guidelines for the storage of timber fender pilings and installation of new timber pilings that may be treated with wood preservatives.
B.C. Guidelines for Industry Emergency Response Plans (located at: http://www2.gov.bc.ca/gov/content/environment/air-land-water/spills-environmental-emergencies/planning-prevention-response/industry-emergency-response-plans	The guidelines provide information for preparing a plan to respond to emergencies.
Esquimalt Harbour – Practices and Procedures 2016 (http://www.navy-marine.forces.gc.ca/en/about/structure-marpac-poesb-practices-procedures.page)	To be followed by all harbour users.
DND Formation Safety Environmental Management System (FSEMS) Directives and Shipyard BMPs	Directives for emergency reporting, solid waste management, hazardous materials management, spill response, storage tanks, and effluent management.
The National Oceanic and Atmospheric Administration's Interim Sound Threshold Guidance for Marine Mammals (NOAA 2016), and the California Department of Transportation's Technical Guidance for the Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish (Caltrans 2015)	Underwater noise threshold criteria for injury and disturbance to marine mammals.

5.0 ENVIRONMENTAL INCIDENTS

An environmental incident is an event that has caused, or has the potential to cause, one or more of the following:

- Damage to aquatic or terrestrial habitat.
- Adverse/harmful effects to fish, wildlife or other environmental resources.
- Adverse publicity associated with impacts on the environment.
- Violation of statutes, regulatory authorizations or environmental damage.

Examples of environmental incidents include, but are not limited to:

- Spills of oil, fuel, or other potentially hazardous chemicals.
- Discharges of deleterious substances into fish-bearing waterbodies.
- Landslides, erosion, or floods with the potential to adversely affect environmental quality.
- Serious harm to fish without prior authorization.

All environmental incidents are to be reported to DND immediately. An Environmental Incident Report (EIR) is to be prepared and submitted by the Contractor(s) to provide a timely and accurate internal written notification of environmental incidents to DND. The deadline for submission of the EIR is within 24 hours following an incident. The EIR will include the following information:

- Who reported, and responded, to the incident.
- A description of the incident (e.g. date, time, cause, personnel present, type of material spilled, environment affected).
- Actions taken to mitigate the incident.
- Preventative measures implemented following the incident.
- Photo documentation

The written EIR is not intended to take the place of verbal notification of an incident requiring immediate action or further notification of regulatory agencies (e.g. a spill that affects neighbouring properties or requires assistance in the supply or deployment of containment equipment). In addition to a written EIR report, DND will be notified immediately after any incident occurs. As well as internal reporting to PWGSC, it may be necessary in some situations to report an emergency to Emergency Management BC (EMBC) and notify regulatory agencies (DFO, Environment and Climate Change Canada, Ministry of Environment [MOE]), local municipal environmental representatives (Township of Esquimalt, City of Colwood), and owners of neighbouring properties (e.g. DND, QHM) of the environmental incidents. DND will provide these notifications.

In the event that the incident is considered an emergency, and DND representatives are not available, or where a delay in notification could result in environmental damage or risk to human health, PWGSC's EM will provide these notifications. Notification of corrective measures and closure of the incident may also be reported, as per direction from DND.

The Contractor(s) will prepare a spill prevention and emergency response plan that provides project-specific details regarding notification and alerting procedures (Section 7.11).

6.0 ENVIRONMENTAL MONITORING PROGRAM

6.1 Overview

An environmental monitoring program will be implemented as part of the Projects to verify and document that the objectives of environmental legislation, terms and conditions of regulatory permits and approvals, and environmental contract requirements, including this EMP, are being met. Environmental monitoring tasks will include participating in meetings, conducting work site inspections, and reporting.

6.2 Meetings

Environmental requirements of the Projects will be reviewed in the pre-construction and daily tailgate meetings by the EM with the Contractor(s) and their crews. Environmental updates will also be provided during weekly progress meetings with the Departmental Representative.

6.2.1 Pre-Construction Meeting(s)

A pre-construction meeting will be held between the EM, DND, PWGSC and the Contractor(s), which will include at a minimum, the following:

- A review of environmental requirements of the contract.
- Transfer of further relevant information or precautions that DND is aware of, and which pertain to the contract.
- Consequences of non-compliance with environmental law, authorizations, approvals, permits and other regulatory guidance.
- Reporting of environmental incidents and emergencies.

6.2.2 Tailgate Meetings

Environmental requirements will be addressed, as necessary based on the nature of the work being conducted, in daily tailgate meetings. These meetings will be used to review environmental requirements of the work and environmental precautions applicable to the work. The Contractor(s) will keep a record of environmental requirements addressed in daily tailgate meetings and provide to PWGSC upon request.

6.3 Work Site Inspections

Environmental work site inspections will be conducted by EM(s) as outlined in Table 1 below. These inspections will be separate from inspections to be carried out by the Contractor as part of their implementation and quality control for the EPP. Environmental work site inspections will be undertaken at the beginning of the work and at least twice per week thereafter dependent on the activities and equipment on-site. The frequency of inspections may be increased based on direction from PWGSC or based on co-ordination with PWGSC/DND regarding the results of the inspections.

The Contractor is responsible for mechanical inspections by qualified personnel and for maintaining health and safety equipment and procedures for their work. The Contractor is also responsible for maintaining equipment logs (maintenance and inspection), which can be produced upon request to verify that mechanical inspections are being conducted.

Table 1: Work Site Inspection Tasks.

Component	Description
Dust and Emissions Control (Air Quality)	■ Visually observe activities for conformance with the Dust and Emissions Control Plan.
Spill Prevention and Response (Water Quality)	■ Confirm that the Contractor spill prevention and emergency response plan is posted on-site, readily available to personnel, and discussed at daily pre-job briefings. ■ Confirm with the Contractor that operating personnel are familiar with the locations, contents and use of spill response equipment. ■ Confirm with the Contractor that operating personnel are familiar with the location and operation of emergency 'shut-offs', and the notification procedures to be followed in the event of an emergency or environmental incident. ■ Verify that spill response equipment is available on-site and confirm with the Contractor that trained personnel are available to deploy the spill response equipment. ■ Verify that Material Safety Data Sheets (MSDS) are available on-site. ■ Confirm with the Contractor that operating personnel are familiar with the locations and use of the MSDS. ■ Visually inspect equipment for hydraulic fluid, fuel and other leaks. ■ Equipment logs (maintenance and inspection) may occasionally be checked to verify that maintenance/inspection of equipment is being conducted. ■ Confirm with the Contractor that the spill prevention and emergency response measures have the capability to effectively manage spills resulting from their activities and operations. ■ Visual observation of fueling events and confirm that they conform to Spill Prevention and Response plan.
Stormwater Pollution Prevention (Water Quality)	■ Visually inspect stormwater protection measures to confirm they conform to the Stormwater Pollution Prevention Plan and that they are functioning to prevent pollution from entering surface waters.
Silt Curtain (Water Quality/Fish and Fish Habitat/Species at Risk)	■ Visibly inspect silt curtain daily from above water for damage, shift in location, and anchorage to shore and conformance with the Silt Curtain Control Plan.
Sediment and Erosion (Water Quality)	■ Visually inspect sediment and erosion control measures to confirm they conform with the Sediment and Erosion Control Plan and that they are functioning as intended.
Noise, Light and Odour	■ Inspect work areas and work activities for conformance with the Noise, Light and Odour Plan.
Non-hazardous Waste Storage and Disposal	■ Inspect work areas and work activities for conformance with the Non-hazardous Waste Storage and Disposal Plan.
Hazardous Materials Storage and Disposal	■ Inspect hazardous materials storage for compliance with Hazardous Materials Storage and Disposal Plan.

6.4 Monitoring

6.4.1 Water Quality

Water quality monitoring procedures are outlined in the WQMP in Appendix A.

6.4.2 Fish

Herring

As in-water work is proposed to be conducted outside of the DFO marine/estuary winter work window of December 1 to February 15 for the area (Area 19), monitoring for herring spawning will be undertaken. The EM will visually observe from the surface of the water for herring spawning and herring eggs within the in-water work areas. If herring spawning is observed within in-water work areas, the EM will inform PWGSC and work with potential to affect herring egg masses or emergent larvae will be stopped for 10 to 14 working days. If herring eggs are found on equipment, the EM will inform PWGSC, and work will be stopped and will not resume until after eggs have hatched.

Underwater Noise Monitoring

Should existing timber pilings that are removed during the structure removal stage need to be replaced, new timber pilings have been proposed for reinstatement (Anchor 2016a). The use of steel piles for reinstatement has not been proposed; however, mitigation measures to protect fish from the noise associated with potential use of steel piles using impact pile driving methods have been included within this report as a potential “worst case scenario”. Environmental monitoring requirements for fish and fish habitat for the potential use of impact pile driving of steel piles and for all other Project activities are provided below.

Assessment of the potential effects of underwater anthropogenic noise on fish requires acoustic impact thresholds for which to compare emitted sound levels and establish potential for injury. Currently, there are no legislated underwater noise criteria in Canada for assessing injury in fish. In absence of specific legislated criteria, assessing potential for injury to fish from underwater noise is typically based on ‘best available evidence’, as documented in the scientific literature and/or established by other government agencies. The U.S. National Marine Fisheries Service (NMFS) have adopted interim acoustic threshold criteria specific to impact pile driving that are based on sounds pressure levels (SPLs) that are known to potentially result in physical effects in fish (Stadler and Woodbury 2009). The current NMFS interim threshold for potential injury to fish is 206 dB re 1 uPa SPL_{peak} (Stadler and Woodbury 2009; FHWG 2008).

Clamshell dredging produces continuous, non-pulsive underwater noise and produces in-water SPLs ranging from 150 to 162 dB (re to 1 □Pa) at 1 m from the source (Richardson et al. 1995). This is below the injury threshold for fish (206 dB SPL_{peak} re 1 µPa) (Richardson et al. 1995; Stadler and Woodbury 2009; FHWG 2008); therefore injury to fish is not expected. Potential effects related to underwater noise from clamshell dredging will likely be restricted to behavioural disturbance.

Vibratory pile driving of timber piles is expected to be used during this Project. Vibratory pile driving produces continuous, non-impulsive underwater noise. In-water SPLs for vibratory pile driving have been recorded in the range of 165 dB (re 1 □Pa; Caltrans 2015) and are not expected to exceed the injury threshold for fish (206 dB SPL_{peak} re 1 [µPa]) (Stadler and Woodbury 2009; FHWG 2008). Vibratory pile driving noise may cause changes to fish behaviour (Caltrans 2015).

Should impact pile driving of steel piles occur, it would have the potential to create sound pressure levels which could exceed 206 dB SPL_{peak} re 1 (µPa) and may adversely affect fish through direct mortality, sublethal injuries, or behavioural changes (Caltrans 2015; FHWG 2008; SLR 2014). Impact pile driving (by hammer) is typically louder than clamshell dredging or vibratory pile driving. In-water SPLs ranging from 131 to 135 dB (re 1 □Pa) have been measured 1,000 m from the source and up to 200+ dB (re 1 □Pa) at 1 m from the source (Richardson et al. 1995). Based on reported SPLs for steel piles of equivalent dimensions as the timber piles proposed for the Projects, and standard noise attenuation losses in water (assuming simple spherical spreading), fish would not be expected to experience physical injury from sound pressures generated by impact pile-diving of steel piles unless they were <4 m from the source (Annex E). Impact pile driving noise will also likely cause changes to fish behaviour.

Should impact pile driving of steel piles be required for pile installation, the following mitigation measures will be implemented:

- Impact pile driving of steel piles, should it occur, will not take place between April 1 and May 31 due to potential effects from underwater noise on fisheries resources in Esquimalt Harbour. The April 1 to May 31 time period is particularly sensitive due to the potential for herring spawning and out-migration of juvenile salmon in Esquimalt Harbour.
- Monitoring of underwater noise using a hydrophone will be undertaken during impact pile driving, should it occur, to ground-truth the assessment predictions and determine if injury thresholds are being exceeded.
- Monitoring for signs of dead fish will be undertaken by the environmental monitor.
- The following mitigation measures may be employed if underwater noise monitoring determines that injury thresholds of fish are exceeded or if dead fish are observed:
  - Work will be suspended and DFO consulted on the course of action to take to reduce underwater sound levels to below injury thresholds.
  - Measures to reduce sound transmission (e.g. bubble curtains, isolation casing, coffer dams, cushion blocks).
  - Measures to reduce sound generated by the pile (e.g. design specifications, pile-driving equipment used).

A qualified environmental monitor will be on-site during Project activities to implement mitigation measures for underwater noise effects on fish if/as required and to observe, record, and notify the PWGSC Departmental Representative of other potential concerns arising from Project activities related to fish and fish habitat.

6.4.3 Aquatic Mammals

The use of steel piles for reinstatement has not been proposed within the design specifications (Anchor 2016a); however, mitigation measures for aquatic mammals for the potential use of steel piles using impact pile driving methods have been included within this report as a potential “worst case scenario”. Environmental monitoring requirements for aquatic mammals for the potential use of impact pile driving of steel piles and for all other Project activities are provided below.

Impact pile driving of steel piles has the potential to exceed underwater noise injury thresholds for marine mammals (Table 2), as demonstrated by underwater noise modelling performed for pile driving activities for the Project (Golder 2016a [Annex E]).

Table 2: Undewater Noise Injury Thresholds for Marine Mammals

	Pinnipeds	Cetaceans
SPL_{rms} (dB re 1 µPa)	190	180
SPL_{peak} (dB re 1 µPa)	218	230
SEL (dB re 1 μPa^2s) (24-hrs)	186	198

Source: (NOAA 2016); Note: dB – decibel; µPa – microPascal; SEL=Sound Exposure Level; SPL – sound pressure level

- Should impact pile driving of steel piles be required for pile installation, the following mitigation measures will be implemented by the EM who will also be a certified Marine Mammal Observer (MMO) with relevant marine mammal monitoring experience:
  - A marine safety perimeter of 100 m will be visually monitored during impact pile driving activities should they occur. If an aquatic mammal enters the marine safety perimeter during impact pile driving, these activities will be suspended until such time as the aquatic mammal departs outside the marine safety perimeter. Activities will not resume until it is visually confirmed that the aquatic mammal is outside the marine safety perimeter, or if a minimum of 10 minutes has elapsed since the animal was last sighted within the safety perimeter.
  - Concurrent multiple underwater noise generating activities will be minimized where practicable (e.g. avoiding multiple pile driving activities at the same time). Where multiple underwater noise generating activities are planned they will be sequenced where possible to minimize cumulative underwater noise effects.

Additional mitigation measures outlined in the Fish and Fish Habitat VEC section above will be followed for pile driving that may result in sound levels which exceed the injury thresholds for pinnipeds and/or cetaceans.

A qualified EM will be on-site during all Project activities. Aquatic mammal monitoring will be implemented during all in-water Project activities as a component of the environmental monitoring, with presence/ absence communicated to the contractor.

6.4.4 Birds

Osprey Monitoring

Osprey nests are located adjacent to the D Jetty and F/G Jetty Project Areas (Figure 3). The osprey nest adjacent to D Jetty is approximately 80 m from the proposed dredge area, and the osprey nest adjacent to F/G Jetty is approximately 100 m from the proposed dredge area. Environmental monitoring will be undertaken for ospreys during their breeding season to confirm that Project activities are in compliance with the BC *Wildlife Act*.

Section 34 of the provincial *Wildlife Act* prohibits the injury, molestation, or destruction of birds, bird eggs, nests of eagle, peregrine falcon, gyrfalcon, osprey, heron or burrowing owl, and nests occupied by a bird or its eggs. Loud noises from equipment may be considered 'molestation' if this causes the birds to abandon active nests. MOE (2014) recommends a quiet buffer of 200 m for raptor nests (such as osprey nests) during the breeding season in urban areas. Some Project components are within this 200 m buffer.

During Project activities within the buffer area between March 21 and September 5, the EM will monitor for nesting activity. If osprey disturbance while nesting is observed, Project works may need to be modified or halted until nesting is complete or reduced to a level which does not disturb the nesting ospreys. If nesting is observed outside of March 21 and September 5, monitoring should also be undertaken as described above.

Barn Swallows

Barn swallows, listed as threatened under COSEWIC, may also nest under structures to be removed in the Project Areas. Barn swallows are protected under the federal *Migratory Birds Convention Act* and the provincial *Wildlife Act*. Section 6 of the Migratory Birds Regulations under the federal *Migratory Birds Convention Act* prohibits disturbing or destroying a migratory bird or its eggs except when authorized. The barn swallow is protected under this Act (Environment and Climate Change Canada 2016). Permits are only issued for certain activities such as for hunting and scientific purposes. Permits are not issued for nest disturbance or destruction during construction activities which is considered incidental take. Instead, best management practices are to be employed by the Contractor. Barn swallows are also protected under Section 34 of the provincial *Wildlife Act*. Therefore, if a barn swallow nest is removed when the nest is occupied by a bird or its egg, it would be considered an offence. The DND Natural Resource Management Directive also provides direction on nest disruption. It indicates that fully formed nests and nests with eggs should not be removed. If (old) nests are to be removed, FSE should be contacted.

The breeding season is considered to be March 1 to August 31 for passerines (MOE 2014), including for barn swallows, which also encompasses the regional nesting period for the area (Region A1) as indicated by Environment Canada and Climate Change (2016). Structures should be removed outside of the breeding season. Prior to removal, surveys for old nests should be undertaken. If old nests are found on structures to be removed, Environment Canada and the Ministry of Environment should be consulted first before removal.

If structures are to be removed during the breeding season, non-intrusive surveys should be conducted by a qualified professional to determine the presence of active nests immediately before structures are to be removed. If nests containing eggs or young are located, removal of the structures will be halted until nesting is completed.

6.4.5 Archaeology

As per the results of the archaeological impact assessment (AIA), the precontact archaeological site DcRu-136 is located adjacent to the F/G Jetty Project Area (Figure 4). No further archaeological investigations are recommended prior to the initiation of the Projects provided there are no alterations to the currently proposed boundaries of the dredging at the Project Area; if Project activities encroach on the boundaries of the archaeological site DcRu-136, it has been recommended that archaeological monitoring of Project activities (i.e. dredging) that could cause sub-surface impacts to the archaeological site be conducted by a professional archaeologist and representatives of the Esquimalt and Songhees Nations. Dredging elsewhere in the Project Area will be conducted following Archaeological Chance Find Management Guidelines.

Golder understands that the processing of the dredgeate at the Processing/Sorting Facility will allow for the direct examination of excavated sediments that are expected to contain historical materials of unknown significance. Additional inspection of all dredgeate from the Project Area at the Processing/Sorting Facility by a professional archaeologist and/or First Nations assistants will be conducted to facilitate the chance find of precontact archaeological materials which may have eroded into the intertidal seabed outside the boundary of archaeological site DcRu-136, as well provide for the collection of potentially significant historical artifacts from the seabed. The archaeological monitor will be required to provide weekly updates to the Departmental Representative on the results of the archaeological monitoring at the Project Area and the inspection of dredgeate from the Processing/Sorting Facility.

If suspected human remains are observed during the Projects, all work will stop in the immediate vicinity of the find spot and the Departmental Representative will be notified. The Departmental Representative will determine if additional actions are required, including notifying a professional archaeologist, a policing authority and/or leadership from the Esquimalt and Songhees Nations.

At the conclusion of the Projects, precontact archaeological materials that were collected during archaeological monitoring will be offered to the Esquimalt and Songhees Nations for accession. If the Esquimalt and Songhees Nations cannot accommodate this request, the artifacts will be provided to the Royal BC Museum in Victoria for accession.

It is expected that a considerable amount of historical materials and non-cultural faunal specimens will be collected during the inspection of the dredgeate at the Processing/Sorting Facility. Historical materials will be offered to the CFB Esquimalt Naval and Military Museum and the Royal BC Museum for accession; unwanted cultural materials and non-cultural faunal specimens will be discarded.

6.5 Environmental Monitoring Reporting Procedures

6.5.1 Daily Reporting

Reporting will involve submission of daily environmental monitoring reports. Reports may be submitted, as required, to regulatory agencies, First Nations, and public stakeholders, during the course of the Projects. The monitoring reports will be prepared by the EM and will include, at a minimum, the following information (templates for environmental monitoring reports are provided in Appendix C):

- A description of construction activities undertaken during the reporting period.
- A description of site inspections and monitoring undertaken including water quality, underwater noise, marine mammal and osprey monitoring.
- Results of testing (e.g. water quality data).
- A description of environmental issues and corresponding mitigation measures implemented.
- Tracking of emerging and outstanding environmental issues.
- Photos documenting construction activities, environmental issues, and corresponding mitigation measures.
- Reporting on environmental incidents (e.g. spills).

6.5.2 Completion Reporting

The EM will also prepare an environmental completion report one month following completion of the Projects. The report will include representative site photographs, a summary of monitoring data collected, a summary of construction activities, environmental management and issues during construction, how these issues were managed, and mitigation measures.

7.0 ENVIRONMENTAL REQUIREMENTS

This section is an overview of environmental requirements of the Projects and is intended to be read in conjunction with legislation, and best management practices and guidance documents (Section 4.0), environmental authorizations, permits, and approvals issued for the Projects (Section 7.1), and the contract requirements for the Projects, which includes this EMP. The environmental requirements are based on potential Project effects identified in the EED Report (Golder 2016a).

7.1 Environmental Authorizations, Permits and Approvals

The Contractor(s) will be provided with copies of environmental authorizations, permits and approvals received by DND from regulatory agencies and will be responsible for complying with the terms and conditions specified within these documents as well as the provisions of the statutes under which the approvals have been issued. DND and the Contractor(s) will be required to keep copies of all Project approvals, authorizations, and permits on the Project site available for inspection as needed.

7.2 Air Quality Protection

7.2.1 References

- Occupational Health and Safety Regulation (Table of Exposure Limits for Chemical and Biological Substances (updated September 15, 2011), Guidelines Part 5).
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).
- Contract technical specifications.

7.2.2 Protection Measures

Protection Measures	Responsibility	Timing
Environmental Protection Plan Component		
Dust and Emissions Control Plan which will include specific measures that will be undertaken to meet prohibitions outlined within relevant municipal bylaws and exposure limits outlined within the Occupational Health and Safety Regulation.	Contractor	Before work commences
Implementation		
Vessels and equipment will be well maintained and in good working order.	Contractor	On-going during work
Efforts will be made to minimize exhaust emissions. The contractor will be encouraged to use clean alternative fuels for vessels and equipment. Idling of vessels and equipment will be minimized.	Contractor	On-going during work
To reduce potential dust emissions during hot, dry weather, sediment on barges, in trucks, or stockpiled on land will be covered or wetted as required, if it is being left overnight or if there are strong winds.	Contractor	On-going during work

Protection Measures	Responsibility	Timing
Hydrogen sulphide (H_2S) monitoring will be undertaken in and around the work area during dredging of subtidal sediment and the contractor will be responsible for preparing a Health and Safety plan detailing appropriate personal protective equipment, training and safe work practices for H_2S. The Occupational Health and Safety Regulation includes an air quality guideline of 10 parts per million for H_2S (ceiling short-term exposure level; Table of Exposure Limits for Chemical and Biological Substances (updated September 15, 2011), Guidelines Part 5 pursuant to the Occupational Health and Safety Regulation.)	Contractor	As needed
Monitoring		
In the event that odours are noted, or complaints are received regarding hydrogen sulphide odours, H_2S monitoring will be undertaken in and around the work area where personnel are or need to be actively working per The Township of Esquimalt Maintenance of Property Bylaw (Bylaw No. 2826) and the City of Colwood Nuisance Controlled Substance Bylaw (Bylaw No. 851)	EM	As needed

Notes

[1] Table of Exposure Limits for Chemical and Biological Substances (updated September 15, 2011), Guidelines Part 5 pursuant to the Occupational Health and Safety Regulation

7.3 Water Quality

7.3.1 References

- *Fisheries Act*
- *Canada Shipping Act* and associated regulations.
- *Environmental Management Act.*
- Capital Regional District (CRD) Bylaw No. 2922 (Consolidated).
- DFO “Guidelines to Protect Fish and Fish Habitat From Treated Wood Used in Aquatic Environments in the Pacific Region” (Hutton and Samis 2000).
- Water Quality Monitoring Plan (WQMP; Appendix A).
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).
- Contract technical specifications.
- Formation Safety and Environment Management System Directives for spill response, storage tanks, and effluent management.

7.3.2 Protection Measures

Protection Measures	Responsibility	Timing
Environmental Protection Plan Component		
Water Quality Protection Plan (WQPP) which will include specific measures that will be undertaken and equipment used to meet the water quality objectives outlined in the WQMP for barge dewatering.	Contractor	Before work commences
Spill Prevention and Response Plan which will include specific measures that will be undertaken to prevent and respond to spills.	Contractor	Before work commences
Stormwater Pollution Prevention Plan which will include specific measures that will be undertaken to prevent the direct or indirect discharge of contamination into or through facilities connected to stormwater systems.	Contractor	Before work commences
Silt Curtain Control Plan to describe how the silt curtain will be installed and maintained.	Contractor	Before work commences
Sediment and Erosion Control Plan which will include specific measures that will be undertaken and equipment to be used to prevent sediment transport and erosion of stockpiles during periods of rain and/or wind.	Contractor	Before work commences
Substrate Sampling and Analysis Plan (SSAP) for testing of imported materials (e.g. sand, rock) to be placed in the Project Areas. Testing requirements as per the Contract technical specifications.	Contractor	Before imported materials are brought to site
Implementation		
Structure Removal, Relocation and Reinstallation		
During removal and storage of creosote pilings, best management practices (Hutton and Samis 2000) will be followed, for example: ▪ A reasonable attempt should be made to remove the entire pile. ▪ Piles will be removed in a manner that minimises disturbance of seafloor habitats and to avoid bringing creosote-contaminated sediments to the surface. If the pile breaks off below the biologically-active zone in the sediment, it may not be advisable to dredge the remainder of the pile out, depending on the sensitivity of the habitat at the site. ▪ Cleaning of pilings, if necessary, will be conducted within the dredge area prior to dredging such that material (e.g. attached biological growth and sediment) is ultimately removed during dredging. ▪ Booms or other measures will be implemented to contain floating debris from pile removal and cleaning. ▪ Treated piles should be stored in an area away from the water and surface runoff contacting treated piles should be directed away from the water. ▪ Used/decommissioned piles will be disposed of on land in an appropriate waste management facility (Hutton and Samis 2000). ▪ Use allocated storage areas per the contract technical specifications. ▪ Removed creosote treated piles will be inspected for excessive creosote. If excessive creosote is observed, new treated piles treated with creosote following best management practices in Hutton and Samis (2000) will be used instead.	Contractor	On-going during work
Dredging and Residuals Management		
Prior to dredging, the perimeter of the dredge area will be delineated, so that work occurs within the confines of the Work Site.	Contractor	Before work commences

Protection Measures	Responsibility	Timing
A silt curtain will be used to help contain re-suspended sediments and contribute to attainment of the water quality performance objectives outlined in the WQMP. The silt curtain will be of a suitable type for the conditions (i.e. tidal waters).	Contractor	On-going during work
Dredging will be undertaken in a manner to minimize disruption, disturbance and re suspension of seabed sediments (i.e. no multiple bites with the clamshell bucket and no underwater stockpiling as per the design specifications).	Contractor	On-going during work
The dredge material barge will be loaded in such a way to prevent loss of sediment over the side rails or as a result of barge listing.	Contractor	On-going during work
Barge Dewatering		
Barge dewatering will be managed as outlined in the WQMP (Appendix A) Specifically, passive dewatering is not permitted in DUs 4 and 5 on the north side of D Jetty and the barge will need to be water-tight. Passive dewatering is permitted in the remainder of the D Jetty dredge footprint and at F/G Jetty provided that TSS is controlled (i.e. 75 mg/L TSS maximum).	Contractor	On-going during work
To facilitate dewatering, the Contractor may elect to mix additives with the sediments to bind available water. Additives, if used, will require proper storage, handling and containment. Any leachate generated will need to be contained, treated and appropriately disposed of (see also Section 7.13).	Contractor	As necessary.
If the contractor chooses to make arrangements to dispose of water via the sanitary sewer system, approval must be obtained from the Capital Regional District (CRD) and meet site specific requirements. At a minimum, it must be demonstrated that this water meets discharge water quality requirements specified in the *Capital Regional District (CRD) Bylaw No. 2922*. The contractor will be responsible for obtaining permission from PWGSC and the CRD, and in demonstrating compliance with discharge requirements by monitoring during construction.	Contractor	As necessary.
In-water Transportation		
Transport of dredge material and debris will be performed using a barge/vessel with sidewalls of sufficient height to fully contain the dredge material, water, and debris.	Contractor	On-going during work
Watertight barges will be used when dredged material is being transported from the site	Contractor	On-going during work
The contractor will be required to provide certification of seaworthiness from an independent Marine Surveyor for each haul barge that will be used for the Projects. In the event that a barge is damaged during Project activities and requires repair, a new certification of seaworthiness will be required. In addition, material transportation by barge will require the contractor to obtain authorization from the Queen's Harbour Master pursuant to the *Canada Marine Act* and from DND.	Contractor	On-going during work
Offloading and Associated Activities		
Contingency stockpiling of dredged material will be necessary for contaminated sediments and additional testing will be necessary to evaluate disposal options. Stockpiled material will be stored to prevent entry to the waterbody.	Contractor	On-going during work
Additional mitigation measures that may be applied to control water quality may include: ▪ Construction of stockpile areas at the offload facility (no stockpiling will be permitted at the DND work site) using berms or other barrier devices to prevent uncontrolled spreading of debris and/or contaminated sediment. ▪ Covering stockpiles to prevent erosion during periods of rain and/or wind.	Contractor	On-going during work
Monitoring		
The EM will monitor water quality as per the WQMP	EM	On-going during work

7.4 Fish and Fish Habitat

7.4.1 References

- *Fisheries Act.*
- DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat.
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).

7.4.2 Protection Measures

Protection Measures	Responsibility	Timing
Implementation		
Timing Windows		
In-water work including sediment dredging, structure removal and reinstatement, and backfill and material placement will occur inside and outside the least-risk work window with the application of appropriate mitigation measures, with the exception of impact pile driving of steel piles should it occur. Impact pile driving of steel piles will not take place between April 1 and May 31 due to potential effects from underwater noise on fisheries resources in Esquimalt Harbour. The April 1 to May 31 time period is particularly sensitive due to the potential for herring spawning and out-migration of juvenile salmon in Esquimalt Harbour. Vibratory pile driving will still occur outside the window.	Contractor	Before work commences
Dredging		
Prior to dredging, the perimeter of the dredge area will be delineated using GPS chart plotting software, so that work occurs within the confines of the Work Sites.	Contractor	Before work commences
The barge will not come to rest on the seafloor (no grounding).	Contractor	On-going during work
Pile Driving		
The following mitigation measures may be employed if underwater noise monitoring determines that injury thresholds of fish are exceeded or if dead fish are observed: ▪ Work will be suspended and DFO consulted on the course of action to take to reduce underwater sound levels to below injury thresholds ▪ Measures to reduce sound transmission (e.g. bubble curtains, isolation casing, coffer dams, cushion blocks). Measures to reduce sound generated by the pile (e.g. design specifications, pile-driving equipment used).	Contractor	As necessary
Monitoring		
As in-water work is proposed to be conducted outside of the DFO marine/estuary winter least risk work window of December 1 to February 15 for the area (Area 19), monitoring for herring spawning will be undertaken. The EM will visually observe from the surface of the water for herring spawning and herring eggs within the in-water work areas. If herring spawning is observed within in-water work areas, the EM will inform PWGSC and work with potential to affect herring egg masses or emergent larvae will be stopped for 10 to 14 working days. If herring eggs are found on equipment, the EM will inform PWGSC, and work will be stopped and will not resume until after eggs have hatched.	EM	During in-water works after February 15

Protection Measures	Responsibility	Timing
Monitoring of underwater noise using a hydrophone will be undertaken during impact pile driving, should it occur, to ground-truth the assessment predictions and determine if injury thresholds are being exceeded.	EM	As necessary
Monitoring for signs of dead fish will be undertaken by the environmental monitor.	EM	During in-water works

Notes:

[1] 206 dB SPL_{peak} re 1 (µPa) is the most conservative injury threshold for fish and the threshold which represents best available science (Stadler and Woodbury 2009; FHWG 2008).

7.5 Marine Mammals

7.5.1 References

- Marine Mammal Regulations (pursuant to the *Fisheries Act*).
- *Species at Risk Act.*
- DFO's guidelines Be Whale Wise – Marine Wildlife Guidelines for Boaters, Paddlers, and Viewers (DFO 2013).
- The National Oceanic and Atmospheric Administration's Interim Sound Threshold Guidance for Marine Mammals (NOAA 2016).
- The California Department of Transportation's Technical Guidance for the Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish (Caltrans 2015).
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).
- DND FSE EMS Natural Resource Management directive E5.

7.5.2 Protection Measures

Protection Measures	Responsibility	Timing
Implementation		
Concurrent multiple underwater noise generating activities will be minimized where practicable (e.g. avoiding multiple pile driving activities at the same time). Where multiple underwater noise generating activities are planned they will be sequenced where possible to minimize cumulative underwater noise effects.	Contractor	On-going during work
Pile driving will, when practical and feasible, be undertaken with vibratory methods rather than impact methods to minimize underwater sound pressure levels.	Contractor	On-going during work
Timber piles will be used, when practical and feasible, rather than steel piles to minimize underwater sound pressure levels.	Contractor	On-going during work
The following mitigation measures may be employed if underwater noise monitoring determines that injury thresholds of fish are exceeded or if dead fish are observed: ▪ Work will be suspended and DFO consulted on the course of action to take to reduce underwater sound levels to below injury thresholds.	Contractor	As necessary

Protection Measures	Responsibility	Timing
▪ Measures to reduce sound transmission (e.g. bubble curtains, isolation casing, coffer dams, cushion blocks). ▪ Measures to reduce sound generated by the pile (e.g. design specifications, pile-driving equipment used).		
Vessels will follow standard boat operation when in proximity to marine mammals: ▪ Under no circumstances, other than in the case of an emergency, will vessels approach within 300 m of any marine mammal engaged in feeding activities. For all other marine mammal encounters, vessels will not approach within 100 m of a marine mammal in the water or a seal/sea lion haul out. ▪ As safe navigation allows, reduce speed to less than 7 knots when within 300 m of the nearest whale. Avoid abrupt course changes. ▪ Do not drive through groups of porpoises or dolphins to encourage bow or stern riding. Should dolphins or porpoises choose to ride the bow wave of your vessel, avoid sudden course changes, hold course and speed, or reduce speed gradually. ▪ Be cautious when motoring near seal and sea lion haul-outs, especially during breeding and pupping seasons (generally May to September). Reduce speed when approaching or driving by a haul-out, minimize wake, wash and noise, and then slowly pass without stopping. ▪ Pay attention and move away, slowly and cautiously, at the first sign of disturbance or agitation. ▪ Do not disturb, move, feed or touch any marine wildlife, including seal pups. ▪ Emergency collisions with marine mammals, or a sighting of an entangled or injured marine mammal, are to be immediately reported to Coast Guard (VHF Channel 16) or Whale Emergency Network (1-800-465-4336)	Contractor	On-going during work
Monitoring		
Should impact pile driving of steel piles be required for pile installation, the following mitigation measures will be implemented by the EM who will also be a certified Marine Mammal Observer (MMO) with relevant marine mammal monitoring experience: ▪ A marine safety perimeter of 100 m will be visually monitored during impact pile driving activities should they occur. If an aquatic mammal enters the marine safety perimeter during impact pile driving, these activities will be suspended until such time as the aquatic mammal departs outside the marine safety perimeter. Activities will not resume until it is visually confirmed that the aquatic mammal is outside the marine safety perimeter, or if a minimum of 10 minutes has elapsed since the animal was last sighted within the safety perimeter.	EM	As necessary

7.6 Birds

7.6.1 References

- Migratory Birds Convention Act.
- Wildlife Act.
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).
- DND FSE EMS Natural Resource Management directive E5.

7.6.2 Protection Measures

Protection Measures	Responsibility	Timing
Implementation		
Structures with nests should be removed outside of the breeding season for barn swallows. The breeding season for passerines including barn swallows is March 1 to August 31 according to Develop with Care 2014 (MOE 2014).	Contractor	Outside of March 1 to August 31 breeding season.
Monitoring		
During Project activities within the 200 m buffer area for osprey nests between March 21 and September 5, the EM will monitor for nesting activity. If osprey disturbance while nesting is observed, Project works may need to be modified or stopped until nesting is complete or reduced to a level which does not disturb the nesting ospreys. If nesting is observed outside of March 21 and September 5, monitoring should also be undertaken as described above.	EM	During work
Outside of the March 1 to August 31 breeding season, prior to removal of structures, surveys for old barn swallow nests should be undertaken. If old nests are found on structures to be removed, FSE, Environment Canada and the Ministry of Environment should be consulted first before removal.	EM	Outside the March 1 to August 31 breeding season.
Inside of the March 1 to August 31 breeding season, prior to removal of structures, non-intrusive surveys should be conducted by a qualified environmental professional to determine the presence of active nests immediately before structures are to be removed. If barn swallow nests containing eggs or young are located, removal of the structures will be halted until nesting is completed.	EM	Inside the March 1 to August 31 breeding season.

7.7 Species at Risk - Abalone

7.7.1 Reference

- *Species at Risk Act*
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).

7.7.2 Protection Measures

Protection Measures	Responsibility	Timing
Environmental Protection Plan(s) Component		
Silt Curtain Control Plan	Contractor	Before Work Commences
Implementation		
DFO has indicated to DND (M. Waters, pers. comm.) that the silt curtain around the dredge area would be sufficient to mitigate potential effects to water quality in the vicinity of the identified abalone habitat. An abalone field assessment will be conducted in accordance with DFO survey protocol guidance (e.g. conducted during nighttime) to survey for potential abalone presence in areas previously identified as potentially suitable abalone habitat. Should the density of abalone observed during the nighttime survey exceed the density threshold in DFO's guidance (Lessard et al. 2007), DFO will be consulted to develop appropriate mitigation measures. Mitigation measures may include relocation of individual abalone; therefore, a permit pursuant to the *Species at Risk Act* will be applied for to allow for relocation if necessary.	Contractor	Before Work Commences

Protection Measures	Responsibility	Timing
Monitoring		
The EM will visibly inspect the silt curtain daily from above water for damage, shift in location, and anchorage to shore and appropriate implementation of the Silt Curtain Control Plan.	EM	Ongoing during work

7.8 Navigation

7.8.1 References

- Esquimalt Harbour – Practices and Procedures (DND 2016).
- *Canada Shipping Act* and its associated regulations.
- Contract technical specifications.
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).

7.8.2 Protection Measures

Protection Measures	Responsibility	Timing
Environmental Protection Plan(s) Component		
An Emergency Docking Plan will be developed that includes planning for the relocation of damaged Project equipment, so that in this event, vessels or equipment know where they should go, and can do so quickly.	Contractor	Before work commences
Implementation		
The work will be conducted in accordance with the QHM Esquimalt Harbour Control Instructions (DND 2011).	Contractor	On-going during work
▪ The QHM will be informed 48 h before barges and other Project related vessels are expected to enter the harbour.	Contractor	As necessary
▪ Work will be phased to minimize disruptions to other vessel traffic.	Contractor	On-going during work
▪ QHM will be consulted for overnight moorage of equipment.	Contractor	On-going during work

7.9 In-Air Noise, Light and Odour

7.9.1 References

- City of Colwood Noise Bylaw (Bylaw No. 38) (2001).
- The Township of Esquimalt Property, Unsightly Properties and Nuisance Bylaw No. 2826 (2014).
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).
- Contract technical specifications.

7.9.2 Protection Measures

Protection Measures	Responsibility	Timing
Environmental Protection Plan(s) Component		
Preparation of an In-Air Noise, Light and Odour Plan that will describe specific measures that will be undertaken and equipment used to minimize nuisance noise and light and to meet bylaws.	Contractor	Before work commences
Implementation		
Maintain equipment in good working order and switch it off when not in use.	Contractor	On-going during work
Implement best practices for construction such as installation mufflers on machinery for noise control.		
Undertake noisier work during daytime, weekday hours and modify activities based on noise monitoring and resident feedback.		
Spotlights will be directed away from residential areas or lights will be fitted with shrouds to direct light to the immediate work area.		
Monitoring.		
A monitoring program will be implemented on an as needed basis if complaints are received, to verify that specified bylaw noise levels are met.	EM	As necessary
Complaints will be received and reviewed to evaluate the need to implement additional noise monitoring or modifications to activities.	PWGSC	As necessary

7.10 Archaeology

7.10.1 References

- *Heritage Conservation Act*.
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).
- Archaeological Overview Assessment (Golder 2015).
- Archaeological Impact Assessment (Golder 2016c)

7.10.2 Protection Measures

Protection Measures	Responsibility	Timing
Implementation		
Avoidance of areas where archaeological potential has been determined.	Contractor	As necessary
Monitoring		
Conducting additional archaeological impact assessment and/or monitoring as necessary during Project activities that have the potential to cause sub-surface impacts (e.g. dredging) within the boundaries of recorded archaeological sites and/or in areas identified as having archaeological potential. Archaeological Chance Find Management Guidelines are to be followed for Project activities conducted in areas of low archaeological potential.	EM	As necessary

7.11 Spill Prevention and Emergency Response

7.11.1 References

- *Fisheries Act*.
- *Environmental Management Act*.
- Spill Reporting Regulation (pursuant to the *Environmental Management Act*).
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).
- FSEMS Emergency Reporting Directive SE1.
- Contract technical specifications.

7.11.2 Protection Measures

Protection Measures	Responsibility	Timing
Environmental Protection Plan Component		
Spill Prevention and Emergency Response Plan. Specific measures that will be undertaken and equipment used to prevent spills and to respond to emergencies will be described At a minimum, the plan will include: ▪ A general measure of the probability and severity of an adverse effect to health, property, or the environment, on the basis of fuel, oil, and other hazardous materials consumed, handled, and stored. ▪ Spill/release notification and alerting procedures. ▪ Spill incident report forms. ▪ Containment, recovery, and clean-up procedures. ▪ On-site spill/release clean-up materials, equipment, and locations. ▪ Names and telephone numbers of persons and organizations that may be contacted in the event of a potential environmental incident, including PWGSC/ DND and representatives, the EM, Contractor(s) representative and local emergency response organizations. The Plan will be available for inspection by PWGSC and regulatory agency personnel and will be posted at conspicuous locations in the work site and in relevant machinery.	Contractor	Before work commences
Implementation		
To reduce the risk of fluid spills reaching the aquatic environment and to protect worker safety, the Contractor will follow, at a minimum, the following mitigation measures: ▪ Vessels and machinery will arrive on site in a clean/good condition and maintained free of fluid leaks. ▪ All work will be conducted in a manner that does not result in the deposit of a toxic or deleterious substance into waters frequented by fish. ▪ All field personnel will be made aware of the location of Emergency Spill Response equipment and the procedures necessary to contain spills of any fluid.	Contractor	On-going during Projects

Protection Measures	Responsibility	Timing
▪ The washing, refueling and servicing of machinery, and the storage of fuel and other materials for the machinery will occur away from the water to prevent any deleterious substance from entering the water. ▪ Secondary containment trays will also be used for any products that have potential to leak or spill, such as gasoline, diesel fuel, oil, paints and solvents ▪ Excess lubrication and grease will be wiped off of equipment where practical. Oily rags and used spill cleanup materials will be appropriately disposed of in sealed storage containers. ▪ Appropriate spill control equipment will be kept on site at all times during the work. The spill kit will be checked prior to commencement of work to ensure that it contains (at a minimum) all of the recommended spill kit contents as listed in ▪ Table 3. Operating personnel are to be familiar with the contents and use of spill response equipment and the location and operation of emergency 'shut-offs'.		
If the amount of the substance spilled is equal to or exceeds the quantities in Table 4, a verbal report will be made at the earliest practical opportunity (see also the Spill Reporting Regulation for additional substances and quantities) to: ▪ Emergency Management BC (EMBC) 1 800 663-3456 ▪ DFO's 'Observe, Record and Report' line 1-800-465-4336 In the event of a reportable spill, a written incident report will be prepared and submitted to government authorities having jurisdiction within 24 hours. Information within the report will include the reporting organization, date, time, location, hazardous materials involved, source, persons or organizations notified, how the spill occurred, remedial action taken or planned, and actions necessary to prevent recurrence. In accordance with fisheries protection and pollution provisions of the *Fisheries Act:* In the event of a non-compliant incident (i.e. serious harm or deposit of deleterious substance or imminent danger of such occurrences), a Project representative will contact DFO's Observe, Record and Report line at (1-800-465-4336) to report the incident. Any materials contaminated by a Project-related release of deleterious substances will be recovered and placed into containment for subsequent off-site disposal at an appropriate facility.	EM	On-going during work
Monitoring		
Monitoring will be undertaken as described above in the Environmental Monitoring Program section.	EM	On-going during work

Table 3: Recommended Minimum Spill Kit Contents

Item	Quantity
Oil spill boom	1
360L polyethylene overpack drum	1
Oil Sorbent socks (3”x 4’)	5
Oil Sorbent Pillows (12” x 13”)	5
Oil Sorbent Sheets (16.5” x 20” x 3/8”)	50
Oil Sorbent Roll (16.5” x 115’ x 3/8”)	1
Universal (non-hydrocarbon) Sorbent socks (3” x 4’)	5
Universal (non-hydrocarbon) Sorbent sheets (16.5” x 20” x 3/8”)	25
Sphag-sorb or other hand-cast sorbent material (bag)	1
Drain Cover (36”x36”x1/16”)	1
Caution Tape (3”x500’)	1
1 lb. Plugging Compound	1
Nitrile Gloves	2
Safety Glasses	2
Tyvek Coveralls	2
Instruction booklet	1
Printed Disposal Bags	10

Table 4: Spill Reporting Requirements

Substance Spilled	Reportable Amount
Oil and Waste Oil	100 L
Diesel Fuel	100 L
Gasoline	100 L
Antifreeze	5 L
Battery Acid	5 L
Other substances that could cause pollution (as defined by the BC *Environmental Management Act*)	200 kg

7.12 Non-hazardous Waste Management

7.12.1 References

- BC Industrial Non-hazardous Waste Landfills Code of Practice.
- Formation Safety and Environment Management System Directives.
- Contract technical specifications.

7.12.2 Protection Measures

Protection Measures	Responsibility	Timing
Environmental Protection Plan(s) Component		
Specific measures to be undertaken and equipment to be used to manage non-hazardous waste will be described. The measures will address, at a minimum: ▪ A list of approved locations that will accept recyclable and non-recyclable solid non-hazardous construction wastes to be generated during the Work. ▪ The types and quantities of materials to be recycled, as well as those requiring disposal, names of construction waste material haulers, and approved disposal facilities that meet the requirements of the BC *Environmental Management Act*.	Contractor	Prior to work commencing
Implementation		
Refuse and debris related to the Work will be collected and disposed of at approved disposal facilities in compliance with laws and requirements of all authorities having jurisdiction.	Contractor	On-going during Projects
Surficial debris, such as metal, cable and tires, encountered during excavation will be removed and recycled or disposed of at an appropriate disposal site.		
The Contractor will not dump, burn, bury, or allow others under its control to dump, burn, or bury construction wastes and refuse associated with the Work. Should refuse or construction wastes related to the Work be dumped, the Contractor will immediately act to clean up and remove the waste material to an approved location.		
The Contractor's work area will have a recycling and waste management program in place. Among other things, clearly labelled garbage bins with lids and recycling containers must be made available for food waste and recyclable office waste. The Contractor will arrange for the placement of garbage receptacles and recycling containers at key locations within the Project Areas such as in the vicinity of the laydown area.		
The Contractor will establish regular clean up and disposal programs so as to prevent the unnecessary accumulation of excessive construction waste and refuse.		
Monitoring		
The work area will be inspected by the EM for effectiveness of control measures put into place by the Contractor(s).	EM	As necessary

7.13 Hazardous Materials Handling and Storage

7.13.1 References

- BC Fire Code.
- National Fire Code of Canada.
- *Transportation of Dangerous Goods Act.*
- Transportation of Dangerous Goods Regulation.
- Workplace Hazardous Materials Information System (WHMIS).
- Occupational Health & Safety Regulation, BC Regulation 296/97.
- BC A Field Guide to Fuel Handling Transportation & Storage.

- Formation Safety and Environment Management System Directive.
- Contract technical specifications.
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).

7.13.2 Protection Measures

Protection Measures	Responsibility	Timing
Environmental Protection Plan(s) Component		
Specific measures that will be undertaken and equipment that will be used to manage hazardous materials will be described, including: ▪ The proposed location and types of facilities where hazardous materials will be stored and handled, and where construction equipment will be refuelled. ▪ Details of containment facilities for fuels, oils, antifreeze, and other liquid forms of hazardous materials such that spills can be contained and collected before contaminants enter soils or reach any watercourse or storm water system. This information may be included in the Health and Safety Plan prepared by the Contractor for the Projects.	Contractor	Prior to work commencing
Implementation		
Hazardous materials will be disposed of in accordance with law and the requirements of all authorities having jurisdiction.	Contractor	On-going during Projects
Should the on-site storage of hazardous materials such as gasoline or oils be required, secondary containment capable of holding at least 110% of all hazardous materials stored within will be in place.		
Above ground storage tank areas will be bermed, lined, and have in place appropriate drainage systems for removing accumulated rainwater.		
Current Material Safety Data Sheets (MSDS) and an inventory will be maintained for all controlled substances used, stored, and handled onsite associated with Project activities.		
An area will be designated, as required, for the transfer or temporary storage of hazardous materials and wastes. The area will be clearly labelled and controlled in accordance with WHMIS and other statutes.		
Where construction activities involve the handling, storage, and removal of hazardous waste, the Contractor(s) will maintain the following records: ▪ Inventories of types and quantities of hazardous waste generated, stored, or removed. ▪ Manifests identifying hazardous waste haulers and disposal destinations. ▪ Disposal certification documents.		
Personnel will be trained in the handling and transportation of dangerous goods and controlled substances.		
Monitoring		
The work area will be inspected for effectiveness of control measures implemented by the Contractor(s).	EM	As necessary

7.14 In-water Transportation, Offloading, Stockpiling, Processing and Off-Site Disposal of Dredged Material

7.14.1 References

- *Canada Marine Act.*
- *Transportation of Dangerous Goods Act.*
- *Navigation Protection Act.*
- *Fisheries Act.*
- Final Environmental Effects Determination: F/G Jetty Optimization Project and Colwood South Remediation Project (Golder 2016a).
- Contract technical specifications.

7.14.2 Protection Measures

Protection Measures	Responsibility	Timing
Environmental Protection Plan(s) Component		
Stormwater Pollution Prevention Plan which will include specific measures that will be undertaken to prevent the direct or indirect discharge of contamination into or through facilities connected to stormwater systems.	Contractor	Before work commences
Sediment and Erosion Control Plan which will include specific measures that will be undertaken and equipment to be used to prevent sediment transport and erosion of stockpiles during periods of rain and/or wind.	Contractor	Before work commences
Specific measures that will be undertaken and equipment used to manage the off-site transport, handling and disposal of dredged material will be described.	Contractor	Before work commences
Implementation		
In-water Transport of Debris and Dredged Material		
Transport of debris and dredge material will be managed such that debris, dredged material, and water are contained during transportation.	Contractor	On-going during Projects
The Contractor will provide certification of seaworthiness from an independent marine surveyor for each haul barge that will be used for the Projects. In the event that a barge is damaged during Project activities and requires repair, a new certification of seaworthiness will be required.	Contractor	Before dredged material is loaded and transported
Material transportation by barge will require the contractor to obtain an authorization from the QHM pursuant to the *Canada Marine Act*.	Contractor	Before dredged material is transported
Off-Site Upland Offloading and Processing Facility		
Dredged material will be transported by barge to a contractor-provided upland offloading and processing facility. All offloading activities will occur at an upland offloading and processing facility that needs to provide adequate containment of dredge material and debris prior to final shipping of this material.	Contractor	On-going during Projects

Protection Measures	Responsibility	Timing
No sediment, debris, or water transfer can begin at the off-site offloading and processing facility until the spill prevention measures are reviewed by the Departmental Representative and determined to be in place.		
The Contractor shall offload in-water transportation barges at the upland offloading and processing facility in a manner that prevents spillage of waste or effluent to the water. A spill apron (or equivalent spill prevention measure) will be used during all offloading activities.		
Any spillage on the spill apron shall be removed as soon as practicable and properly disposed. Any such spillage outside of the upland offloading and processing facility shall be promptly cleaned up.		
Spillage of sediment or debris during offloading will be promptly cleaned up. If uncontrolled spillage occurs, all offloading operations will cease until the spillage is contained and cleaned up.		
The Contractor shall construct, operate, and maintain the upland offloading and processing facility such that all effluent drainage water, stormwater, or other form of discharges from stockpiled sediment and debris are collected for treatment and proper disposal. ■ No direct discharge of untreated effluent from the upland offloading and processing facility to the receiving waters is allowed. ■ All effluent from the upland offloading and processing facility shall be collected, treated, and discharged to federal, provincial, and local laws and regulations, and conditions of the permits. ■ The Contractor may elect to construct a water treatment system at the upland offloading and processing facility and shall demonstrate in the Construction Work Plan compliance with water quality requirements to discharge treated effluent back to the receiving waters. All water discharged to any surface water originating from the Off-Site Staging and Stockpile Area shall meet Canadian Council of Ministers of the Environment (CCME) or BC Ministry of the Environment water quality guidelines, or the more stringent of the two. The Contractor shall provide analytical test results to the Departmental Representative prior to discharge and shall account for time for the Departmental Representative to review and accept the discharge as part of the completion of the work.		
Upland stockpiles will be managed to prevent uncontrolled runoff of water that has been in contact with the dredged material and to protect them from the weather.		
Catch basins beneath stockpiles will be sealed and all water will be collected and stored on site for treatment and/or off-site disposal. Other catch basins within the upland staging area but not directly beneath stockpiles will be protected with a below-grate inlet device (BGID) to collect sediment and debris from stormwater prior to discharge. The BGID will be inspected and maintained on a regular basis, with records available.		
The contractor will be required to maintain a clean upland offloading and processing facility and provide a wheel/truck wash to prevent vehicles from tracking contaminated soil or sediment off site.		
Equipment will be fuelled in a designated area that separates fuelling operations and protects the environment from accidental spills during fuelling.		
The Contractor will be responsible for site security at the upland offloading and processing facility. If necessary, a fully enclosed security fence with lockable gate will be installed around the upland staging area.		

Protection Measures	Responsibility	Timing
Upland Transport and Disposal of Dredged Material		
If temporary storage of material is proposed prior to final transportation and disposal, the Contractor will use appropriately permitted sites.	Contractor	On-going during Projects
The Contractor will dispose of the dredged material at a permitted disposal facility and will provide certification from the landfill operator that they can accept the dredged sediment with its contaminant and salinity concentrations.		
Material transported from the site will be safe for transport, and adequately secured.		
If required, based on the quality of the material for off-site disposal, materials will be transported by a licensed hauler in accordance with the *Transportation of Dangerous Goods Act.*		
The Contractor will provide waste manifests for shipment/disposal of dredged materials.		
Monitoring		
Inspection of upland offloading and processing facility prior to or during material transportation from the site may be conducted. Environmental records pertaining to the management of the sites will be made available by the Contractor, if requested.	PWGSC	On-going during Projects

8.0 CLOSURE

If you have any questions regarding this EMP, please do not hesitate to contact the undersigned at 250-881-7372.

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- BC Contaminated Sites Regulation, 1997.
- BC *Environmental Management Act* (2004).
- BC Hazardous Waste Regulation.
- BC *Workers Compensation Act* (1996).
- *Canadian Environmental Assessment Act, 2012*.
- *Canadian Environmental Protection Act, 1999*.
- *Fisheries Act*, 1985.
- *Migratory Birds Convention Act, 1994*.
- *Navigation Protection Act*, 2014.
- *Species at Risk Act*, 2003.
- Occupational Health and Safety Administration (OSHA) Occupational Health and Safety Standards.
- The Bylaw to Regulate Noise within the City of Colwood (Bylaw No. 38) (2001).
- The Township of Esquimalt (ToE) Property, Unsightly Properties and Nuisance Bylaw No. 2826 (2014).
- The City of Colwood Nuisance Controlled Substance Bylaw No. 851 (2006).
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APPENDIX A

Water Quality Monitoring Plan (WQMP)

7 July 2016

DND CFB ESQUIMALT F/G-JETTY OPTIMIZATION PROJECT AND COLWOOD SOUTH REMEDIATION PROJECT

Water Quality Management Plan

Submitted to:
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Environmental Services, Pacific Region
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V8W 3X4

REPORT

Report Number: 1657898-011-R-Rev0

Distribution:

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Golder Associates

Notice to Readers

This report was prepared for Canada in accordance with terms and conditions of the task authorization contract #EZ899-150978/002/PWY, dated February 16, 2015.

The inferences concerning the Site conditions contained in this report are based on information obtained during the assessment conducted by Golder personnel, and are based solely on the condition of the property at the time of the Site reconnaissance, supplemented by historical and interview information obtained by Golder, as described in this report.

This report was prepared, based in part, on information obtained from historic information sources. In evaluating the subject Site, Golder has relied in good faith on information provided. We accept no responsibility for any deficiency or inaccuracy contained in this report as a result of our reliance on the aforementioned information.

The findings and conclusions documented in this report have been prepared for the specific application to this project, and have been developed in a manner consistent with that level of care normally exercised by environmental professionals currently practicing under similar conditions in the jurisdiction.

With respect to regulatory compliance issues, regulatory statutes are subject to interpretation. These interpretations may change over time, these should be reviewed.

If new information is discovered during future work, the conclusions of this report should be re-evaluated and the report amended, as required, prior to any reliance upon the information presented herein.

Record of Issue

Company	Client Contact	Version	Golder Project Number	Date Issued	Method of Delivery
PWGSC	K. Ritchot	RevA	1657898	30 June 2016	E-mail
PWGSC	K. Ritchot	Rev0	1657898	7 July 2016	E-mail

Executive Summary

Project Description

The Department of National Defence (DND) is proposing to remediate contaminated sediment in the areas of F/G-Jetty and D-Jetty as part of the F/G-Jetty Optimization Project (FGOP) and Colwood South Remediation Project (CSRP) (collectively referred to hereafter as 'the Project'). The proposed remediation involves the removal of sediments that have contaminant concentrations more than five-times greater than the probable effects level (PEL) sediment quality guidelines (SQG).

Golder Associates Ltd. (Golder) was retained by Public Works and Government Services Canada (PWGSC) on behalf of DND to develop a Water Quality Monitoring Plan (WQMP) that will be implemented during the Project to verify water quality predictions for Project activities, including the dredging itself, as well as discharge of barge dewatering effluent, and that will provide a feedback mechanism for implementing management actions. The WQMP, which is part of the Environmental Management Plan (EMP), outlines the scope of monitoring that will be undertaken during project activities and identify appropriate parameters and assessment criteria.

Why Monitor Water Quality?

Water quality monitoring is a necessary part of the CFB Esquimalt F/G-Jetty Optimization Project (FGOP) and Colwood South Remediation Project (CSRP) (collectively referred to hereafter as 'the Project') for the following reasons:

- To verify that the remedial project is not resulting in environmental impacts (i.e., harmful changes) during its implementation;
- To verify that the environmental controls on the dredging project are adequate to protect the environment;
- To provide environmental management data that will identify, through pre-established triggers, when additional controls on, or cessation of, Project-related activities (e.g., dredging, intertidal excavation) is necessary;
- To provide data that will enable regulatory reporting and confirmation of regulatory targets; and
- To form part of PWGSC's due diligence efforts for this project.

What are the Monitoring Plan Elements?

Water quality in and adjacent to the Project Area may be affected by Project activities through the following:

- Induced suspension of solids / turbidity (e.g., during structure removal, dredging, dewatering of dredged material, in-water transport of dredged material and debris, placement of substrate in-fill).

- Release of contaminants from:
  - Re-suspension of contaminated sediments during dredging to a lesser extent during piling removal, cleaning, and installation.
  - Dewatering of the dredged sediment on the barge.
  - In-water transportation of dredged material, offloading and stockpiling of dredged material through stormwater system, or upland equipment decontamination through stormwater system.
- Release of creosote from pilings during removal and storage (before disposal) as well as re-installation of existing timber piles if in suitable condition.
- Fuel or hydraulic spills from equipment.

Physical controls will be used to minimize the induced suspension of solids and potential release of contaminants associated with sediments and monitoring will be undertaken in part to verify that these controls are functioning as intended.

The monitoring plan is based on a combination of “real-time” collection of *in situ* measurements for day-to-day management of Project activities, as well as collection of water samples for laboratory analyses for verification purposes. The monitoring program is also designed to provide information to distinguish induced turbidity related to Project activities from that generated by normal vessel activities in Esquimalt Harbour.

- ***In situ* turbidity measurements** – turbidity can be monitored manually on a “real-time” basis without costs for laboratory analysis (i.e., *in situ* with a field meter), which allows for more measurements to be collected at a greater frequency and across a greater spatial scale. This provides the monitoring program with flexibility to meet the conditions of the project at a given time. A turbidity-total suspended solids (TSS) relationship has been developed, which allows for turbidity to be a surrogate for TSS, and by extension, contaminants of concern associated with the TSS. The turbidity-TSS relationship will be verified and re-calibrated as necessary based on the results of paired turbidity and TSS results.
- **Collection of water samples for laboratory analysis** – these samples will be collected, but on a less frequent basis to verify that the environmental controls are functioning as intended and that environmental impacts are not being caused.

Table of Contents

TABLES

FIGURES

APPENDICES

List of Abbreviations

ASTM	American Standard Testing Methods
BC	British Columbia
CALA	Canadian Associate of Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
CD	Chart datum
CRM	Certified reference material
DFO	Department of Fisheries and Oceans
DQO	Data quality objective
DU	Dredge unit
EGD	Esquimalt Graving Dock
EMP	Environmental management plan
EPP	Environmental protection plan
GPS	Global positioning system
HHW	Higher high water
LLW	Lower low water
MMER	*Metal Mining Effluent Regulation*
MoE	Ministry of Environment
NLW	North Landing Wharf
NTU	Nephelometric turbidity units
OBS	Optical backscatter
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
POD	Point of discharge
PVC	Polyvinyl chloride
PWGSC	Public Works and Government Services Canada
QA/QC	Quality assurance / quality control
QP	Qualified professional
RAO	Remedial action objective
RPD	Relative percent difference
TBT	Tributyl tin
TSS	Total suspended solids
UTM	Universal transverse mercator
WQG	Water quality guideline
WQMA-A	Water Quality Management Area A
WQMA-B	Water Quality Management Area B
WQMP	Water quality monitoring plan

List of Units

°C	degrees Celsius
g	gram
h	hour
m	metre
µg/L	micrograms per litre
mg/L	milligram per litre
mm	millimetres
NTU	Nephelometric turbidity units

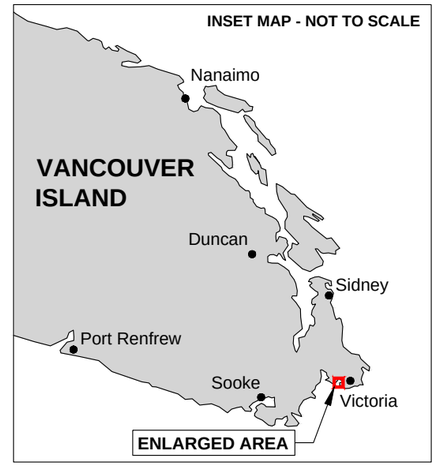
1.0 INTRODUCTION

1.1 Background

The Department of National Defence (DND) is proposing to remediate contaminated sediment in the areas of F/G Jetty and D Jetty as part of the F/G-Jetty Optimization Project (FGOP) and Colwood South Remediation Project (CSRP) (collectively referred to hereafter as 'the Project') (Figure 1). The proposed remediation involves the removal of sediments that have contaminant concentrations more than five-times greater than the probable effects level (PEL) sediment quality guideline (SQG; CCME 1999) as outlined in the basis of design reports for the two remediation areas (Anchor 2016a,b).

Golder Associates Ltd. (Golder) was retained by Public Works and Government Services Canada (PWGSC) on behalf of DND to develop a Water Quality Monitoring Plan (WQMP) that will be implemented during the Project to verify water quality predictions for Project activities, including the dredging itself, as well as discharge of barge dewatering effluent, and that will provide a feedback mechanism for implementing management actions. The WQMP, which is part of the Environmental Management Plan (EMP), outlines the scope of monitoring that will be undertaken during project activities and identify appropriate parameters and assessment criteria.

KEY MAP



LEGEND

REMEDIATION FOOTPRINT

REFERENCE(S)

1. PROJECT FOOTPRINT PROVIDED BY ANCHOR QEA; DRAWING: DFG Remediation Areas_20160630.dwg.
2. IMAGERY DOWNLOADED FROM SLR CONSULTING EXAVAULT; ACCESSED 2016-02-03; 2015 AIR PHOTOS, 10 cm RESOLUTION.

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CLIENT
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-07-07
DESIGNED	J. SHERRIN
PREPARED	S. BIRDSELL
REVIEWED	V. LAWRENCE
APPROVED	B. WERNICK

PROJECT
F/G JETTY OPTIMIZATION PROJECT
AND COLWOOD SOUTH REMEDIATION PROJECT
ENVIRONMENTAL EFFECTS DETERMINATION

TITLE
KEY PLAN

PROJECT NO.	PHASE	REV.	FIGURE
1657898	1000	0	1

Path: \\golder.gds\gal\Victoria\CAD-GIS\Client\PWGSC\esquimalt_harbour\99_projects\15455562_marinehabitat\02_PRODUCTION\3000_EnvEffects\Det\DWG\ | File Name: 1545562-3000-RB-52.dwg

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1.2 Objectives

The objectives of the WQMP are to address the following:

- Outline the scope of water quality monitoring that will be undertaken during Project activities including location and frequency of monitoring;
- Identify appropriate parameters and assessment criteria;
- Present decision criteria and high-level management actions; and
- Present data compilation and quality assurance/quality control (QA/QC) measures.

1.3 Report Structure

The WQMP includes the following components:

- A description of baseline water quality conditions in Esquimalt Harbour, including an evaluation of implications for the Project (Section 2.0);
- Parameters to be monitored (Section 3.1) and limits that will trigger management actions (Section 3.2);
- Methodology for i*n-situ* water quality monitoring for real-time assessment and automated turbidity monitoring (Section 3.3);
- Validation of total suspended solids (TSS) levels and plume direction (Section 3.4);
- Monitoring data management procedures (Section 3.5.3);
- Monitoring data quality assurance/quality control (QA/QC) procedures that will be undertaken to verify the reliability of collected data (Section 3.5); and
- Reporting (Section 4.0).

This WQMP is intended to be read in conjunction with the Environmental Management Plan (EMP), environmental approvals, authorizations and contract requirements for the Project.

A summary of federal and provincial pollution prevention legislation is provided in the EMP for the Project. The intent of this WQMP is to provide direction to DND, Consultants, and the Contractor that is consistent with the provisions for environmental protection contained in that legislation. Should further clarification of any environmental issue be required, the appropriate regulation or legislative document should be consulted, or advice sought from DND.

2.0 PROJECT AREA AND LOCATION

Esquimalt Harbour is a sheltered body of water that covers a total area of 3.38 km^2 and occupies approximately 15 km of linear shoreline. The harbour entrance, Royal Roads passage, connects to the Strait of Juan de Fuca. The main body of Esquimalt Harbour has an average depth of 10 m below CD in open-water areas, and is deepest near the mouth of the harbour and shallowest towards Price Bay at the northern extent of the harbour. The mouth of Millstream Creek, at the northwest end of Esquimalt Harbour, is a productive estuary and mud flats, with tidal influence present for several hundred metres upstream of the shoreline of the harbour.

Surface water in Esquimalt harbour exchanges with waters of the Strait of Juan de Fuca through the harbour entrance, Royal Roads passage, which is approximately 750 m across. The relatively wide entrance of the harbour allows the tidal regime of the harbour to match surrounding areas outside the harbour.

Based on Canadian Tide and Current Tables, Esquimalt Harbour's mean tide is 1.8 m (relative to chart datum) with a reported large tide of 3.1 m. The mean tide Higher High Water (HHW) is 2.5 m, and the large tide HHW is 3.4 m. The mean Lower Low Water (LLW) is 0.7 m, and the large tide LLW is 0.1 m (DFO 2010a).

An investigation of currents and tidal effects in the harbour was conducted in 2010 (Golder 2011). A vessel mounted acoustic doppler current profiler (ADCP) was towed along five survey lines to determine current speeds and direction over an entire tidal cycle. Exchange of water through the mouth of the harbour during peak flood and ebb tidal periods resulted in depth-averaged current speeds in excess of 1 m/s near the mouth of the harbour. For most of the harbour, including the Project Area, the measured currents were shown to be typically weak and variable in direction (Golder 2011).

The Project is located at D Jetty and F/G Jetty on the west shore of Esquimalt Harbour at DND Colwood (Figure 1).

2.1 Water Quality in Esquimalt Harbour

2.1.1 Surface Water Quality

Existing surface water quality is relevant to the Project water quality monitoring because:

- It provides a characterization of pre-project water quality conditions; and
- It provides a basis of "background" conditions against which monitoring data can be compared, such that interpretation (by a Qualified Professional [QP])[1] of water quality monitoring results is better supported.

A brief overview of contaminants data is provided here, with additional detail on background turbidity data provided because this parameter will be a substantial component of the water quality monitoring program during remedial dredging. In the event that further interpretation is needed, the QP should refer to the original reports referenced below. Overall, the available data indicate the importance of collecting contemporary and project-specific data for managing the dredging at D Jetty and F/G Jetty because intermittent events unrelated to dredging can affect what is relatively good water quality in Esquimalt Harbour.

[1] A QP is an applied scientist specializing in the area of biology, who: is registered in British Columbia with an appropriate professional organization; and through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice regarding environmental management of the Project. This definition was adapted from the Municipal Wastewater Regulation (pursuant to the BC *Environmental Management Act*).

Water quality data for Esquimalt Harbour are available from surface water samples collected during multiple separate investigations between 2005 and 2014. Metals were generally found to be below or at federal (CCME 1999a) and provincial (MOE 2010) water quality guidelines (WQGs), with slightly higher concentrations occurring near the mouth of the Esquimalt Graving Dock than in Esquimalt Harbour to the west (SLR 2008, 2014; SEACOR 2005, Golder 2006a,b). Polycyclic aromatic hydrocarbons (PAHs) were also below WQGs except in some samples collected near Outfall D adjacent to Monroe Head on the east side of Esquimalt Harbour in 2005. This dataset is limited and these conditions should not be assumed to represent background concentration at the time the Project is implemented.

Turbidity monitoring was undertaken in Esquimalt Harbour between October 18 and December 15, 2010 prior to remedial dredging at the Esquimalt Graving Dock (Golder 2011). Turbidity values ranged between 0 and 165 nephelometric turbidity units (NTU) south of D Jetty and up to 817 NTU at stations on the east side of Esquimalt Harbour. The 99th percentile of all NTU values observed in the field was 6.4 NTU (n = 59,000). The short-duration peaks in turbidity observed may have been due to sediment re-suspension caused by operational activities including boat/tug activity, propeller wash, or by natural re-suspension of sediments caused by wind-waves and tidal currents.

Manual monitoring turbidity, water temperature, pH, dissolved oxygen, chlorophyll *a*, and conductivity was also undertaken at each of the automated turbidity monitoring stations (Golder 2011). During the monitoring period, these parameters were relatively consistent among sampling stations and across water depths, indicating that the harbour was relatively well mixed (Table 1). These data may not be representative of conditions during colder or warmer weather when stratification may occur. Potential stratification of the water column will need to be taken into consideration during monitoring for potential turbidity plume generation and distribution.

Table 1: Vertical Profile Data from Esquimalt Harbour (Collected Manually) for Turbidity, Temperature, Dissolved Oxygen, Chlorophyll *a*, and pH (October/November 2010)

Parameter	Depth	West Side of Esquimalt Harbour	East Side of Esquimalt Harbour	
		South of D Jetty	Munroe Head	CFSA
Turbidity (NTU)	Shallow (0-4 m)	0.50	0.53	0.51
	Mid-water (4-8 m)	0.43	0.63	0.48
	Deep (8 m+)	0.54	-	0.60
	Overall	*0.49*	*0.55*	*0.54*
Temp. (°C)	Shallow (0-4 m)	7.53	8.51	7.88
	Mid-water (4-8 m)	8.54	8.00	7.94
	Deep (8 m+)	8.44	-	7.79
	Overall	*8.08*	*8.42*	*7.86*
Dissolved Oxygen (mg/L)	Shallow (0-4 m)	7.98	7.27	7.59
	Mid-water (4-8 m)	7.14	7.25	7.36
	Deep (8 m+)	6.99	-	7.38
	Overall	*7.44*	*7.27*	*7.45*

Parameter	Depth	West Side of Esquimalt Harbour	East Side of Esquimalt Harbour	
		South of D Jetty	Munroe Head	CFSA
Chlorophyll *a* (µg/L)	Shallow (0-4 m)	0.74	1.24	1.08
	Mid-water (4-8 m)	1.06	0.65	0.91
	Deep (8 m+)	1.05	-	1.01
	Overall	*0.92*	*1.13*	*1.00*
pH	Shallow (0-4 m)	8.14	8.07	8.14
	Mid-water (4-8 m)	8.06	8.15	8.13
	Deep (8 m+)	8.08	-	8.17
	Overall	*8.10*	*8.08*	*8.15*

Notes:
CFSA – Canadian Forces Sailing Association; NTU – nephelometric turbidity units; '-' – measurement not made because the sampling station was shallower than 8 m.

2.1.2 Turbidity Implications for the WQMP

On average, turbidity in Esquimalt Harbour is low, with mean values typically being less than 5 NTU[2] at most stations and median turbidity being < 1 NTU. However, the data available from the turbidity loggers demonstrates that Esquimalt Harbour turbidity can, at times be "patchy." Additionally, large turbidity events (e.g., two orders of magnitude increases) can occur as short-duration (i.e., hours long) transient events, for example from activities such as ship passage and propeller wash. Thus a turbidity value that represents an increase over background and thus the operational characterization of background (i.e., during Project activities) will be an important information item because it will aid in deciding if turbidity measurements are of concern or if turbidity measurements are simply normal, transient events associated with operations in the harbour.

Two WQMP considerations are raised by these observations:

- A greater number of reference stations and/or samples than recommended here could be necessary. That determination should be made under operational conditions and with the benefit of visual observations made and turbidity data collected during operations. Because the turbidity monitoring costs are not unit costs (equipment rental plus staff time), this should not appreciably impact on the monitoring implementation costs.
- An appropriate response to a single high turbidity value that is in the range of data depicted in Table 1 is to resample and to identify the reasons for that increase prior to implementing more stringent operational controls. Because of the characteristics of background turbidity data (short duration, relatively high magnitude transient events), there is a risk of incorrect presumptive decisions that could affect project cost and schedule.

[2] For reference, a turbidity reading of 5 NTU is the upper limit for drinking water turbidity. Prior to Metro Vancouver implementing filtration, this was the approximate cloudiness of Vancouver tap water on a "bad day".

3.0 WATER QUALITY MONITORING

This section describes the following components of the water quality monitoring program that will facilitate verification that environmental controls on the dredging project are adequate, and provide environmental management data that will be used to identify when additional controls on, or cessation of Project activities is necessary:

- Monitoring parameters;
- Decision criteria and management actions; and
- Manual ("real-time") water quality monitoring.

Water quality in and adjacent to the Project Area may be affected by Project activities through the following:

- Induced suspension of solids / turbidity (e.g., during structure removal, dredging, dewatering of dredged material, in-water transport of dredged material and debris, placement of substrate in-fill).
- Release of contaminants from:
  - Re-suspension of contaminated sediments during dredging and to a lesser extent during piling removal, cleaning, and installation.
  - Dewatering of the dredged sediment on the barge.
  - In-water transportation of dredged material, offloading and stockpiling of dredged material through stormwater system, or upland equipment decontamination through stormwater system.
- Release of creosote from pilings during removal and storage (before disposal) as well as re-installation of timber piles if suitable for re-installation.
- Fuel and hydraulic spills from equipment.

Anchor (2011) used DREDGE[3] to model the potential for sediment re-suspension and dispersion of contaminants during active dredging for a number of scenarios with various assumptions regarding particle size and density, dredge bucket size and dredge cycle time for dredging at the EGD Waterlot. The modelling did not include the presence of a silt curtain. As expected, the model predicted that the highest TSS concentration would occur in the immediate vicinity of the dredge bucket for all scenarios (11 to 307 mg/L within 1 m of the dredge bucket), with TSS decreasing rapidly within 25 m of the dredge bucket (1 to 60 mg/L). However, depending on the scenario, the associated metals and/or PAH concentrations were predicted to exceed ambient federal (CCME 1999a) and provincial WQG (MOE 2010) up to 150 m from the dredge bucket. Thus, the modelling confirmed that a silt curtain will need to be used to help control and minimize the potential dispersion of fines-associated contaminants. The need for this mitigation is also applicable to the FGOP and CSRP because the sediment to be dredged is similar.

[3] A United States Army Corp of Engineers model (Hayes and Je 2000).

The water discharging to the marine environment during barge dewatering activities has been assessed by Golder by estimating the potential release of sediment-associated substances on the dewatering barge to identify if specification of (for example) sealed barges for the project is required, resulting in the need for appropriate collection and treatment of the dewatering effluent prior to disposal. The assessment also identified controls that may need to be implemented to manage concentrations of TSS in the discharge water. The detailed assessment, including the modelling theory and assumptions, is provided in Golder (2016). The results of the barge dewatering assessment were also used to select appropriate TSS levels to manage dredging activities.

The WQMP provides a more structured monitoring program for induced turbidity/TSS (and by extension) release of contaminants, as this is the primary component of the project with potential for affecting water quality. Monitoring of pile removal activities will rely on visual inspections.

3.1 Monitoring Parameters

The WQMP includes measurement of various parameters that will provide information to manage potential effects from the Project. Background information on these parameters is provided below.

3.1.1 Total Suspended Solids

TSS encompasses both inorganic solids such as clay, silt, and sand, and organic solids such as algae and detritus and is a gravimetric measurement of the dry weight of suspended particulate material (solids) per unit volume of water. The measurement of TSS requires the collection of a sample and submission of that sample to the laboratory. Analysis is done by filtering the sample onto a glass fibre filter and drying the sample at a specified temperature. Data for this analysis are typically available on a 24-h turnaround.

The Project Area has been divided into two Water Quality Management Areas (WQMAs; Figure 2) for which different TSS levels have been established for management of barge dewatering and dredging, related to the physical effects of particulates as well as associated contaminants:

- WQMA-A: As described in Golder (2016), barge dewatering effluent from dredging of sediment on the north side of D-Jetty has the potential to cause effects in the receiving environment due to the presence of copper and zinc. No direct dewatering without additional mitigation (e.g., treatment) will occur when this area is dredged. A TSS concentration of 40 mg/L will be used to manage day-to-day dredging.
- WQMA-B: Potential effects from contaminants associated with the sediment were not predicted. Therefore, passive dewatering will be permitting and the TSS limit will be 75 mg/L (adopted from DFO and MELP [1992]) to manage the potential for physical effects from suspended solids. A TSS concentration of 75 mg/L will also be used to manage day-to-day dredging.

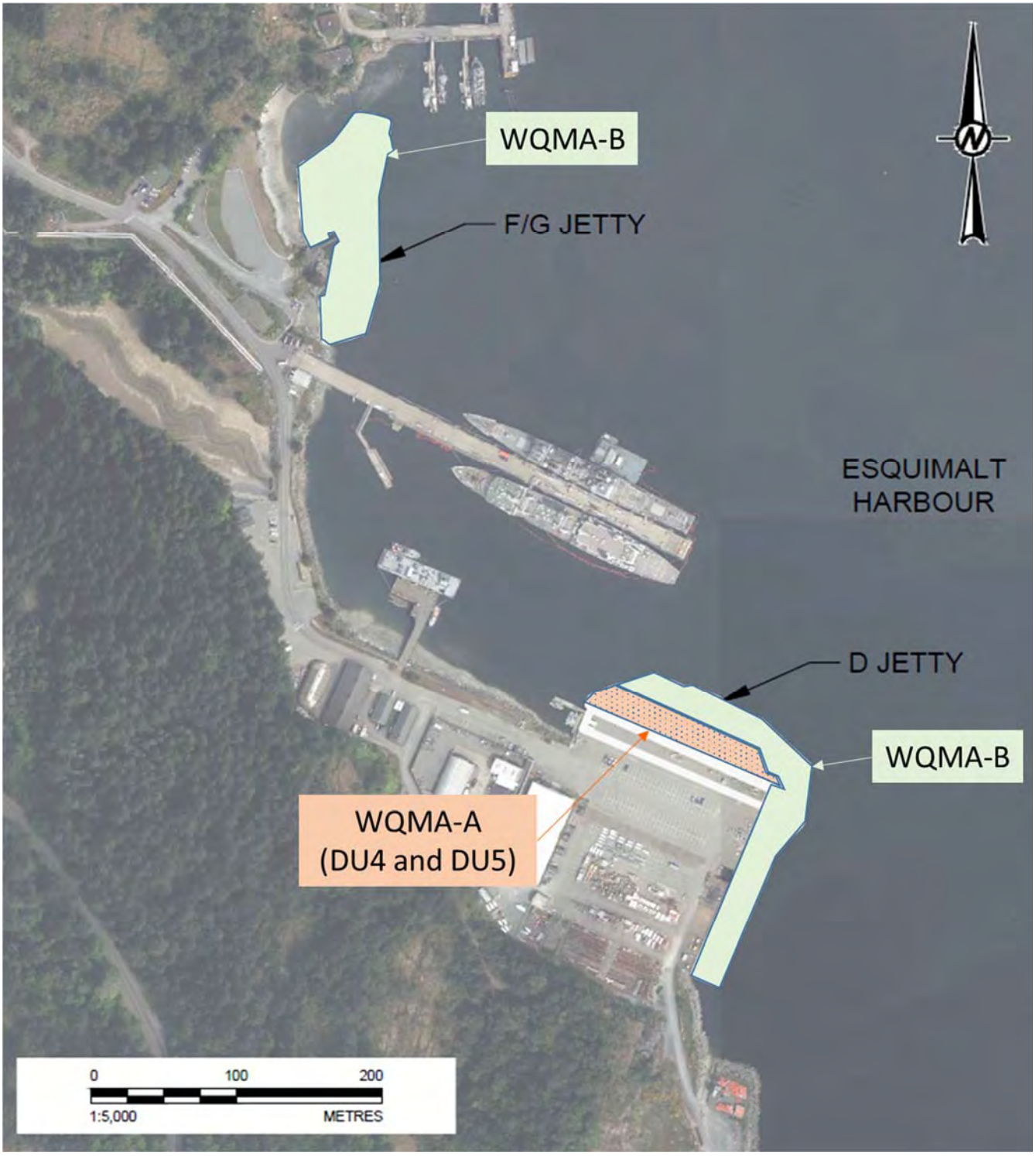

Figure 2: Water Quality Management Areas

3.1.2 Turbidity

Turbidity is a measure of the optical properties (e.g., scattering of light) of particulates suspended in water. Turbidity is often used for the day-to-day management of dredging activities as the results are available in real-time. Turbidity is measured using an instrument that measures the passage of light through the sample as well as the scattered light that is reflected from the sediment particles and reports values in units such as nephelometric turbidity units (NTU). Turbidity can be measured on-site, in real and near-real time.

A relationship was developed between TSS and turbidity based on water and sediment collected at Constance Cove within Esquimalt Harbour (Golder 2011; Appendix A), which has been reviewed against TSS and in-situ turbidity data collected during monitoring compliance for both the Esquimalt Graving Dock Waterlot Remediation Project (EGD) (Golder 2012) and the A/B Jetty Recapitalization Project (SLR 2015). The monitoring data did not result in a change in the original TSS-turbidity relationship. Based on this relationship, a TSS of 75 mg/L is related to a turbidity of 25 NTU and a TSS of 40 mg/L is related to a turbidity of 20 NTU (Figure 3).

The optical properties of suspended particulates may be different *in situ* than in the bench-scale testing; therefore, the TSS-turbidity relationship will need to be verified and re-calibrated as necessary based on measurements collected during dredging. It is recommended that this re-calibration be undertaken during the first month of dredging in each project area.

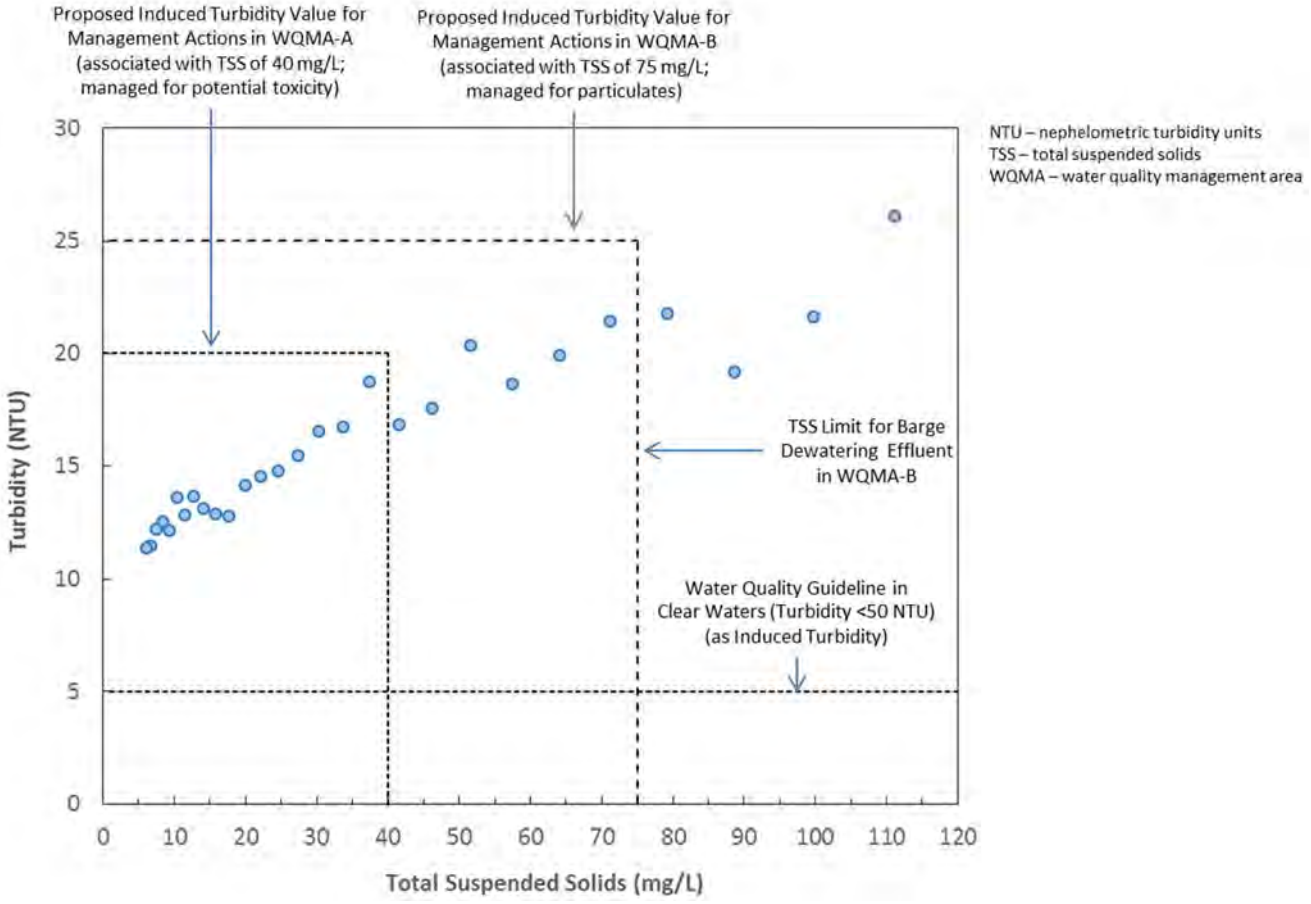

Figure 3: Total suspended solids – turbidity relationship and proposed decision criteria for management actions during dredging and barge dewatering activities (data from Golder 2011)

3.1.3 Dissolved Oxygen

Dissolved oxygen provides a measure of the amount of oxygen available for aquatic organisms. The oxygen content in the atmosphere is 21%, which equates to approximately 210,000 parts per million. However, the amount of oxygen dissolved in water is temperature and salinity-dependent but on the order of 10 parts per million or less. The ability of aquatic organisms to obtain oxygen from water is therefore susceptible to reductions in dissolved oxygen. In Esquimalt Harbour, dissolved oxygen concentrations of 6.23 to 7.98 mg/L were measured during Fall 2010. Concentrations were variable between locations and were lower deeper in the water column than at the surface (Table 1).

Dredging of marine sediments can result in the re-suspension of sediments that may be in an anoxic state, which can reduce the dissolved oxygen concentration in the water column to potentially harmful levels. The content of dissolved oxygen in water can also be affected by natural processes such as photosynthesis by algal blooms.

Dissolved oxygen will be measured *in situ* during manual water quality monitoring and results will be available in near real-time. The information will be used by the Qualified Professional[4] to evaluate potential for environmental impacts, for example to interpret whether effects are project-related or the result of natural processes.

3.1.4 pH

The pH measures how acid or alkaline a substance is with a pH of 7 being neutral (neither acid nor alkaline). Normal seawater pH values are slightly alkaline (in Fall 2010, pH values of 7.86 to 8.17 were measured in Esquimalt Harbour (Table 1) and seawater chemistry has the ability to resist minor changes but can be overcome when such changes are substantial. pH can be influenced by natural processes such as photosynthesis during algal blooms, which can result in elevated pH (i.e., > 9 pH units), whereas open-water dredging is not likely to change pH values to an extent that is, on its own, harmful. pH changes can affect the toxicity of other substances and it is therefore a necessary parameter to monitor so that interpretation of certain results by a Qualified Professional[5] is possible.

pH will be measured *in situ* during manual water quality monitoring.

3.1.5 Polycyclic Aromatic Hydrocarbons (PAH)

PAH substances are present in hydrocarbon products, vessel exhaust, and creosote used to treat timber used in marine construction. They may be adsorbed onto sediments and released from those sediments as a result of dredging. Water samples will be collected as indicated in Section 3.2 for submission to an analytical laboratory for analysis of a suite of PAHs. PAH analysis requires a minimum 24-h turnaround time, making its utility to the WQMP retrospective rather than operational. The purpose of collecting PAH data will be to confirm whether or not TSS limits selected based on predictive modelling PAH concentrations are protective.

[4] See Footnote 1 on page 2.

[5] See Footnote 1 on page 2.

3.1.6 Metals

The environmental effects determination indicated that the metals of potential concern include: arsenic, copper, lead, mercury and zinc. Water samples will be collected as indicated in Section 3.2 for submission to an analytical laboratory for analysis of these metals. Metals analysis requires a minimum 24-h turnaround time, making its utility to the WQMP retrospective rather than operational. The purpose of collecting metals data will be to confirm whether or not TSS limits selected based on predictive modelling of metals concentrations are protective.

3.2 Decision Criteria and Management Actions

There are presently no specific regulations pertaining to discharge from dredging projects, nor are there provincial discharge standards applicable to the point of discharge from a dredging project. The specific parameters and points of compliance are generally determined by agreement at the project level through the process of environmental review and consultation with the responsible regulatory agencies such to meet the general provisions of the environmental statutes.

Regulatory compliance is typically evaluated at the point at which an operator no longer exercises control over a discharge, often called the "end of pipe"[6]. In a dredging operation, there is no pipe terminus and control ends at the point at which turbidity is no longer controlled. In the case of this project, the end of pipe is the edge of the silt curtain for the dredging (Figure 4) and at the point of discharge (POD) for the dewatering barge (Figure 5). In order to evaluate the controls over the dredging project, the Project must meet pre-specified criteria at the POD. For safety reasons, however, if the silt curtain is configured adjacent to/around the dredge bucket, the operational compliance point for dredging may be 25 m from the edge of the silt curtain.

If a different silt curtain configuration is used, the location of the compliance point may need to be re-evaluated.

To verify that these controls are sufficient to protect the surrounding environmental values, additional assessment will be carried out approximately 100 m away (assessment point) where water quality should meet ambient WQGs or a pre-specified change from background condition.

[6] This reasonable operational concept is adapted from the *Metal Mining Effluent Regulation* (MMER), a regulation made pursuant to the *Fisheries Act*. Although the remedial dredging project is obviously not a metal mine and the regulations do therefore not apply, the definition of a discharge point contained in the MMER is a contemporary workable definition for the present purpose and one intended to have conformity with the parent legislation, the *Fisheries Act*. The MMER defines a discharge point as being the point at which the operator ceases to have control over the effluent. This definition provides a workable parallel to prevailing environmental statutes and enables an assessment of ecological risks within the context of federal and provincial regulatory requirements.

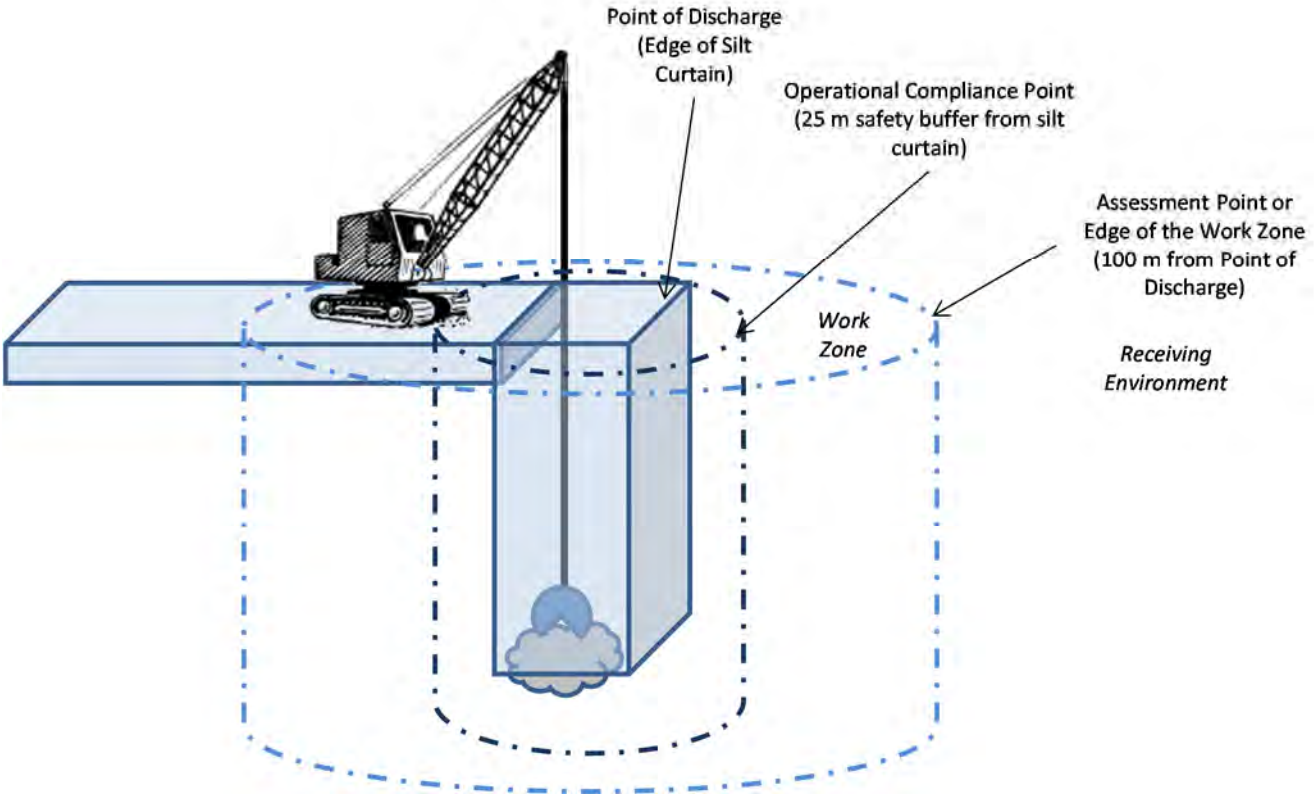

Figure 4: Schematic diagram showing the point of discharge, operational compliance point, and assessment point for a remedial dredging operation.

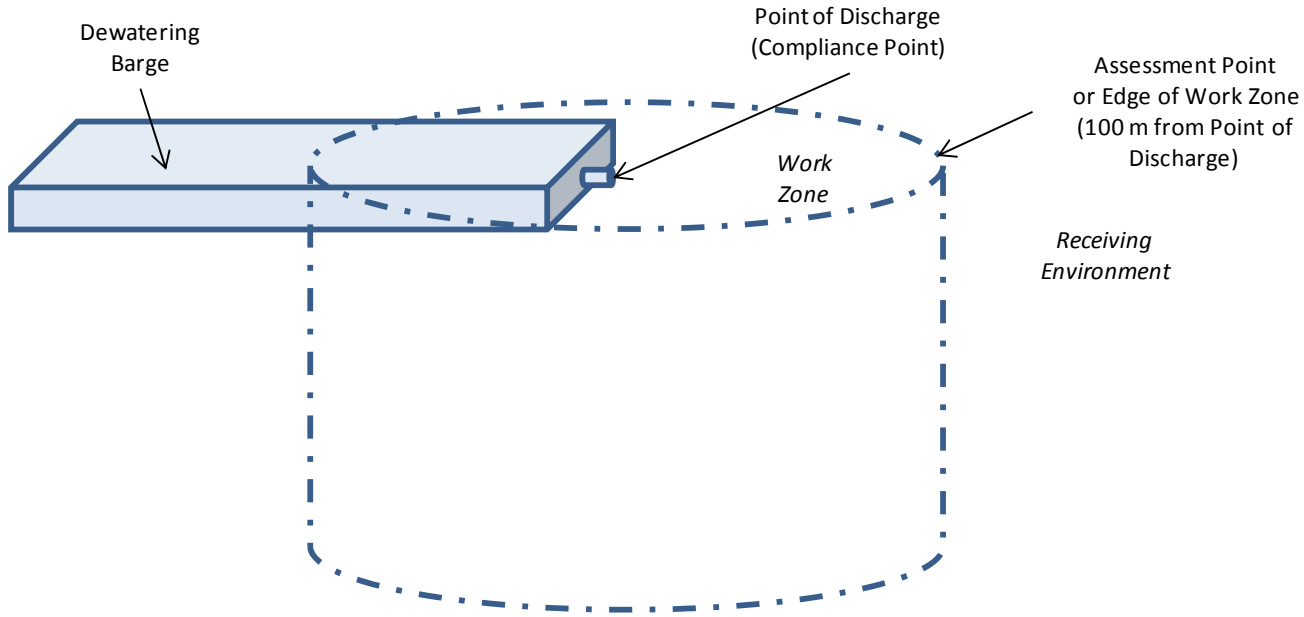

Figure 5: Schematic diagram showing the point of discharge (compliance point) and the assessment point for the dewatering barge.

For the purposes of the Project, site-specific benchmarks were developed for select parameters. The objective of the development and application of these benchmarks was two-fold:

- That lethal conditions (to fish) do not exist at the POD or the immediately surrounding work zone. The potential for acute lethality was evaluated against the proposed benchmarks.
- That chronic sub-lethal conditions (to fish) do not exist outside the work zone, which has been defined as 100 m away from the point of discharge (also called the assessment point). Ambient WQG or the proposed benchmark divided by 10, depending on how the WQG is derived, will be used to screen data from the edge of the work zone.

Decision criteria in Table 2 are provided for both the POD (e.g., the operational compliance point is considered to be 25 m from the edge of silt curtain for dredging) and the assessment point as represented by the outer boundary of the work zone. Parameter limits for TSS for the POD are provided for two portions of the Project Area (shown in Figure 2):

- **WQMA-A** – This management area has been identified in the barge dewatering assessment to have sufficiently high metals concentrations such that direct barge dewatering is not suitable without treatment.
- **WQMA-B** – The metals and PAH concentrations in seabed sediments in the remainder of the Project Area are sufficiently low that they are not predicted to result in potentially acute effects at TSS values of 75 mg/L (or a turbidity of 25 NTU as described in Section 3.1.2). The management consideration for, WQMA-B is related to the control of particulates.

Water quality parameters listed in Tables 3 to 5 are based on previously accepted[7] limits for remedial dredging projects as well as the assessment of barge dewatering effluent quality (Golder 2016). It is proposed that the day-to-day dredging activities be managed on the basis of real-time turbidity measurements (Figure 6). *In situ* measurements will also include dissolved oxygen, temperature, pH and salinity, and samples will be collected for laboratory analysis of TSS, metals, and PAHs on a specified schedule or as necessary in the event of exceedance of turbidity criteria.

[7] By federal regulators for remedial dredging projects in Vancouver Harbour.

Table 2: General Water Quality Requirements for the Project

Parameter	Point of Discharge[1]			Receiving Environment at Edge of Work Zone[2]
Total Suspended Solids	*Barge Dewatering*	WQMA-A: No discharge without treatment	WQMA-B: 75 mg/L[4]	<10 mg/L over background at any given time (<24 h duration) when background is <100 mg/L; <10% of background when background is >100 mg/L
	Open-water Dredging	WQMA-A: 40 mg/L[3]	WQMA-B: 75 mg/L[4]	
Turbidity[6]	Turbidity values as compliance limits for the discharge are not commonly specified for effluents. For the purposes of day-to-day management of dredging activities, turbidity value based on the TSS/turbidity relationship derived (Section 3.1; Figure 3). The TSS/turbidity relationship will be verified and re-calibrated as necessary based on real-time data collected during the Project			< 5 NTU over background[5,6] when background is <50 NTU; < 10% of background when background is > 50 NTU
Dissolved Oxygen	5 mg/L[7]			8 mg/L
pH	6.5 to 9.0 [8]			7.0-8.7 [9]
Metals – various	See Table 3			See Table 3
PAHs – various	See Table 4			See Table 4
Toxicity [10]	*Barge dewatering*:	WQMA-A: 96h LC_{50} ≥ 100% for treated effluent	n/a	n/a

Notes:

[1] Point of Discharge (POD) taken to be the established set-back or safe working distance from active dredging operations (e.g., 25 m from the edge of the silt curtain). For the dewatering barge, the POD is considered to be the discharge from the barge.

[2] Receiving environment taken to be the edge of the work zone or assessment point (i.e., 100 m from the edge of the silt curtain).

[3] Based barge dewatering assessment (Golder 2016).

[4] Originates from DFO and MELP (1992) and is based on freshwater systems during wet weather; however, this number is frequently applied to marine discharges as well. This concentration is based on the release of clean suspended particulate matter, such as may occur during the dredging of uncontaminated materials.

[5] Background is defined as the NTU value measured in the receiving environment up current from the activity.

[6] The baseline monitoring program indicated that background turbidity in Esquimalt Harbour is relatively low (mean = 3.8 NTU). However, intermittent increases to 400 NTU have been observed in related to vessel operations at the EGD and storm events. Therefore, turbidity will be evaluated for the Project as induced turbidity above background measured at the time of sampling.

[7] Based on British Columbia MOE ambient water quality guidelines for instantaneous minimum dissolved oxygen (BCMOE 2016).

[8] The range of pH specified for protection of marine waters is 7.0 – 8.7 to protect mollusk embryo development, based on British Columbia MOE ambient water quality guidelines for pH (BCMOE 2015). However, for the purposes of managing pH during construction projects, DFO has typically specified the same range as for freshwater (6.5 to 9.0), recognizing that these pH differences are small, short-term in nature, are not harmful, and with marine water buffering, the pH water quality guidelines will be met very quickly. Transient pH excursions to less than 7 or greater than 8.7 units are common natural occurrences in coastal environment.

[9] Based on MOE ambient water quality guidelines for pH (MOE 1991).

[10] Based on a test using a salt-water acclimated salmonid. All dewatering effluents are expected to be non-acutely lethal at the point of discharge; see Section 3.2.2 for discussion of when toxicity testing is to be conducted.

h – hour; mg/L – milligrams per litre; NTU – nephelometric turbidity units; POD – point of discharge; TSS – total suspended solids; WQMA-Water Quality Management Area (see Figure 2).

Table 3: Proposed Discharge Criteria for Metals

Parameter (as total)	Monitoring Criteria (µg/L) [1]	
	Point of Discharge [2]	Receiving Environment at Edge of Work Zone [3]
Arsenic	125	12.5
Copper	30	3
Zinc	100	10

Notes:

[1] The selection of this subset of metals is discussed in Golder (2016).

[2] Compliance for the Point of discharge (POD) will be at an established set-back or safe working distance from active dredging/excavation operations (e.g., 25 m from the edge of the silt curtain). For the dewatering barge, the POD is considered to be the discharge from the barge. These values apply to all Water Quality Management Areas (see Figure 2). The values are based on 10 x ambient WQG.

[3] Receiving environment taken to be the edge of the work zone (i.e., 100 m from the POD). Values are based on ambient WQG (CCME 2016; CCME 1999c; Singleton 1987; Nagpal 1999)

Table 4: Proposed Discharge Criteria for Polycyclic Aromatic Hydrocarbons

Parameter	Monitoring Criteria (µg/L) [1]	
	Point of Discharge[2]	Receiving Environment at Edge of Work Zone[3]
Acenaphthene	510	51
Anthracene	5.0	0.5
Benzo(a)anthracene	1.8	0.18
Benzo(b)fluoranthene	8.6	0.86
Benzo(a)pyrene	5.6	0.56
Benzo(g,h,i)perylene	1	0.1
Chrysene	8.6	0.86
2-Methylnaphthalene	58	5.8
Naphthalene	100	10
Phenanthrene	40	4.0
Pyrene	12.8	1.28

Notes:

[1] The selection of this subset of PAHs is discussed in Golder (2016).

[2] Point of discharge (POD) taken to be the established set-back or safe working distance from active dredging/excavation activities (e.g., 25 m from the edge of the silt curtain). For the dewatering barge, the POD is considered to be the discharge from the barge. These values apply to all Water Quality Management Areas (see Figure 2). The values are based on a combination of literature review and quantitative structure-activity (QSAR) relationship evaluations as described in Golder (2016).

[3] Receiving environment taken to be the edge of the work zone (i.e., 100 m from the POD). The values are based on the POD values with a 10-fold safety factor applied.

3.2.1 Decision Framework for Open-water Dredging

The decision framework for implementing management actions during **open-water dredging** is comprised of a series of steps to allow for adaptive management of dredging that will be responsive to environmental protection goals without unnecessary disruption to the operational needs of the Project. The framework for dredging in WQMA-A and WQMA-B is illustrated in Figure 6. The steps are as follows (turbidity values for WQMA-A are used in this example; for dredging in WQMA-B, the applicable turbidity values should replace the ones below):

1) Regular monitoring (Section 3.3) is undertaken to evaluate potential for induced turbidity (i.e., the change in turbidity greater than background) at the edge of the work zone (i.e., the assessment point) during dredging (Figure 4).

2) If turbidity is observed to be less than the ambient WQG (i.e., <5 NTU above background), regular monitoring of turbidity continues, with no application of management actions. In the event that turbidity is greater than the ambient WQG, the level of exceedance determines whether:

    a) Confirmatory sampling will be conducted (i.e., when induced turbidity is between 5 and 20 NTU above background for dredging in WQMA-A). Confirmatory turbidity measurements will be made at three locations along the assessment point (100 m from the silt curtain) at three depths (1 m below surface, mid-water column, and 2 m above the seabed).

    b) Implementation of management actions is warranted (when induced turbidity at the assessment point is >20 NTU above background for dredging in WQMA-A), followed by confirmatory sampling at the assessment point as described in Step 2a to evaluate the effectiveness of the management action.

3) Step 2 is repeated. If the ambient WQG is met at the assessment point, regular monitoring is continued and the process returns to Step 1. If the ambient WQG is exceeded, the level of exceedance determines whether confirmatory sampling should be conducted or management actions are implemented.

4) If, after Steps 2 and 3, induced turbidity continues to exceed the ambient WQG at the assessment point:

    a) Management actions will be implemented if induced turbidity is >5 and <20 NTU (in WQMA-A) and confirmatory sampling will include collection of turbidity measurements at 3 depths and 5 locations along the compliance point (25 m from the silt curtain or closer depending on configuration of the silt curtain relative to the dredge head) as well as at the assessment point (100 m from the silt curtain). The purpose of the additional monitoring locations is to collect information about the behavior of the turbidity plume that can be used by a Qualified Professional to evaluate the potential for environmental effects (which is determined in part by a combination of duration and magnitude). The QP will need to take into account background conditions, visual observations, and level of accuracy of field instrumentation when assessing which course of action should be taken.

    b) Dredging will be stopped if induced turbidity is >20 NTU (in WQMA-A). After corrective actions are implemented, dredging may re-commence as will regular turbidity monitoring.

5) If, after Step 4a, induced turbidity continues to exceed the ambient WQG at the assessment point (i.e., is >5 and <20 NTU for WQMA-A) or is >20 NTU at the compliance point (for WQMA-A), dredging will be stopped and corrective actions will be implemented. Dredging and regular turbidity monitoring may then resume.

The same process will be followed for dredging in WQMA-B; however, a different turbidity trigger value will be used (i.e., 25 NTU rather than 20 NTU).

In the event that validation of the TSS-turbidity relationship indicates that a different turbidity is associated with the TSS values applied as limits, the turbidity trigger values may be modified accordingly.

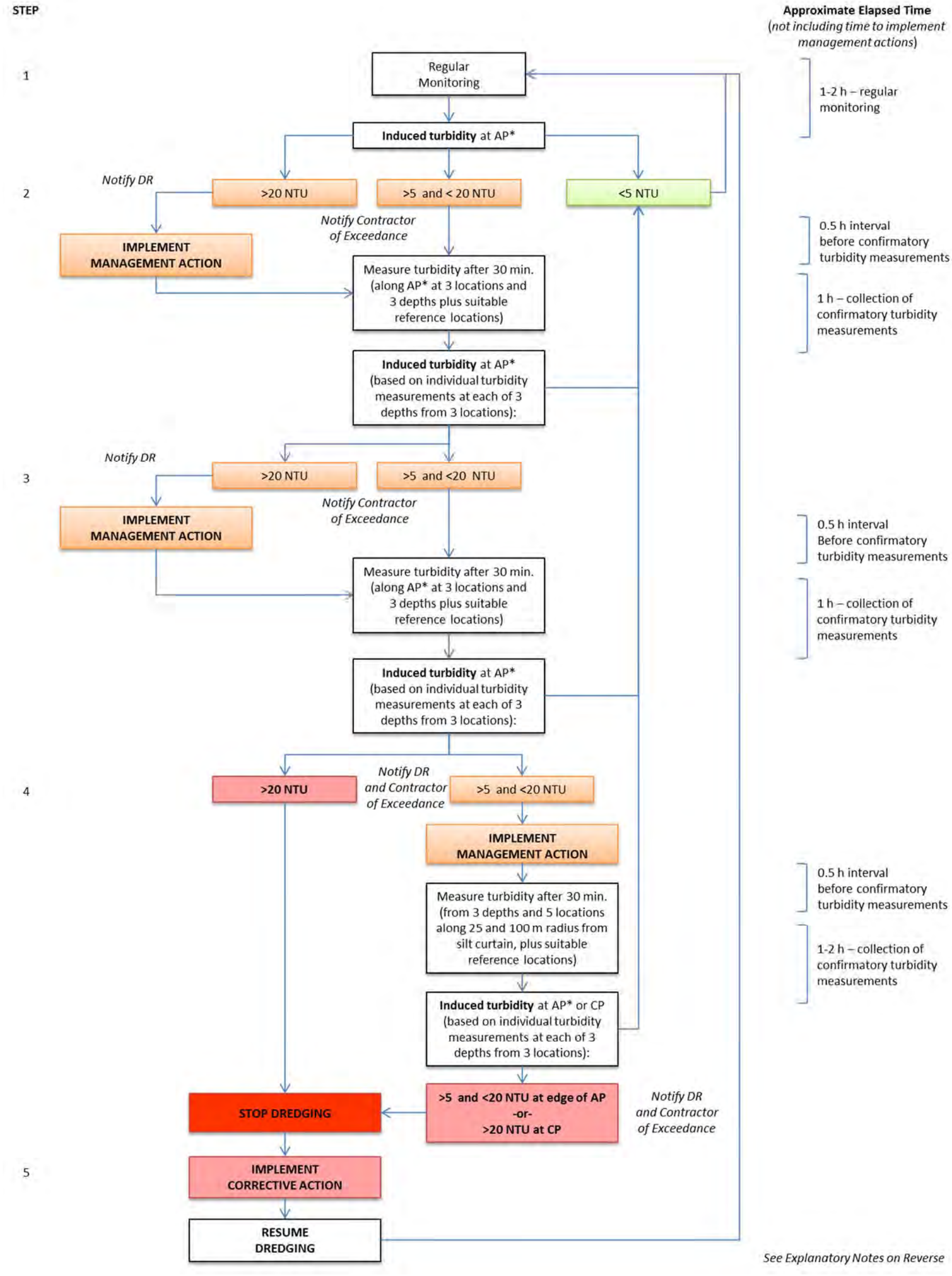

Figure 6: Decision Framework for implementing management actions during open-water dredging of water quality management areas a and b based on real-time monitoring of turbidity.

Notes for Figure 6:

IMPLEMENT MANAGEMENT ACTION – this may include: checking the silt curtain; slowing dredge cycle; changing bucket.

STOP DREDGING – Re-assess dredging to determine cause and define corrective actions prior to re-commencing dredging.

Induced turbidity is the level of change in turbidity greater than background. The value used for triggering management actions is dependent on the WQMA in which the work is being conducted. For dredging in WQMA-A, the turbidity limit is 20 NTU, and for dredging in WQMA-B, the turbidity limit is 25 NTU.

Turbidity values triggering confirmatory sampling and/or implementation of management actions may change as the TSS-turbidity relationship is verified and recalibrated based on data collected during dredging.

A Qualified Professional will evaluate potential for exceedances of performance objectives to cause environmental impact.

* Measurements based on real-time monitoring (collection of discrete samples in three locations in the water column). Additional sampling for metals and PAHs may need to be conducted in the event of exceedances of these induced turbidity values.

** Measurements made at 25 m from the silt curtain (or closer based on the configuration of the silt curtain relative to the dredge head) will be used to evaluate plume behaviour and potential for effects from exceedance of performance objectives.

Abbreviations:

AP – assessment point (100 m from POD; also called the edge of the work zone).
CP – compliance point (25 m safety buffer from silt curtain assuming that it is relatively close to the dredge bucket – the location of the compliance point will be re-evaluated based on the configuration of the silt curtain relative to the dredge head and may be at the edge of the silt curtain or at some distance within 25 m from the silt curtain).
DR – PWGSC Departmental Representative
m – metres.
min. – minutes.
NTU – nephelometric turbidity units.
PAH – polycyclic aromatic hydrocarbon.
TSS – total suspended solids.

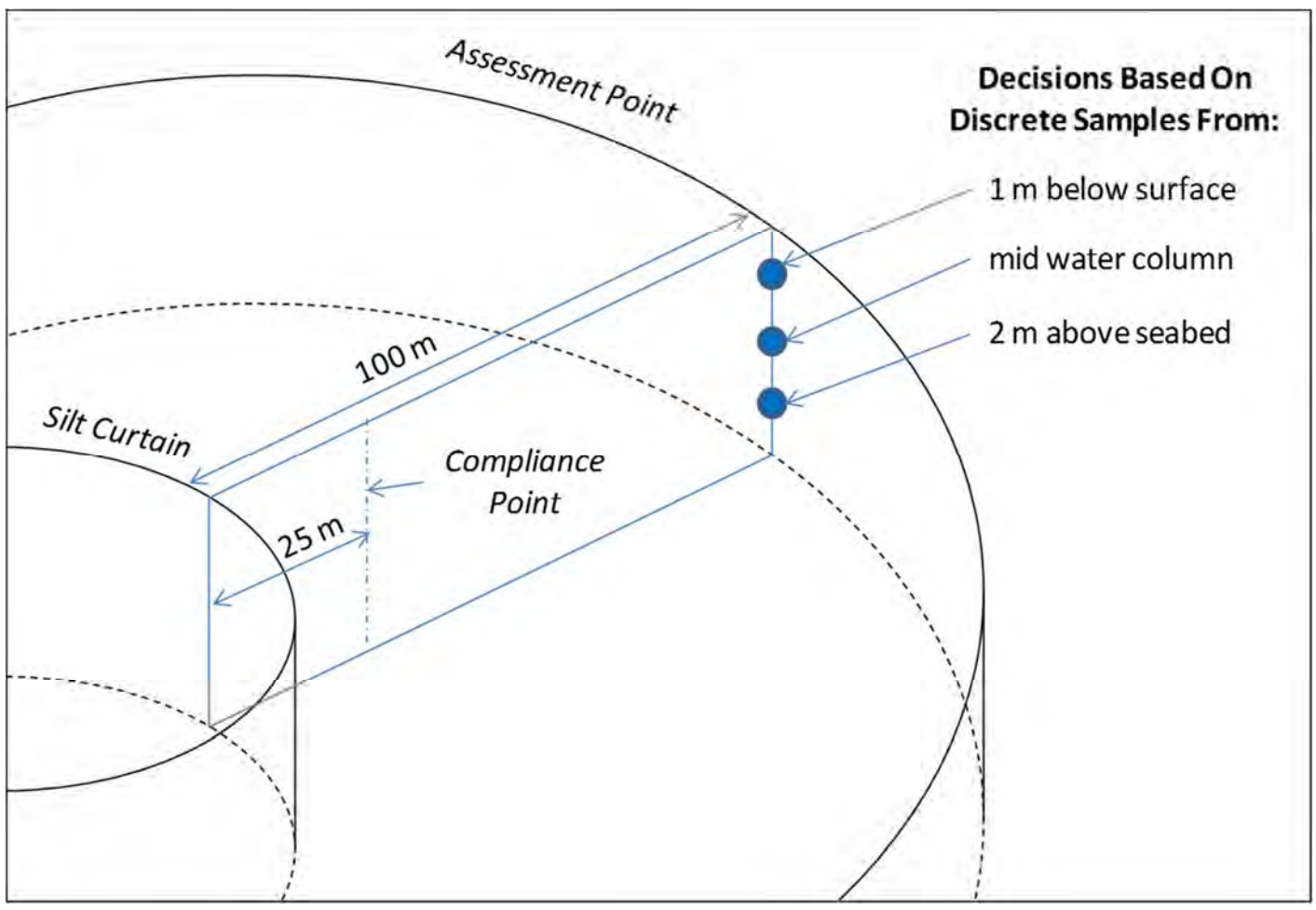

Figure 7: Conceptual layout of location of turbidity measurements in the water column.

3.2.2 Decision Framework for Barge Dewatering

For **barge dewatering** the compliance point is the point of discharge from the barge, and the assessment point is 100 m down current from the barge outlet (Figure 5). Both points will be monitored regularly, and if the dewatering discharge is found to contain a TSS concentration >75 mg/L in WQMA-B, management actions (e.g., cease loading of dredged material on the barge) will be implemented and confirmatory monitoring conducted on the water in the barge and at the assessment point to evaluate the potential for environmental impacts. No direct discharge from the barge will occur without treatment or other mitigation in WQMA-A. Prior to commencement of discharge of treated barge dewatering effluent from WQMA-A, the effluent should be tested for toxicity (96-hr LC_{50} test using a salt-water acclimated salmonid) to confirm that the effluent is non-acutely lethal.

3.2.3 Decision Framework for Placement of Material

During **placement of in-fill substrate material** in both WQMAs, a silt curtain is not required and turbidity measurements will be taken at three depths in the water column down-current at a suitable safety distance (25 m) from the activity (the compliance point), as well as 100 m from the activity (the assessment point), and the decision framework for WQMA-B outlined in Section 3.2.1 generally be followed.

3.3 Manual ("Real-time") Water Quality Monitoring

3.3.1 Monitoring Locations

The focus of the manual water quality monitoring program will be turbidity measurements, although *in situ* measurements of pH and dissolved oxygen will also be made occasionally to evaluate the effect of the Project activities on these parameters. The assumed number of sampling locations is described below and summarized in Table 5; however, a greater or lesser number of measurements may be made depending on the conditions at the time (e.g., presence of confounding sources of turbidity or additional monitoring triggered per the decision framework for implementing management actions [Figure 6]). Water samples will also be collected for chemical analysis; samples for analysis of TSS will be collected as noted in Table 5, whereas metals and PAH analysis (for both total and dissolved[8] fractions for both sets of parameters) will be conducted only on a subset (approximately 50%) of samples to be determined at the time of sampling, at least initially. The number of samples for analysis of TSS will be relatively high initially to facilitate validation of the TSS-turbidity relationship (see also Section 3.4). If the environmental management measures for the Project are demonstrated to be consistently effective at the start of dredging, the frequency of collection of samples for laboratory analysis may be reduced (frequency is discussed further in Section 3.3.2).

Sampling stations will be located both up-current and down-current of the works, and will be adjusted throughout the event depending on the location of the dredging activity and the direction of prevailing current at the time of sampling (as noted in Section 2.0, currents in Esquimalt Harbour are variable). The sampling locations will be documented using hand-held GPS and laser rangefinder units. The selection of specific monitoring locations will be refined on the basis of the final dredging plan and site-specific conditions. A conceptual layout of the sampling

[8] Samples for analysis of dissolved metals will be filtered through a 0.45 µm filter, and samples for dissolved PAH analysis will be prepared by centrifugation. Dissolved PAH analysis will only be conducted initially to evaluate the potential for presence of the soluble fraction).

locations is provided in Figure 8 for dredging and Figure 9 for barge dewatering, and described below. The conceptual layout of sampling locations for dredging activities can be applied to turbidity measurements during monitoring of other Project activities (e.g., structure and debris removal, timber pile installation, and placement of substrate in-fill).

- **Compliance Samples**
  - **Dredging location, 25 m from the edge of the silt curtain**[9] – this will consist of measurements collected down-current from the dredging in the water column outside the silt curtain as safety permits (Figure 8). Turbidity measurements will be collected from multiple depths:
    - At the surface of the water column: 1 m below the surface.
    - At the bottom of the water column 2 m above the sea bed (the grab sampler should be fitted with a weighted lead to help prevent the sampler itself from hitting the seabed and causing re-suspension of solids that may become entrained in the sample).
    - Mid-water column. This can be approximately half-way between the surface and bottom of the water column when it is not stratified, or just below the density barrier (i.e., thermocline or halocline) when/if stratification is occurring.

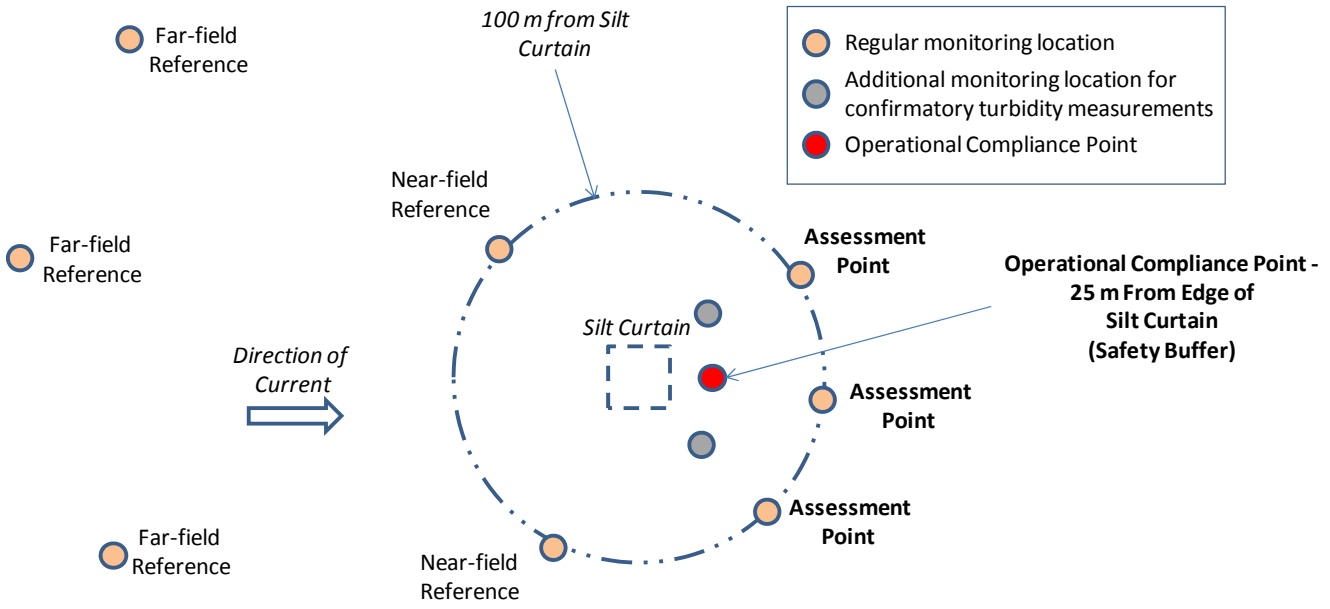

Figure 8: Conceptual layout of monitoring locations for dredging activities.

[9] The safety distance assumes that the silt curtain will be placed relatively close to the dredge bucket. The distance of the CP from the silt curtain may need to be re-evaluated if a different silt curtain configuration is used.

- **Barge Discharge location, dewatering material** – this will be a single grab sample of the dewatering discharge as it leaves the dewatering barge (or other facility depending on the dredging plan) (Figure 9).

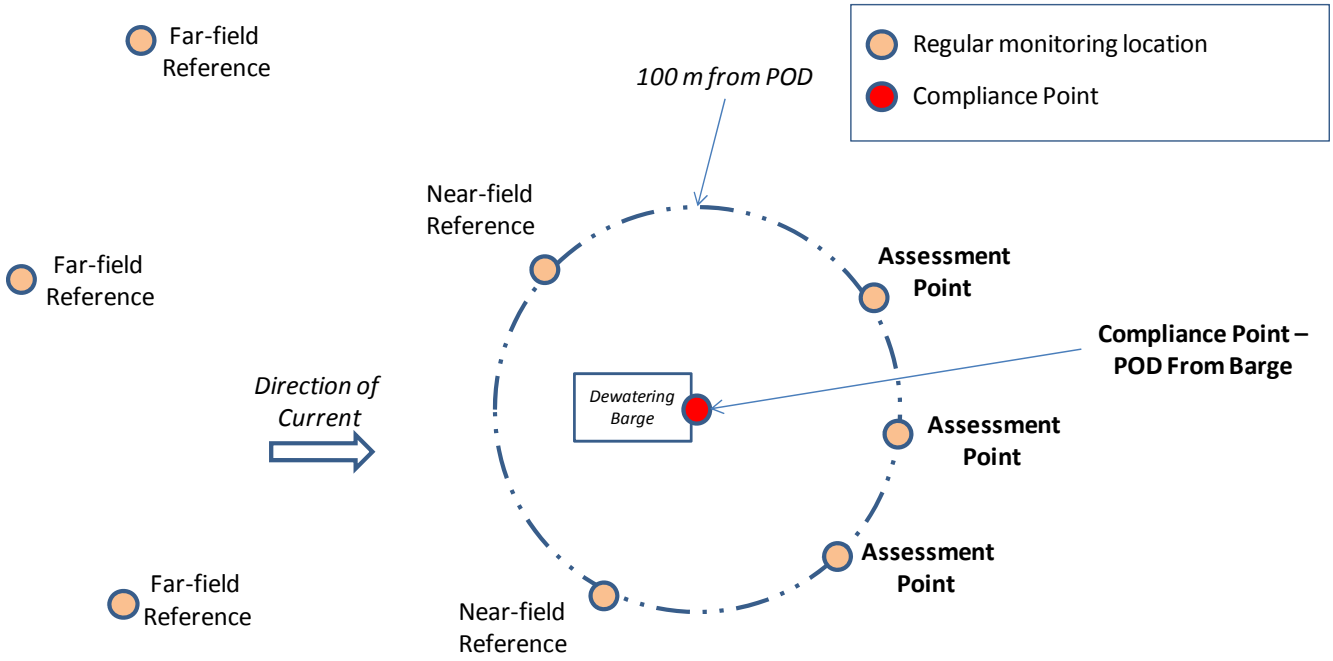

Figure 9: Conceptual layout of monitoring locations for barge dewatering.

- **Assessment Samples –** samples will be collected at a distance of 100 m down-current from the point at which the operator no longer exercises control over the discharge material (e.g., from the edge of the silt curtain). It is proposed that turbidity measurements will be made at three locations along this radius with discrete measurements at three depths, as noted above. In the event that confirmatory sampling is triggered, two additional locations may also be sampled at this distance, for a total of five.
- **Reference samples** – samples will be collected outside of the project area influence to obtain reference (or background) turbidity measurements. During periods of time when the potential for non-Project related activities (e.g., vessels berthing at nearby jetties) to influence background turbidity, a higher number of reference stations will be sampled, including near-field (two stations) and far-field (three stations) locations. When the potential for non-Project related activities is low, fewer reference samples may be collected. Turbidity will be measured at three depths, in the same manner as the compliance samples. When the potential for confounding activities is relatively low, the QP may take turbidity measurements at fewer reference locations.

Table 5: Summary of Sampling Locations and Numbers per Sampling Round for Laboratory Analysis

Type of Sample	Number of Locations[5]	Number of Depth Intervals	Estimated Number of Samples for Analysis of TSS [3]	Frequency of Laboratory Samples[1,2]		
				Week 1	Weeks 2 and 3	Weeks 4 and following
Compliance Point (Discharge Locations)				Once daily (rush analysis)	Once, every three days (standard TAT)	Once, one day per week (standard TAT)
25 m [4] from Edge of Silt Curtain	1	3	3			
Barge Dewatering Discharge	1	1	1			
Assessment Point						
100 m from Discharge Point	3	3	9			
References						
Near-field	2	3	6			
Far-field	3	3	9			

Notes:

1 This schedule assumes that effective environmental management measures are in place and water quality decision criteria are being met**. In the event that requirements for discharge quality are not being met, the frequency of monitoring may be increased.** Metals and PAHs will be analysed in approximately 50% of the samples collected, at least initially, to be determined at the time of sampling.

2 Field duplicates will be collected at a rate of approximately 10% for quality control purposes and equipment blanks will be collected once per week (Section 3.5).

3 The number of samples collected for analysis of TSS and metals/PAHs may be reduced over time if the monitoring indicates that the environmental management measures are demonstrated to be effective. Field and laboratory measurements of turbidity will be collected concurrently with TSS analyses for the purposes of verifying the TSS-turbidity relationship.

4 This is a safety buffer.

5 The actual number of locations from which samples are collected for laboratory analysis will be determined by the QP and number of reference samples collected will be dependent on the need to evaluate the potential for non-Project related activities (e.g., vessels berthing at EGD) to influence background turbidity.

TAT – turn around time.

The collection of samples for laboratory analysis at smaller distances from the discharge point (e.g., 25, 50, or 75 m) could be an agency requirement in situations where there may be habitat sensitivities within the 100 m radius (e.g., abalone habitat). This is unlikely to be the case if consideration to equipment placement is incorporated into the plan. There can also be advantages to collecting samples between the discharge point and the assessment point where other contaminant sources are possible because it provides a stronger basis to interpret monitoring data at the edge of the work zone. At the present time, it is proposed that sampling in these locations only be conducted as part of “real-time” turbidity monitoring as outlined in the decision framework for implementing management actions (Figure 6).

Real-time monitoring will also be conducted during structure and **debris removal, timber pile removal and installation, and placement of substrate in-fill,** but will consist only of turbidity measurements (and TSS as necessary). The structure and debris removal and timber pile installation is not expected to substantially disturb seabed sediments, and the placed material is expected to be similar to adjacent sediment. Turbidity measurements will be taken down-current at a suitable safety distance (25 m) from the activity (the compliance point), as well as 100 m from the activity (the assessment point), and suitable reference points at multiple depths as described above.

3.3.2 Monitoring Frequency

A higher frequency of monitoring will occur at the beginning of each type of work (e.g., structure and debris removal, timber pile installation, open-water dredging, placement of substrate in-fill) and each WQMA. For in situ monitoring, turbidity measurements would be taken daily for the first two to three weeks. Monitoring frequency may be progressively reduced after the first three weeks (e.g., twice during the fourth week and once a week thereafter) if water quality decision criteria are met during this interval. **If an exceedance is observed during any stage of the dredging program, the frequency of monitoring may be increased.** The management of day-to-day Project activities will rely on *in situ* monitoring of turbidity, which may be carried out more frequently, as necessary, than collection of samples for laboratory analysis, the primary purpose of which is the verification of predictions of contaminant release and the TSS/turbidity relationship. There are no laboratory costs associated with *in situ* turbidity monitoring, which allows for greater flexibility in frequency and spatial coverage for day-to-day monitoring. Water samples for laboratory analysis will be collected during open-water dredging at the frequency summarized in Table 5.

3.4 Validation of TSS/Turbidity Relationship

The TSS/turbidity relationship upon which the decision framework for management actions during open-water dredging was based used a bench-scale test. Although this assessment was based on a combination of data from Constance Cove (Golder 2011), in reality, the relationship between turbidity and TSS may be different due to factors such as the behaviour of sediment plumes and differences in and heterogeneity of the optical properties of the material in the natural water column. For example certain blasting abrasives have reflective surfaces and those surfaces will produce different turbidity measurements as they will scatter light differently than particles of native geological material. Thus, a review of data collected throughout the dredging program will be undertaken and additional sampling will be conducted as necessary to validate the TSS/turbidity relationship. This is an appropriate step because turbidity is used as a real-time proxy for TSS, on which certain decision criteria are based.

Throughout the dredging program, paired laboratory TSS and field turbidity measurements collected during the manual monitoring program (Section 3.3). Commencing at the end of the first month, the data collected will be compared to the bench-scale relationship initially derived (Section 3.1). The data collected can then be reviewed periodically to confirm that an appropriate turbidity value is being used for day-to-day management of the dredging. The turbidity values used in the decision framework (Section 3.2) may need to be adjusted from time to time if the results obtained during the Work differ significantly from the bench-scale testing (Section 3.1.2).

3.5 Quality Assurance/Quality Control (QA/QC)

3.5.1 Field

3.5.1.1 General

The following general guidelines will apply to field sampling activities:

- Sampling equipment will be decontaminated between sampling stations where applicable (i.e., when sampling for analysis of contaminants).

- Samples will be:
  - Collected in containers and preserved as necessary with supplies provided by the analytical laboratory.
  - Collected in such way as to minimize the introduction of foreign material to the sample and the loss of material of interest from the sample prior to analysis.
  - Stored in coolers with ice packs[10] during collection and shipping.
- Sufficient volume will be collected, where possible, such that required analytical detection limits can be met and quality control samples can be analyzed.
- Field meters will be calibrated according to manufacturers' instructions and calibrations will be verified with applicable commercially-formulated calibration standard solutions. Calibration records will be kept and submitted with data reports.
- Chain-of-custody documentation will be maintained to document holding times and storage conditions and sample continuity.
- Field duplicate samples will be collected where applicable, and the relative percent difference (RPD) calculated to provide a measure of method precision:

$$RPD = \left(\frac{sample - duplicate}{(sample + duplicate)/2}\right) \times 100$$

In accordance with the BC Field Sampling Manual (BCMOE 2013), an RPD value of ± 20% for values ≥ 5 times the method detection limit (MDL) will be used to identify notable differences between original and duplicate samples. RPDs are not calculated for values < 5 times the MDL due to increased variability near analytical detection limits.

3.5.1.2 Water Sampling for Laboratory Analysis

Duplicate water samples will be collected for laboratory analysis at a rate of 10% (i.e., for every 10 samples collected, one sample will be collected as a duplicate) and analyzed for the same set of parameters as the original sample.

Equipment blanks will be collected once per week and analyzed for metals and/or PAHs.

3.5.2 Laboratory

Samples for chemical analyses will be submitted to CALA-accredited laboratories.[11] Laboratory QA/QC will include analysis of laboratory duplicates, method blanks, and certified reference materials (CRMs) as appropriate (i.e., depending on the parameter).

[10] Ice packs or ice in sealed bags. Loose ice is not recommended due to the potential for sampling containers to shift and break when the ice melts (BCMOE 2013).

[11] CALA = Canadian Association of Laboratory Accreditation.

Prior to entry into the data management system (Section 3.5.3), laboratory data will be reviewed to verify that they are reliable. For example, this review may include checking the following:

- Sample control numbers of the chain of custody sheets and laboratory reports match;
- Confirmation that hold times have been met;
- Results are provided for samples submitted and analyses requested;
- Method blanks are below method detection limits; and
- Results of QC samples (e.g., duplicate samples, matrix spikes, CRMs) are within an acceptable range.

3.5.3 Data Management

Protocols for managing data quality will include the following:

- For field collection of water quality measurements, templates standardizing data collection requirements will be developed and used by the Environmental Monitor to promote consistency of data collection. Information to document includes:
  - Field personnel;
  - Weather conditions and other site observations relevant to interpretation of monitoring data;
  - Station ID;
  - Unique ID for laboratory samples with linkage to site identifiers as appropriate;
  - Depth of sample;
  - Sample type (e.g., “normal”, field duplicate, equipment blank);
  - Unit of measurement;
  - Equipment used;
  - Where there are missing values (e.g., data were not collected), explanatory notes will be recorded.
- Data (laboratory chemistry and field measurements) will be entered into a data management system agreed to between PWGSC and the Environmental Monitor following confirmation that laboratory and field data quality objectives (DQOs) were met (Section 3.5.2). Data that do not meeting the DQOs for the project will be flagged.
- A number of different platforms are available for data management. The specific platform for data management will be selected by the Environmental Monitor in conjunction with PWGSC.
- Data entry (either manual or transfer of electronic data) will be cross-checked by a second person at a rate of approximately 10% of entries. The rate of verification will be increased proportionately to errors found, if any.

Archives of original hard and electronic copies, as appropriate, of data files will be maintained for future reference, including original laboratory reports, electronic data files (e.g., telemetry files from automated data loggers), field notes and QA/QC documentation.

4.0 REPORTING

4.1 General

Results of regular real-time monitoring will be documented in daily reports provided to PWGSC who will forward reports to other applicable parties on the frequency outlined in the EMP (weekly reporting and monitoring completion reports following completion of each project phase). Laboratory data will be reported in the next applicable monitoring report following receipt of the Certificate of Analysis from the analytical laboratory.

Interim summary reports will be prepared following completion of dredge within each dredging zone and a final report will be prepared at the conclusion of the open-water dredging. The reports will summarize water quality measurements, corrective measures taken and lessons learned for application to subsequent dredging sessions (as applicable).

4.2 Exceedances

The Environmental Monitor undertaking the monitoring outlined in this WQMP will document exceedances in daily reports and report exceedances and other compliance events to PWGSC (who will provide reports to other parties as applicable) as soon as possible commensurate with the severity of the event.

5.0 CLOSURE

We trust that this Water Quality Monitoring Plan provides sufficient information for your present needs. If you have any questions, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

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LEGEND

TB06	AUTONOMOUS TURBIDITY MONITORING STATIONS - STUDY AREA
TB09	MANUAL TURBIDITY MONITORING STATIONS (YSI6600)
TB06	FIXED TURBIDITY MONITORING STATIONS - REFERENCE
E	OUTFALL LOCATION

REFERENCE

AERIAL PHOTO OBTAINED FROM MICRISOFT BING MAPS AERIAL IMAGERY WEB MAPPING SERVICE

PROJECT
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
EGD WATERLOT SEDIMENT REMEDIATION PROJECT
WATER QUALITY MONITORING PLAN
ESQUIMALT, BC

TITLE

TURBIDITY MONITORING STATIONS

Golder Associates

PROJECT No.		11-1436-0061	FILE No.	1114360061-20000-WQMP-02
DESIGN	RSJ	5DEC12	SCALE	AS SHOWN
CADD	AMW	6DEC12		
CHECK	RSJ	6DEC12		
REVIEW	BW	6DEC12		

FIGURE 2

APPENDIX A

Total Suspended Solids / Turbidity Relationship

1.0 INTRODUCTION

Water clarity is often described using measures of total suspended solids (TSS) or turbidity, which are generally interrelated but represent different measures. TSS is a measure of the amount (by weight) of suspended solids such as sediments in water. At very high concentrations, TSS can reduce fish growth rates, modify fish movements, affect fish egg and larval development, impair foraging and predation behaviour of fish, reduce abundance of fish diet items, affect reproduction of aquatic biota, reduce immuno-competency of aquatic biota, and harm benthic habitats.

Turbidity (measured in nephelometric turbidity units [NTUs]) is a measurement of the decrease in transparency of water as light is scattered by suspended particulate matter (Ziegler 2002). Turbidity is often used as a proxy for TSS, as it is relatively easy to measure in the field and is typically used to provide real-time data that represents approximate levels of sediment re-suspension and can indicate the potential for release of contaminants of potential concern associated with the sediments (Ankcorn 2003). The use of optical sensors to continuously monitor turbidity for a given period may provide a more accurate estimate of suspended sediment in the water column without the collection and analytical costs associated with intensive water sampling. As well, continuous turbidity measurement allows assessment of short term variability in suspended sediment concentrations that have the potential to stress aquatic life (Ehlinger 2002). Results from previous studies have shown that turbidity measurements may correlate closely with TSS concentrations in the marine environment, as long as a site-specific numerical relationship between TSS and turbidity is established to account for variances between these parameters linked to sensor type, sensor calibration, water color, suspended particle size, and/or particle composition (Packman et al. 1999). Environmental samples typically vary within the normal range of 1 to 1,000 NTUs (Chapman 1992).

An initial assessment of the TSS-turbidity relationship for sediments from the EGD Waterlot was reported in Golder (2011). This appendix provides the methods and outcome of a supplementary assessment using TSS concentrations < 400 mg/L.

2.0 METHODS

2.1 Paired TSS/Turbidity Measurements

To assess the feasibility of using turbidity measurements in lieu of TSS to make real-time management decisions during dredging site, sediment and site water were mixed at set concentrations, and tested concurrently for TSS and turbidity[1]. The TSS/turbidity test was conducted for site sediments obtained from the top several centimetres of the seabed. Site sediment was obtained from the EGD Waterlot during the sediment coring program undertaken in September 2010. Site water was obtained from the CFSA waterlot on April 28, 2011 immediately prior to the lab testing to minimize the potential for an introduced bias from using “stale dated” seawater collected during the jet probe investigation undertaken in January 2011.

[1] The approach and methods for this exercise were provided to PWGSC and Anchor for review (Jan. 20, 2011) and agreed upon (Jan. 28, 2011) prior to the task being undertaken.

A relationship was developed separately for soft silt and upper marine sediments for one of the sensors (YSI sonde) deployed to collect baseline data.[2] Site water was mixed in 20-L black buckets with varying weights of moist sediment to encourage mixing. Mixing was achieved using a paint stirrer mounted inside the bucket and powered by a variable speed drill. The buckets were draped with black-out cloth to minimize external infrared (IR) reflectance during each test. Concentrations assessed in sequential order of decreasing sediment loading were: sea water only (~0 mg/L), and incremental sediment loadings from 400 mg/L to 6 mg/L (mg of dry sediment/L). The incremental loadings were calculated based on the known volume of water in the bucket and the known weight of sediment added at the start of the test. Known quantities of water-sediment mixture were removed at each increment in the test and were replaced with the same weight of sea water only. This resulted in a sequential dilution of the sediment load from 400 mg/L to 6 mg/L.

The combined weight of water and moist sediment for each concentration was determined so that the ratio of moist sediment weight to water weight provided the relevant TSS concentration. The mixture of water and sediment was mixed at a moderate speed on the paint stirrer for 30 seconds prior to sampling. The paint stirrer was continuously operated during the test at a low to moderate speed to maintain sediment in suspension without aerating the water in the buckets. The sensor was set to obtain two sets of 60 measurements at a sampling frequency of 1 Hz, for a total of 120 individual NTU readings during a two-minute period for each TSS concentration.

2.2 Quality Assurance / Quality Control

During the paired testing of TSS and turbidity (NTU), an ambient seawater test was repeated at the end of each concentration sequence. To control for potential variability in the seawater samples, the NTU response of each sensor was also measured in clean distilled water at the start and the end of the tests. The sensor test in sea water without sediment provided a measure of the sensor offset at 0 NTU.

3.0 RESULTS

Figure 1 illustrates the relationship between paired calculated TSS and *in situ* turbidity measurements and paired laboratory TSS and turbidity measurements. The slope of the paired calculated TSS and *in situ* turbidity measurements was:

$$y = 0.1083x + 12.328$$

The residuals around the slope in the range of TSS measurements that are proposed for monitoring compliance were positive (by up to 3 NTU), suggesting that the regression relationship under-predicts the turbidity associated with a given TSS.

[2] The remaining sensors were from an external supplier and were not available for the TSS-NTU relationship to be developed.

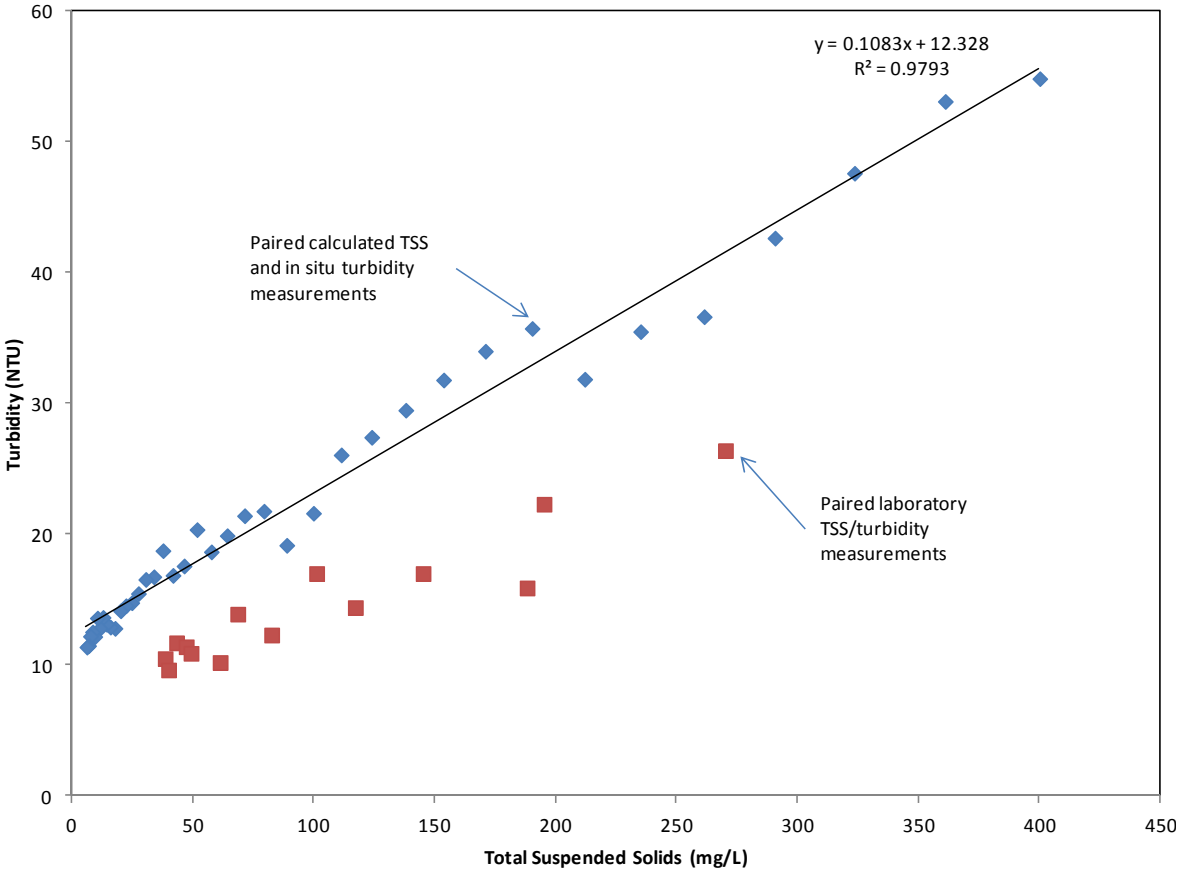

Figure 1: Comparison of paired total suspended solids / turbidity measurements

The slope of the laboratory TSS and turbidity measurements was similar, although the laboratory data tended to have a lower turbidity for a given TSS value. The measurement of turbidity in the lab is based on analysis of a small volume of water using a nephelometer that detects the amount of light passing through the water from a known light source. As turbidity increases, the amount of light passing through the water decreases. The measurement of turbidity *in situ* is based on analysis of a small volume of water using an infrared device which detects the amount of light being reflected (backscatter) back to the sensor head from particles in the water. As turbidity increases, the amount of light reflected (scattered) back increases. The variance between the lab and *in situ* turbidity values may be the result of the difference in sensor technology. As backscatter technology will be used in the field, the relatively close agreement between the two datasets provides confidence that the field turbidity measurements can be used as a proxy for measures of TSS.

Documented TSS-NTU relationships for marine waters include a range of relationships from 1 TSS (mg/L) to 1 NTU to upwards of 8 TSS (mg/L) to 1 NTU (*e.g.*, Earhart 1984; Thackston and Palermo 2000). Earhart (1984) concluded that the most important conditions of any TSS-NTU relationship was that the correlation curve must be developed using site specific sediments and water. Thackston and Palermo (2000) concluded that there is no universal correlation of turbidity and suspended solids. The relationship of 2.5 to 3 TSS (mg/L) to 1 NTU developed using sediments and sea water collected from Constance Cove, although different from the accepted typical range of TSS-NTU relationships for fresh water between 1 mg/L to 1 NTU and 1 mg/L to 3 NTU (Caux *et al*. 1997), meet Earhart's prime condition. This relationship will be verified in the field during the monitoring program.

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APPENDIX B

Environmental Background Information

Table 1: Listed Species with the Potential to Occur in the Project Area

Name	COSEWIC	SARA	BC	Habitat and Range Description	Comments
Birds					
Barn Swallow (*Hirundo rustica*)	T	N/A	Blue	Nests in barns or other buildings, under bridges, wharves, in caves or cliff crevices, usually on vertical surface close to ceiling. Commonly reuses old nests. Flies over open land and water and forages on insects. Usually forages within a few hundred metres of nest when breeding.	May nest under wharves in the Project Areas.
Brandt's Cormorant (*Phalacrocorax penicillatus*)	N/A	N/A	Red	Mainly inshore coastal zone, especially in areas having kelp beds; also around some offshore islands; less commonly, inshore on brackish bays; in winter, mostly around sheltered inlets and other quiet waters. Typically nests on flat or gently sloping surfaces on tops of rocky islands along coast.	May temporarily occur in the Project Areas but would likely not nest.
Caspian Tern (*Hydroprogne caspia*)	NAR	N/A	Blue	Seacoasts, bays, estuaries, lakes, marshes, and rivers. Nests on sandy or gravely beaches and shell banks along coasts or large inland lakes; sometimes with other water birds. Seasonal resident and probably breeds on Vancouver Island. Does not overwinter on Vancouver Island.	May temporarily occur in the Project Areas but would not nest.
Common Murre (*Uria aalge*)	N/A	N/A	Red	Non-breeding: pelagic and along rocky seacoasts. Nests in the open or in crevices on broad and narrow cliff ledges, on stack (cliff) tops, and on flat, rocky, low-lying islands. Breeds on the northern tip of Vancouver Island and overwinters around Vancouver Island.	May temporarily occur in the Project Areas but would not nest.
Double-Crested Cormorant (*Phalacrocorax auritus*)	NAR	N/A	Blue	Forage in all coastal areas of BC, utilising marine habitats such as bays, estuaries, and inlets and occasionally freshwater habitats such as lakes close to coastal areas and large rivers such as the Fraser River. Bare, rocky islands with sparse vegetation are the preferred nesting habitats.	May temporarily occur in the Project Areas but would not nest.
Great Blue Heron (*Ardea herodias fannini*)	SC	1-SC	Blue	Nest in a wide variety of tree species; the Pacific population nests in quiet woodlots within 8 km (most within 3 km) of foraging habitats such as large eelgrass meadows, along rivers, and in estuarine and freshwater marshes.	No nests known to occur within or adjacent to Project Areas. May temporarily occur in the Project Areas.
Marbled Murrelet (*Brachyramphus marmoratus*)	T	1-T	Red	Nests often are in mature/old growth coniferous forest near the coast: on large mossy horizontal branch, mistletoe infection, witches broom, or other structure providing a platform high in mature conifer (e.g., Douglas-fir, mountain hemlock). Most nesting occurs in large stands of old growth.	May temporarily occur in the Project Areas but would not nest.
Purple Martin (*Progne subis*)	N/A	N/A	Blue	Breeds but does not overwinter on Vancouver Island. Nest in natural cavities and woodpecker holes in trees and snags, and in holes in buildings. In recent years they have been almost entirely restricted to nest boxes and artificial holes in pilings in estuaries, bays, and harbours. Birds presumably forage over areas immediately surrounding nest site, although no information on typical travel distance while foraging.	May still occur in Esquimalt Harbour. Not known to nest in the Project Areas, but may forage over the Project Areas.
Peregrine Falcon (*Falco peregrinus anatum / tundrius*)	SC	1-SC	Blue	Nests on cliff ledges, crevices, and sometime on tall buildings or bridges, preferably between 50-200 m in height. Suitable nesting sites are often dispersed and can be either natural or on structures built by humans. Forages on small birds, bats, rodents and mammals. Often returns to use the same nesting sites for decades.	May temporarily occur in the Project Areas but would likely not nest.
Fish					
Canary Rockfish (*Sebastes pinniger*)	T	N/A	N/A	Juveniles occupy shallow inshore waters. Larvae and pelagic juvenile canary rockfish occupy the top 100 m for up to 3 to 4 months after live-birth (parturition) and then settle to a benthic habitat. Adults typically inhabit rocky bottom in 70 to 270 m depth on the continental shelf. Canary rockfish are widely distributed throughout BC coastal waters. The prevalence of this species in recreational fishing in the Strait of Georgia indicates that they are probably well distributed in enclosed waters and inlets.	Some potential for juveniles to occur in the Project Areas; however, none have been identified to date.
Cutthroat Trout, *clarkii* subspecies (*Oncorhynchus clarkii clarkii)*	N/A	N/A	Blue	Requires small, low gradient coastal streams and estuarine habitats. Some may spend entire life in freshwater, but most are anadromous. In marine habitats, generally remains close to the coast, usually remaining within estuary. Eelgrass and kelp beds provide habitat for cutthroat trout, as they host a wide variety of prey species, and provide shelter (CRD 2011e).	Cutthroat trout may migrate or forage in the Project Areas; however, none have been identified in the Project Areas to date.

Name	COSEWIC	SARA	BC	Habitat and Range Description	Comments
Invertebrates					
Northern Abalone (*Haliotis kamtschatkana)*	T	1-T	Red	Suitable abalone habitat is typically characterized as bedrock or boulder substrate containing encrusting coralline algae (*Lithothamnion* sp.) with presence of brown bladed kelp (e.g., bull kelp *Nereocystis luetkeana,* tangle kelp *Laminaria sp.,* walking stick kelp *Pterygophora californica*, etc.) (Breen and Adkins 1979). Abalone occur in sheltered bays to exposed coastlines and typically range from low intertidal to 30 feet depth.	Abalone were observed adjacent to the D Jetty Project Area.
Olympia Oyster (*Ostrea conchaphila)*	SC	1-SC	Blue	Mainly found in the lower intertidal and shallow subtidal zones of saltwater lagoons and estuaries. They have also been found on tidal flats, tidal channels, bays and sounds, in splash pools, near freshwater seepage, or attached to pilings or the undersides of floats. On the outer coast, this oyster species is only found in protected locations. Within suitable habitat, Olympia oysters need hard substrate for settlement.	No known occurrences of Olympia oysters within the Project Areas.
Marine Mammals					
Steller Sea Lion (*Eumetopias jubatus*)	SC	1-SC	Blue	Marine habitats include coastal waters near shore and over the continental slope; sometimes rivers are ascended in pursuit of prey. When not on land, the sea lions may congregate at nearshore traditional rafting sites, or move out to the edge of the continental shelf.	Steller sea lions have been observed in Esquimalt Harbour; however, the Project Areas are not considered important habitat for the Steller sea lion.
Harbour Porpoise (*Phocoena phocoena*)	SC	1-SC	Blue	Coastal waters and adjacent offshore shallows; also inhabits inshore areas such as bays, channels, and rivers. Mothers and young tend to move into sheltered coves and similar sites soon after parturition.	Harbour porpoises have been observed in Esquimalt Harbour; however, the Project Areas are not considered important habitat for this porpoise.
Killer Whale (Northeast Pacific southern resident population) *Orcinus orca pop. 5*	E	1-T	Red	The range during spring, summer, and fall includes the waterways of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait. Little is known about winter movements and range.	The Project Areas are not considered important habitat for this whale. Killer whales frequent nearshore waters of Juan de Fuca; however, they are not known to frequent the active harbours of Esquimalt and Victoria. It is considered unlikely that killer whales would enter within or adjacent to the Project Areas during the planned work.

APPENDIX C

Example Reporting Templates

PRE-WORK ORIENTATION RECORD

Date:		**Orientation Delivered By:**
Work Location:		
Issues addressed:		

By signing this record, the person is acknowledging that they have received orientation on the noted date.

Name		Affiliation
(PRINT)	(SIGNATURE)	

TECHNICAL MEMORANDUM

DATE **PROJECT No.** 13-1436-0061

TO

CC

FROM **EMAIL**

ENVIRONMENTAL MONITORING DAILY FIELDWORK SUMMARY

1.0 INTRODUCTION

2.0 CONSTRUCTION ACTIVITIES

3.0 MONITORING ACTIVITIES

Item	Assessed / Discussed / Observed / Not Applicable	Comments
Orientation		
Site Inspection		
Water Quality Monitoring		
Underwater Noise Monitoring		
Marine Mammal Monitoring		
Osprey Monitoring		

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Table 1: Turbidity Measurements.

Time	Construction Activity	Turbidity Measurement Location	Turbidity Measurement (NTU)

Notes:
NTU – nephelometric turbidity units

4.0 ISSUES AND RECOMMENDATIONS

5.0 CLOSURE

GOLDER ASSOCIATES LTD.

R.P.Bio

Reviewed by:

Associate, Senior Environmental Scientist

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