PORT MOODY ARM
PROPOSED CHANNEL DREDGE
PROJECT ENVIRONMENTAL REVIEW DOCUMENT

Proposed to:
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TABLE OF CONTENTS

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LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

The section of Port Moody Arm Navigation Channel in front of Reed Point Marina is a shipping restriction for loaded vessels departing PCT. Vessels currently require up to 4.0m of tidal assistance to navigate the channel posing a significant safety and economic restriction for PCT and its shipping partners.

The proposed project involves maintenance dredging within the Navigation Channel to increase channel depth from -10.5m to -14.0m (including 0.5m over dredge). The added depth will consequently allow loaded vessels to safely sail from PCT with only one metre of tidal assistance and enable more flexible for sailings across four tides per day rather than one (high-high slack). The Port Moody Arm was most recently dredged in 1995 with Vancouver Port Corporation as the proponent. Including the approach channel and turning basin, approximately 280,000m3 was dredged and placed behind a sub-tidal berm constructed adjacent to the turning basin as “experimental fish habitat enhancement” (see letter in **Appendix I**). In 2009 at the request of PCT, Port Metro Vancouver initiated planning and designed to deepen the navigation channel by further dredging westward from PCT. Since PCT is seen as the sole tenant interested in this work, PCT is pursuing this project as the proponent. The current dredge plan is to relocate approximately 530,000m^3 of sediment for placement (beneficial end use through habitat restoration, not ocean disposal) within an expanded area including the existing and additional containment perimeter berm. Dredging will involve an effective combination using three equipment types:

- Hopper dredge, with closed overflow chute, for the area west of the Ioco pipeline;
- Clamshell for precision in the immediate vicinity of the submerged Ioco pipeline; and,
- Cutter dredge, with floating pipeline, for the area east of the Ioco submerged pipeline. Berm modification and dredge works are proposed to last for approximately 30 and 50 days respectively in Q3 and later in Q4 2013.

The creative project plan achieves a balanced approach that supports the Port of Metro Vancouver initiative for sustainable enterprise. Expected benefits include vital business process efficiency at PCT through more timely (and safer) shipping; minimal to no residual environmental impact; local fish habitat restoration (compensation); a dredge plan that makes good financial sense; and potential opportunities to partner with local First Nations.

2.0 PROPOSED DREDGE WORKS

Pacific Coast Terminals is planning a modified approach to the dredge that was conducted in 1995. After considerable research, PCT is proposing an innovative combination of hopper, cutter suction and clamshell dredges with direct placement in an expanded version of the containment basin established in 1995. Keeping the dredge spoils within the Arm achieves many advantages ranging from significantly reduced emissions and shorter work duration to restoring fish habitat in previously dredged areas (circa 1960’s when the original site was developed). Provided below and in subsequent sections is the sustainable, holistic decision-making framework used to achieve desired engineering objectives, optimize cost effectiveness, minimize environmental impacts and restore sub-tidal habitat with dredged material.

The operations plan will involve sequential dredging from west to east at an average of 12,500 m^3 / day using the three equipment types. The berm will be constructed of clean suitable material (e.g., demolition concrete or rock from civil excavation) that would otherwise be disposed as "waste" in landfills or through the Environment Canada Disposal at Sea programme. As contingency, angular "pit run" rock may be sourced from neaby mining operations (e.g., Texada Island) or material could be harvested from other suitable areas within the harbour such as first and second narrows.

2.1 Dredge Location

The proposed dredge is located in Port Moody Arm from the west side of Reed Point Marina progressing eastward to the PCT turning basin. The dredge channel is approximately 1000m long by 150m wide before expanding into the semi-circular vessel turning basin at the east end of the dredge area (see **Figure 1**). The proposed dredge area remains unchanged from the dimensions originally designed by PMV in 2009.

2.2 Project Regulatory Framework

The application and this document will be submitted to PMV for review and in consideration of a dredging permit and authorization to relocate material within the Port area. We understand and expect PMV in turn will refer and request input from other agencies as required.

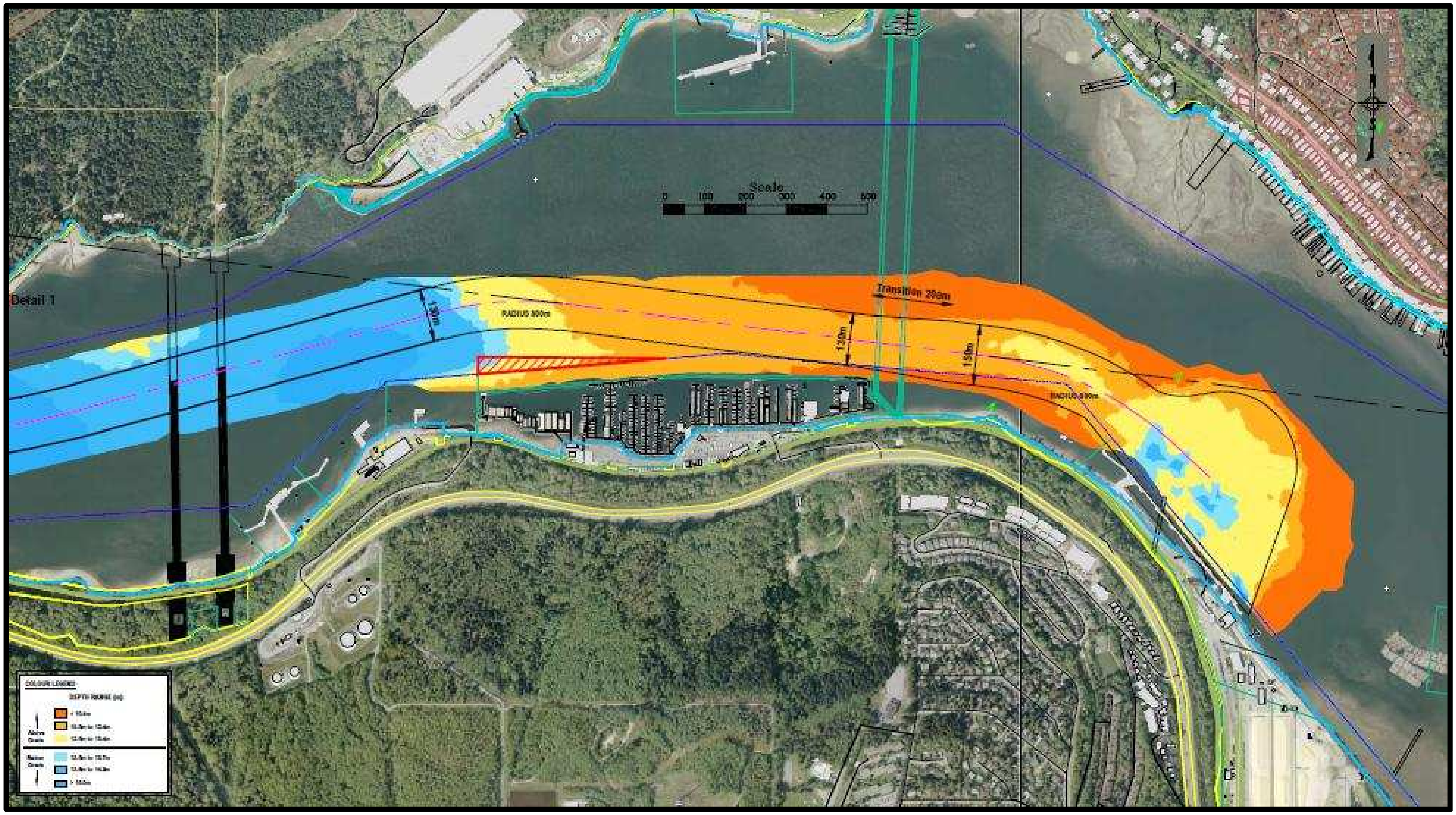

FIGURE 1:PLANNED DREDGE LOCATION

2.2.1 Environment Canada Requirements

In a letter dated January 11, 1995 from Adrian Duncan of Environment Canada to Nancy Yates of BIEAP, the dredge and placement project completed in 1995 was deemed not a disposal project under Environment Canada but a construction project accepted by DFO as an experimental fish habitat enhancement (see **Appendix I** for a copy of the letter). The proponent, PCT, anticipates a similar approach will apply for the planned channel deepening project in 2013. Dredge material placement is regulated under subsection 122(1) of Canadian Environmental Protection Act 1999 (CEPA 1999). Specifically, PCT believes the project meets the criteria for "placement of a substance for a purpose other than its mere disposal" as follows:

- There must be evidence that there is a purpose other than mere disposal, including that the material has the appropriate physical characteristics for the alternative use. The proponent should provide additional detail substantiating how this criterion is met.
  - ✓ Dredge material will be carefully placed behind the existing berm (in the Port Moody turning basin for sub and intertidal habitat creation. The planned outcome is to create viable eelgrass communities, ultimately enhancing what is currently a relatively low productivity soft-bottom marine environment. See **Section 4.0**, Habitat Creation, for full details.
- There must be evidence that the placement can be done so it does not result in deleterious effects to the marine environment or conflict with other legitimate uses of the sea. The proponent should provide additional detail substantiating how this criterion is met.
  - ✓ The proponent plans to employ a holistic approach that not only prevents deleterious marine effects; it does not obstruct other uses of the sea. Additional factors considered include minimizing air pollution, noise and avoidance of additional turbidity by not disposing at sea. Controls for protection of marine habitat (namely water column turbidity) will include innovative use of customized silt curtains; operational modifications including installation and placement of a diffuser close to the seabed; and minimizing dredge pressure that will lower the velocity at the diffuser. Please see Section 3.0 for additional details on operations and mitigating measures.
- The material must be clean and the proponent should provide additional detail substantiating how this criterion is met. For example, material destined for the marine environment must be below the lower action levels as set out in the Disposal at Sea Regulations under CEPA 1999.
  - ✓ The 20 surficial samples analyzed in 2009 (PMV) and 10 surficial samples in 2012 (PCT) respectively indicate compliance with DAS requirements. The 2012 samples were further supported by biological testing (Microtox, Echinoid and Amphipod). Additional core sampling by PCT in 2012 suggests (inferred) compliance with DAS requirements. See Sections 2.2.2.1 and 2.2.2.2 for additional details.

2.2.2 Department of Fisheries and Oceans Regulatory Requirements – Fisheries Act

The Fisheries Act is the prevailing legislation administered by DFO for this project. In late June 2012, Omnibus Bill C-38 received Senate approval, thereby introducing several changes to the Act. Under the new legal framework, key sections of the Act that apply to this project are as follows:

- The project will not involve the release of deleterious substances (sec 34.1) as defined by the Act.
- Potential turbidity generated by dredging and placement activities will be effectively controlled using several mitigation measures including sediment curtains, containment berms (including extra height to accommodations for sediment bulking factors), use of a discharge diffuser, regular monitoring and possible operational adjustments to further reduce discharge velocity.
- Section 35.1 (harmful alteration, disruption or destruction of fish habitat) has been replaced with provision that "no person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery". Serious harm to fish is the death of fish or any permanent alteration to, or destruction of, fish habitat".
- The proposed project will not result in serious harm to fish that is part of a commercial, recreational or Aboriginal fishery. The dredge will involve temporary disturbance of the low productivity seabed that is predicted to recover quickly from the planned 3.0m depth cut. Additionally, the dredge material will be placed for beneficial end-use to restore fish habitat.
- Under section 35.2, material placement for purposes of habitat restoration will require an authorization by DFO.
- "Ecologically sensitive areas" is not defined; invariably, 37.1.1 reverts back to fish habitat, for which, in accordance with 35.2, an authorization will be issued.

Please see more details in **Section 3** of this document regarding potential operational environmental impacts.

2.3 Existing Conditions

2.3.1 Dredge Material Properties

Dredge materials within the defined project area were examined by PMV in 2009 and by PCT in 2012. Overall, the 30 samples analyzed indicate compliance with Environment Canada Disposal at Sea requirements. Material properties (predominantly fine sediment) and chemistry were similar across sample locations and indicate that all material within the area is homogeneous and adequately represented by the samples.

2.3.1.1 PMV Sampling Results

When the dredging project was originally considered by PMV in 2009, Mr. Dave Hart, Operations Dredging Specialist, defined the dredge area by conducting surficial seabed sampling using divers. A total of 20 composite samples were submitted for analysis The approach taken and results were reported as follows:

- Twenty (20) sites within Port Moody Arm were sampled on July 21, 2009.
- Samples were collected at about 20cm below the surface using divers.
- Two (2) samples were taken at each site ranging between 5 to 10m apart.
- Samples were submitted for PAH's, PCB's, full metal suite plus load detection for Cadmium.
- Numerical values for Cadmium were exceeded on all samples. To further explore the elevated Cadmium levels we carried out an AVS-SEM test (measure of the biological availability). See **Appendix II** for analytical results.
- Based on the results from all the tests conducted, Environment Canada advises the results support disposal at sea.
- Since the 2009 sampling program, Environment Canada has modified DAS requirements, substituting biological testing for AVS-SEM. Envirochem, supported by the opinion of a professional chemist, believe that the AVS-SEM test remains a credible predictor of contaminant (metals) bioavailability. Please see **Appendix III** for professional opinion rendered by Jamie Downie, PChem.

2.3.1.2 PCT Sampling Results

In advance of conducting the channel dredge, PCT had planned to undertake a small scale (4000m3) trial using the FRPD hopper dredge. In support of the trial, two courses of sampling were conducted to:

- Assess compliance with Environment Canada Disposal at Sea criteria; and,
- Examine particle size to determine hopper dredge effectiveness using vibracore.

Regarding DAS compliance assessment, a total of 10 discrete samples for chemical analysis and four composite samples (including reference points) for biological testing were collected using ponar grab. Sampling was done by Envirochem in the presence of Roanna Leung of Environment Canada. See , sample location map below.

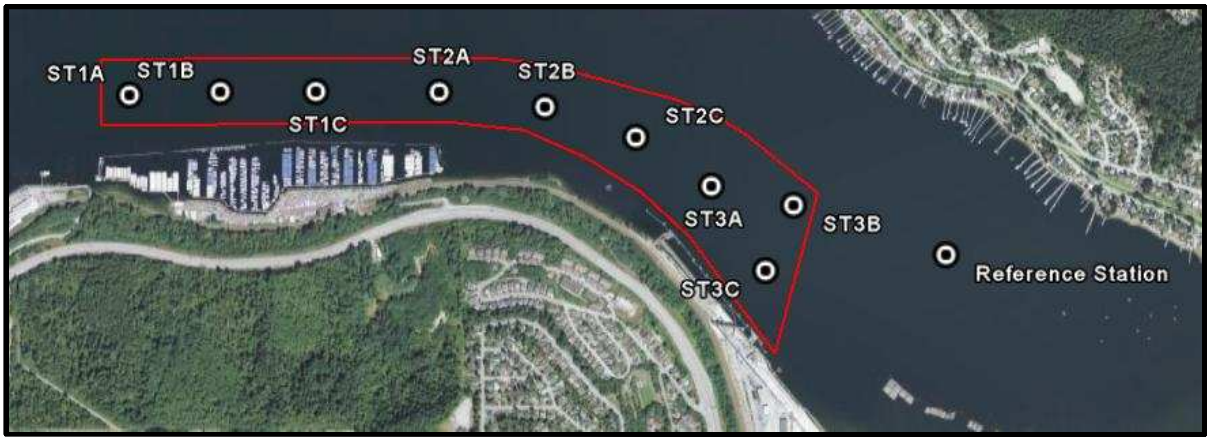

FIGURE 2:MAP LOCATION OF DAS SAMPLES, PORT MOODY ARM

Summary DAS results for regulated chemical requirements were as follows:

- Cadmium:all sites, including reference, exceeded the limit.
- Mercury:no exceedances.
- Lead:eight sample points, including reference, exceeded the limit.
- PCB:no exceedances.
- PAHs:two exceedances.

Other metals "of interest", specifically arsenic, copper and zinc, also exceeded criteria at various sample locations.

Biological tests conducted were Microtox, Amphipod Survival and Echinoid Fertilization as per Environment Canada DAS requirements. Testing was initiated on January 12 and 13, 2012. Maxxam Analytical reported that all samples passed each biological test – none were considered toxic according to the Ocean Disposal Guidelines. Please see **Appendix IV** for chemical and biological test results.

Core sampling was conducted in three locations within the defined dredge area. Sampling sites were proximal to ST1A (west side of Reed Point Marina); ST1C (mid Marina); and on the east side of ST2B opposite Reed Point (see Figure 2 above). Cores varied in depth, from 1.5m to 2.1m. Within each core, three discrete samples were collected to form a single composite. All three composites were analyzed for DAS chemistry: all regulated parameters met DAS criteria with the exception of cadmiumas expected. Even though no further analysis was conducted, it can be inferred that these core samples would have also passed biological tests. As seen in **Table 1** below, the "at depth" core sample readings for cadmium were either below or modestly higher that surface (ponar grab) samples collected in the near vicinity on January 6, 2012. Furthermore, all results are well below conservative BC Contaminated Site Regulation sediment quality limits of 2.6 mg/kg. (SedQCscs) and 5.0 mg/kg. (SedQCtcs) respectively (see **Appendix V** for analytical results).

TABLE 1:COMPARATIVE CADMIUM LEVELS, AT DEPTH AND SURFACE

Type	Sample Locations		
	West / ST1A	Central / ST 1C	East / ST2B
Depth Samples (mg / kg)	0.883	1.34	1.28
Surface Samples (mg / kg)	1.11	1.07	1.52

We consider that these data satisfy the Environment Canada placement requirement that the material be "clean" and, therefore, no additional DAS sampling is required.

2.3.2 Biota

2.3.2.1 Benthic Organisms

The design footprints of the proposed navigation channel, turning basin and placement area are characterized by soft bottom benthic communities. Mud typically comprises greater than 90 percent of bottom sediments (Burd and Brinkhurst 1990[1]) and subsequently verified during the January 2012 core sampling event described above.

That portion of the project that interfaces the terminal is characterized by an invertebrate community of low diversity and abundance (Burd and Brinkhurst, 1990). Member species include the deposit feeders *Capitella capitata* (motile polychaete), *Pectinaria californiensis* (tube-dwelling polychaete) and *Macoma calcarea* (clam), and predators *Nephtys cornuta franciscanum* (motile polychaete) and *Philine polaris* (sea slug). The presence of *Capitella capitata* is notable as it often occurs in areas characterized by organic pollution (Tsutsumi 1987[2], Dean 2008[3]).

That portion of the project seaward of the terminal is described by Swanston (2011[4]). He described the substrate as "very soft, anoxic mud overlain by a thin layer of brown sediment". Little visible marine life was apparent. Several *Clevlandia ios*, a small goby, were noted. Plumose anemones (*Metridium farcimen*) were attached to debris.

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[1] *Burd, B.J., and R.O. Brinkhurst. 1990. Vancouver Harbour and Burrard Inlet benthic infaunal sampling program, October 1987. Canadian Technical Report of Hydrography and Ocean Sciences No.122. 49p.*

[2] *Tsutsumi, H. 1987. Population dynamics of Capitella capitata (Polychaeta; Capitellidae) in an organically polluted cove. Marine Ecology – Progress Series Vol. 36 pp.139-149.*

[3] *Dean, H.K. 2008. The use of polychaetes (Annelida) as indicator species of marine pollution: a review. Rev.Biol.Trop (Int.J.Trop.Biol.ISSN-0034-7744) Vol.56 (Suppl.4): 11-38*

[4] *Swanston, D. 2011. Subtidal Biophysical Inventory East of a Proposed Marine Expansion Reed Point Marina, Port Moody. BC. Seacology, North Vancouver, BC. 17p.*

2.3.2.2 Fish

From a fisheries perspective, a fish survey commissioned by the City of Port Moody ("What Swims Beneath", 2011[5]) stated that:

- Two local hatcheries on Noons and Mossom Creeks release tens of thousands of salmon fry and smolts into local streams and into the Arm annually.
- Juvenile salmonids are known to use the foreshore areas of Burrard Inlet as rearing grounds (Naito and Kwang, 2000[6]).
- During the survey, salmonids captured included coho salmon, chum salmon, pink salmon, chinook salmon and cutthroat trout.

Use of marine and estuarine environments by juvenile salmonids is focused within near shore areas, in particular intertidal mudflats and marshes. The project engages the bottom of Port Moody Arm substantively below local low water, below intertidal elevations. The project will not directly affect intertidal areas, thereby mitigating interactions with juvenile salmonids and their habitats.

2.3.3 Local Marine Conditions

Burrard Inlet has been described as narrow deep water fjord in which tides transport silt into the Port Moody Arm to be deposited on the mudflats located at the east end of the Arm (Eikos Consultants, 1972). It is therefore expected that this eastward deposition pattern will favour containment of suspended sediment generated by the project within the Arm.

Overall, marine conditions in the Arm are expected to have minimal effect (e.g., sediment transport) on the proposed dredge. Modest tides and low fetch resulting in minimal / low erosion characteristics of the area will enhance turbidity control and allow placed material to settle and stay within the containment berms.

2.4 ALTERNATIVE DREDGE AND DISPOSAL OPTIONS CONSIDERED

Clamshell, Hopper and Cutter-Suction dredging options were evaluated against relevant environmental and economic factors as were disposal alternatives including upland, disposal at sea and direct placement.

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[5] City of Port Moody. 2011. What Swims Beneath: A Fish Survey of Port Moody Arm. City of Port Moody, British Columbia. 40p.

[6] Naito, B. and J. Hwang. 2000. Timing and distribution of juvenile salmonids in Burrard Inlet, British Columbia: February to August 1992. Canadian Data Report of Fisheries and Aquatic Sciences 1069. 74p. *cited in:* City of Port Moody 2011.

2.4.1 Alternative Disposal Options

2.4.1.1 Upland Disposal

Upland disposal was immediately eliminated due to prohibitive cost, impractical logistics including barge to land transfer and traffic generated by thousands of dump truck trips, prolonged duration for construction, excessive air emissions and no beneficial end use of the dredge material (i.e., wasted resource).

2.4.1.2 Disposal At Sea (DAS)

While sediment sampling results indicated compliance with DAS criteria, disposal would require transit to and from the dredge site to the disposal site. As a result, only clamshell and hopper are considered as means of dredging as cutter-suction would not apply (i.e., process does not involve vessel or barge transit).

Consequences associated clamshell and hopper dredging and ocean disposal would include:

- Increased navigational traffic in the harbour;
- Elevated air emissions of either option for tug assist for scows or transit of the hopper vessel;
- Vastly extended project duration (potential noise and visual impacts);
- No beneficial end use of dredge material; and,
- Unwarranted and unacceptable costs.

As such, disposal at sea is not the preferred option for this project.

2.4.1.3 Direct Placement

The general approach will be similar to 1995. Direct placement will involve relocating dredge material to defined area(s) behind the existing berm and a newly constructed berm for material containment. With knowledge accumulated since the 1995 dredge, the proponent will employ additional planning and operational mitigation measures including to better control and minimize turbidity. Key benefits of direct placement method selected will include reduced harbour traffic, reduced air emissions and beneficial end use of the material by creating (restoring) marine habitat. See **Section 4.0**, Habitat Restoration, for more details. In preliminary discussions with DFO, sediment quality was deemed acceptable for direct placement. Direct placement will therefore be the preferred solution.

2.4.2 Dredging Equipment Considered

2.4.2.1 Clam Shell Dredge

A clamshell dredge, located on a barge, would collect material in an approximately $5m^3$ bucket, then place on a bottom dumping scow. The full scow would then be towed by tug to the placement site where the dredge

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material would be released. Multiple scows (e.g., 2 or 3) would be anchored in proximity to the clamshell to enable continuous loading. The process would require up to 212 days to complete the entire dredge for the disposal at sea scenario. Under the local placement approach, it would be used sparingly (e.g., three days) for dredging in the vicinity of the Ioco pipeline for and to shape the second containment berm (e.g., seven days).

2.4.2.2 Hopper Dredge

The Fraser Titan is 15.6m (52') wide and on each side there are two (2) "drag heads" that are lowered to the sea floor. The bottom of each drag head is approximately 1.8m wide allowing for a "cut" of approximately 15cm deep. One pass of the vessel will leave behind two cuts that are 52' apart, each 1.8m wide and 15cm deep.

Dredging occurs with the vessel on the move. Vessel speed during dredging is approximately 1 knot (1.852 km/hr). The hopper dredge has a capacity of approximately 3000m^3 when completely full.

In anticipation of a proposed trial, sediment cores were obtained from three locations in Port Moody Arm in the vicinity of Reed Point Marina. All samples were fine sediment (see core logs in **Appendix VI**). As a result, the expected load within the vessel's hold would be comprised of approximately 20% sediment, 80% water (e.g., 600m^3 of sediment). Based on this operating efficiency combined with long transit distance to the (Point Grey) disposal site and operating cost, the hopper dredge was not considered viable for disposal at sea. However, with much short transit distances (1-3km.) in the local placement scenario, the hopper dredge (FRPD Titan) would only be needed for up to 17 days instead of 150 days in the disposal at sea scenario. The local placement option provides scheduling availability for other Port Metro work sites. Overall, the Fraser Titan is only a viable option when dredging the area west of the Ioco pipeline (i.e., estimated volume 210,000m3) with local placement.

2.4.3 Cutter-Suction Dredge

The FRPD Columbia cutter suction dredge operates a suction tube with a cutting mechanism at the suction inlet. The cutting mechanism loosens the bed material and transports it to the suction mouth. The dredged material is subsequently sucked up by a wear-resistant centrifugal pump and will then be discharged through a pipe line and diffuser at the designated placement site. The material is fine enough that a booster pump will likely not be required for moving the sediment. A number of operational modifications will be attempted (e.g., lower pressure; diffuser placement) to reduce dredge and placement turbidity. The Columbia would be used to dredge 320,000m3 of the navigation channel east of the Ioco pipeline, requiring 26 days.

2.4.4 Detailed Dredge Option Evaluation

The table and text below summarizes the key variables in selecting the most appropriate dredge option. Environmental, economic and social factors were considered. **Table 2** below shows conditions and costs associated disposal at sea using clamshell or hopper dredge. **Table 3** shows applicable conditions and costs associated with local disposal using a combination of hopper, clamshell and hopper dredges.

TABLE 2:DREDGE OPTION SUMMARY – INDIVIDUAL EQUIPMENT FOR DISPOSAL AT SEA

Dredge Option	Comparison Variables						
	Dredge Turbidity Limit*	Dredge Duration (days)	Air Emissions tCO2e	Material Recovery / Load**	Economic: Dredge Only	Economic: DAS Fee ($0.47 /t)	Total Economic / Cost
Clamshell	complies	212	5,900	80-85%	$7.6 million	$125,000	$7.8 million
Closed Hopper	complies	150	6,300	15-20%	>>$11.2 million	$125,000	>>$11.4 million

*Expected to comply with similar turbidity limit of 75 ntu above background (set in 1995)**sediment recovered per bucket (clamshell) or hopper.

TABLE 3:DREDGE OPTION SUMMARY – COMBINED EQUIPMENT FOR LOCAL PLACEMENT

Dredge Option	Comparison Variables							
	Dredge Turbidity	Dredge Duration (days)	Air Emissions tCO2e	Placement Logistics	Material Recovery	Economic: Dredge Only	Economic: Berm Construction	Total Economic / Cost
Clamshell	comply	10*	280	good	80-85%	$250,000		
Closed Hopper	comply	17	710	good	20-25%	$1.5 million		
Cutter-Suction	comply	26	1,100	best	80-90%	$2.2 million		
Totals	comply	46	2,100	good	-	$3.0 million	1.5-3.0 million	$4.5-6.0 million

**Iincludes estimate for shaping berm.*

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2.4.4.1 *Turbidity*

All dredge options are expected to remain in compliance with proposed turbidity restrictions (e.g., 75 ntu above background set in 1995).

The fine particulate sediment will remain predominantly as a solid mass in the water column when dredged by the clamshell bucket and when released into the placement area from a bottom dumping scow. The Titan will discharge at a depth of approximately 4.5m under full load.

With respect to the cutter-suction method, turbidity generated at the cutter-head is expected to remain at depth. The majority of sediment will be collected by suction and the cutter head and placed via surface pipeline with a diffuser at depth in the placement area.

2.4.4.2 *Dredge Duration*

Under the disposal at sea option, clamshell and hopper dredges are expected to require 212 and 150 days, respectively. These are reduced to 10 and 17 days, respectively, with the cutter suction dredge requiring 26 days, under the local placement option. Similarly operating efficiency for the hopper dredge is expected to increase from 2400m^3/day (disposal at sea) to at least 12,500m^3/day (local placement). The significantly shortened duration for works will result in lower emissions and a decreased potential for noise disturbance and visual impacts.

2.4.4.3 *Air Emissions*

Under the disposal at sea option, the clamshell and hopper dredge will respectively generate over 5900 and 6300 tonnes of CO_2 equivalents (GHG). The total air emissions estimate for dredge and placement, including berm construction, using a coordinated equipment approach for the local placement option, is 2,100 tonnes of CO_2 equivalents. This reduction of nearly 65% in emissions would be equivalent to removing approximately 785 cars from the road for one year. This emission reduction is also aligned with PMV air quality conservation initiatives.

2.4.4.4 *Economic Considerations*

Including berm construction, local placement approach cost is estimated between $4.5 million to $6.0 million. The range is attributed to berm material sourcing. Disposal at sea estimates are $7.8 million to $11.4 million. As such, savings for the local placement can range from 23% to 60%.

2.4.4.5 *Placement Logistics*

Under the placement option, the cutter suction dredge fitted with floating pipeline and mobile diffuser head will be the most efficient means to distribute sediment within the planned containment areas. The Titan, with careful navigation within the placement area can achieve very similar results, including prevention of voids progressing from higher to lower elevations on the sea bed.

2.4.4.6 Noise

Dredging operations may generate noise levels above background and disturb some citizens (predominantly on the north side of the Arm). The Fraser Titan engines are housed below deck and are therefore expected to be the quietest of all dredge types.

Some mitigating factors include a shortened duration (using cutter suction), installing noise controls (muffler) and project timing (November and December) when most people will be indoors due to seasonally poor weather.

2.4.4.7 Dredge Material Recovery

Bathymetric analysis suggests that upwards of 83% of the material dredged in 1995 (using the Columbia) remained in place behind the constructed berm located east of the turning basin (see section 3.0 for details). Over 90% containment is expected using the Fraser Titan and Columbia combined with silt curtains and expanded berms.

2.4.4.8 Summary Conclusion for Dredge Type

After comparing dredge types under disposal at sea and local placement options, the combined equipment approach with local placement was clearly the preferred option. It has:

- The lowest environmental impact, including shortest duration to minimize citizen disturbances;
- The best value (lowest cost) to achieve the desired outcome (-14.0m channel depth); and the,
- Higher efficiency for material placement.

3.0 OPERATIONS PLAN, POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION

Outlined below are the phased projects plans that begin with building a second containment followed by dredging and placement.

3.1 OPERATIONS PLAN

3.1.1 Phase I: Containment Berm Construction

An evaluation of recent bathymetric data furnished by Department of Fisheries and Oceans (2012) –indicated that available volume for placement behind (east of) the existing berm is limited to approximately 55,000m^3. With a total dredge volume estimated at 530,000m3, building a second berm to accommodate the remaining volume is required. Design and construction concepts are summarized below.

3.1.1.1 Berm Design Concepts

- The new berm will be located west of the existing berm, adjacent and no closer than 31m to the turning basin. The structure will proceed linearly to a 6.5m contour north of the turning basin and make a right angle until it intersects with the existing berm at 4.5m chart datum. This triangular alignment creates a full enclosure at depth (see

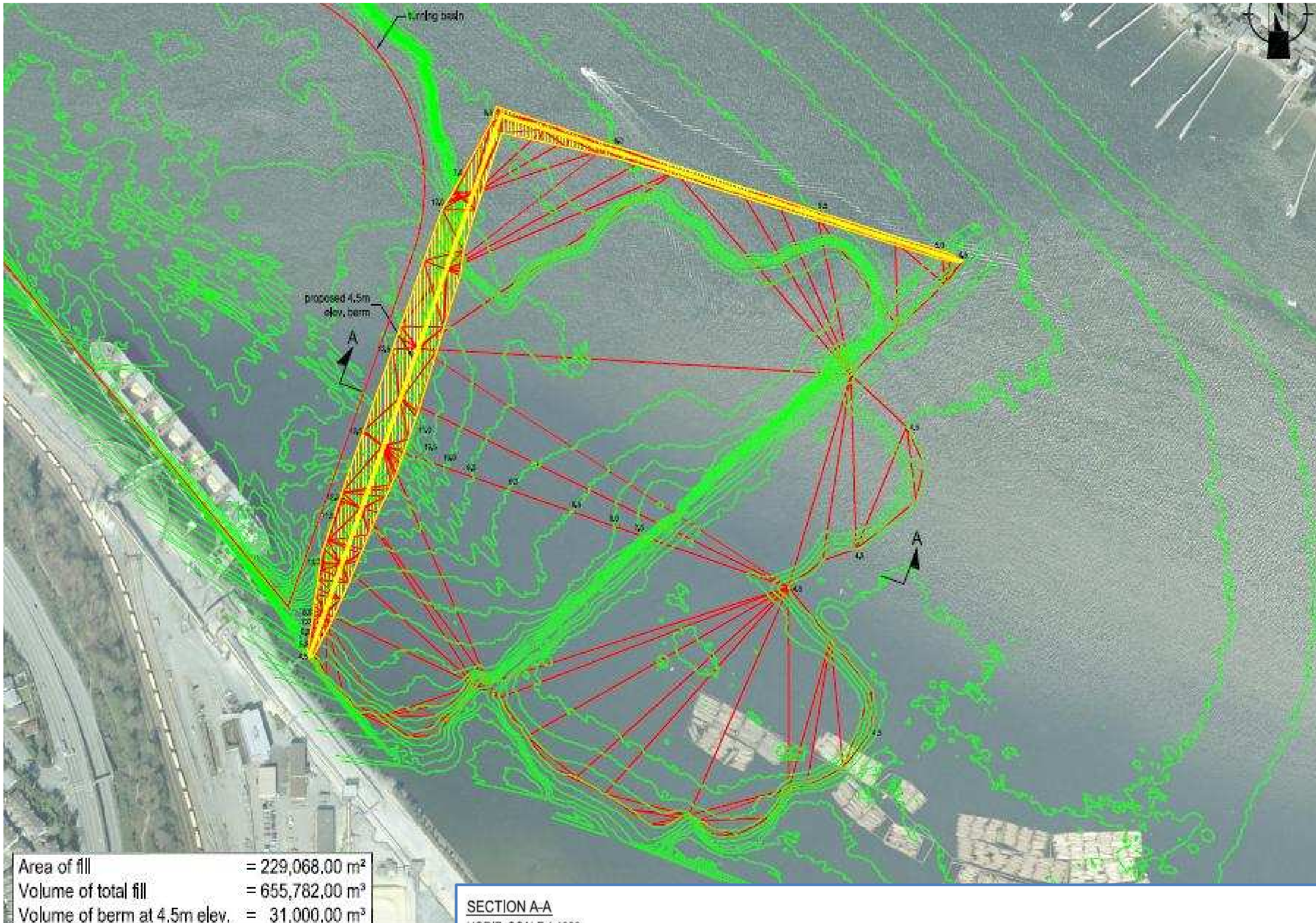
Figure 2).

- Combined with the existing berm, there will be total containment of 655,000m^3. This volume was selected for two reasons:
  - ✓ To accommodate the planned placement volume (530,000m3); and,
  - ✓ To accommodate sediment bulking factor which demonstrated by Tarbotton*et al*. (1999[7], using a US Army Corp of Engineers method -sediment column test). The factor indicates volumetric consolidation of suspended sediment over time (see **Section 4.2.1** for additional details). Using a final bulking factor of 1.2, times the planned sediment volume, results in a final placement volume of 636,000m^3.
- It will initially be built to 6.0m chart datum to allow the Fraser Titan to sail into the placement area with amply draft under a full load. Once the Titan's work area (i.e., west of the Ioco pipeline) is complete, the berm will be elevated to 4.5m below chart datum prior to dredging with the Columbia. The berm will be built with 2.5:1 side slope and 2m cap.
- At 4.5m chart, the chosen berm elevation will not cause navigable water obstruction.
- Up to 33,000m^3 of material (including 5% contingency for settling into the soft bottom seabed) to build the berm.
- Possible sources for berm material will be clean, otherwise diverted as "waste" through Disposal at Sea or upland (landfill) disposal. A strict material acceptance policy will be implemented to prevent introducing potential sources of contamination. Possible sources for clean, "reusable" material includes, but is not limited to:
  - ✓ Concrete crushed to site from construction sites (e.g., Port Mann bridge demolition); and / or,
  - ✓ Suitable material crushed to grade from the Translink Evergreen Line tunnel excavation.
- Diversion from DAS program.
- Contingency will also be explored for angular pit run from nearby mining operations (e.g., Texada Island).
- Other suitable dredging projects within the harbour (first & second narrows).

[7] Tarbotton, M., M. Mattila, and J. Jordan. 1999. Underwater Containment of Hydraulic Dredge Material Pacific Coast Terminals, Vancouver Harbour British Columbia. In Proceedings of the 1999 Canadian Coastal Conference. May 19-22 Royal Roads University, Victoria, British Columbia. pp. 531-542.

3.1.1.2 Berm Construction

Berm construction will take place exclusively waterside. Clean material will be towed to the designated site and released from the surface via bottom-dumping scows. One or two derricks will be used to shape (trim) the berms to the specified 2.5:1 side slopes and a final 2.0m cap. Final elevations will be confirmed to ensure compliance with the planned 6.0m and subsequent 4.5m chart datum heights for length of the berm. Construction will require approximately 30 days and is scheduled to begin in February, 2013. Once construction is complete and elevations verified, the dredge and placement program will begin.



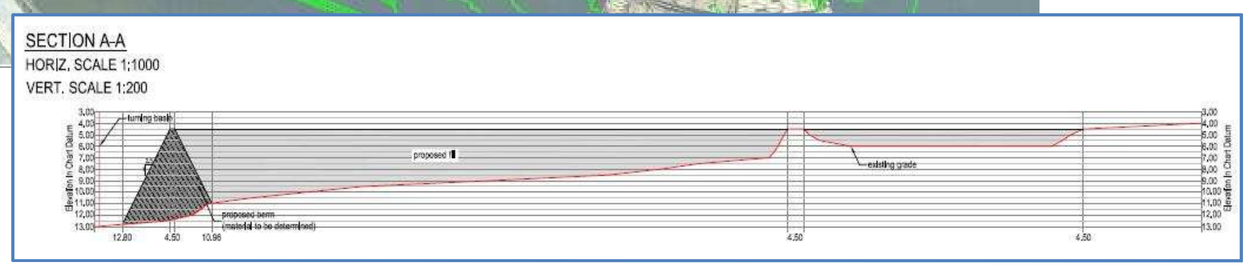


FIGURE 2:PLANNED PLACEMENT AREA BERM

3.1.2 Phase II: Dredge and Placement

Key operational considerations for the dredge include the following:

- Dredging will require approximately 46 days, operating 24 hours a day, and 7 days per week.
- Dredge sequencing will be as follows:
  - ✓ Begin with the Fraser Titan to dredge up to 210,000m3 west of the Ioco pipeline. The overflow chute will be closed. The Titan will take on approximately 600m3 of sediment and 2400m3 of water, then transit to the new placement area for placement then return to the dredge channel work area. It is expected to make approximately 20-22 sailings per day and complete this section of the dredge in 17 days.
- The next major step is to dredge the navigation channel east of the Ioco pipeline using the Columbia cutter dredge. It will take an estimated 26 days dredge and convey via floating pipeline the planned 320,000m^3.
- The clamshell may operate concurrently with the hopper or cutter-suction dredges. It will otherwise add approximately three days duration to complete dredging in the near the Ioco pipelines. PCT is regular communication with Imperial Oil for safe operations in this area. The pipeline has not been used for over 25 years, but the status of contents is unknown at this time. Imperial Oil is planning to pig the lines in the near future.
- Using cutter-suction dredge and floating pipeline, material will be transferred at approximately 12,500m3 / day. This translates to 8.7m^3 / minute at the point of discharge.
- As concluded by Tarbotton *et al*. (1999[7]), a diffuser will be used at the discharge point to effectively control turbidity when using the cutter suction.
- Material will be placed in multiple locations within each containment area. The triangular containment area will be used as the primary placement site. The area behind the existing berm will be used for contingency, most likely for short durations (e.g., <24 hours) to allow settling in the main containment area.
- The operators will attempt placement of material from higher to lower elevations to encourage more even settling and minimize voids.

3.2 OPERATING MITIGATION MEASURES

Building on the knowledge obtained from the dredge conducted in 1995, several planning and operational controls will be implemented to minimize and / or prevent environmental and social impacts resulting from the project:

The project will be timed to occur:

- Within a fisheries window so as to not interfere with sensitive juvenile salomonid development stages.
- During the early to mid-fall season where most residents will be indoors due to typically poor weather. This will help reduce visual obtrusion and potential noise disturbance.

Multiple turbidity control measures:

- While maintaining operational efficiency, pump velocity rates may be adjusted to help minimize potential turbidity (1995).
- Diffuser installation to reduce discharge velocity.
- Deployment of silts screens (geotextile, sisal, etc.) to a depth of 6m (20ft) near the diffuser to trap sediments in the water column that may otherwise escape from the placement area.
- Berm design that accommodates time required for suspended volumes to settle within the planned containment area.
- Allow for temporary shutdowns if indicated by monitoring, although none where necessary during the 1995 dredge.
- Potential to further reduce dredge pump rates to, in turn, reduce discharge velocity if and when necessary when using the cutter suction.

Timely Project Notification:

- PCT will work with the Port to ensure that stakeholders, including local residents and water based businesses, and interest groups are informed of project timing and potential short-term impacts (noise, turbidity). Project notification will follow previous project communications undertaken by PMV and the Port (see section 5.0, public communication and First Nations for additional detail).

3.3 POTENTIAL RESIDUAL PROJECT IMPACTS

There are no long-term residual negative impacts expected as a result of the proposed dredge and placement activities, serious harm to fish. This is supported by available historical information and related interpretations as follows:

- Recent bathymetric analysis confirmed that 83% of the planned dredge volume (231,000m^3 out of 280,000m^3) was successfully deposited behind the berm. It is otherwise assumed that the remaining 17% entered the water column and was subsequently deposited elsewhere in the Arm and Burrard Inlet. Consequences of a likely sediment rain were likely positive in a short-term nutrient distribution followed by rapid recovery of the benthic community through colonization and reproduction.
- Post 1995 dredge monitoring conducted by Tarbotton *et al.* (1999[7]) stated that “ongoing site environmental monitoring indicates a full recovery of the local habitat”.
- Material properties led to rapid settlement as demonstrated by monitoring data accumulated during dredge. Data indicated quick settling within 100m of the discharge point and that material largely remained near the seabed after discharge from the diffuser.

From a “positive” impact perspective, the project offers several long-term environmental benefits:

- As a result of an elevated sea bottom (to 4.5m chart datum) achieved through material placement, the duration and intensity of light reaching the sea bottom is enhanced, increasing primary productivity (e.g., algae and prospectively eelgrass (*Zostera marina*), and hence, foraging opportunities for motile benthic invertebrates. Such invertebrates will invariably drift with currents to near shore environments, where they will be available as prey to local fish populations, including economically and culturally important salmon species at their early (juvenile) stages of development.

- An opportunity to reuse clean construction material and aggregates for developing habitat instead of losing the material as waste to landfills or disposal at sea.
- Protecting air quality by selecting the most efficient approach of dredging and direct placement within the Arm. This approach also offers the shortest duration of potential noise and visual disturbances to local citizens.

3.4 PROJECT MONITORING PLAN

The proposed monitoring plan significantly expands the geographical and technical scope undertaken in 1995. Changes include increasing the number of on-shore sampling locations from two to eight in order to get a more accurate indication of turbidity within the Arm; and biophyscial parameters to assess potential changes caused by sedimentation. The approach includes logic and correction for natural seasonal events (e.g., avoid algal bloom) and anthropogenic sources (e.g., tracking in water works). The monitoring program scope will cover the pre-dredge, dredge and post-dredge periods

3.4.1 Measured Parameters and Sampling Protocols

Total Suspended Solids

Total suspended solids (TSS) provides a measure of the loading of solids within the marine environment; it will provide an indication of the: potential of sedimentation of intertidal habitats; fouling of the gills of marine organisms; and, the attenuation of light throughout the water column.

Nephelometric Turbidity Units

Nephelometric turbidity units (ntu) provides of measure of the attenuation of light throughout the water column which, if it persists over an extended duration, can have an effect on the vigor of benthic algae, kelp and eelgrass

Particle Size Distribution

The distribution of particle sizes of TSS and of sediments will indicate what portion of the initial tss readily settles within the immediate zone of influence and what portion may be transported outside the immediate zone of influence.

Sedimentation

Sediment plates will be utilized to measure sedimentation within the intertidal zone; sedimentation provides a measure of the prospective impact on benthic/epibenthic/encrusting invertebrates and algae.

Areal Cover/Abundance of Intertidal Benthic/Epibenthic/Encrusting Invertebrates and Algae

The measure of areal cover and abundance of invertebrates and algae provide an indication of the response of the biological component of the environment to TSS, ntu and sedimentation.

Analyzed at CAEAL certified laboratories such as ALS Environmental and Maxaam.

3.4.2 Sample Locations

Proposed open water and shoreline sample locations are outlined below and shown in Figure 3. Shoreline locations are situated to monitor the primary zone of influence in Port Moody Arm. Monitoring stations are not located within Indian Arm as factors extrinsic to project (e.g. currents, fetch, water uses, fluvial discharge) would confound monitoring data obtained from such stations.

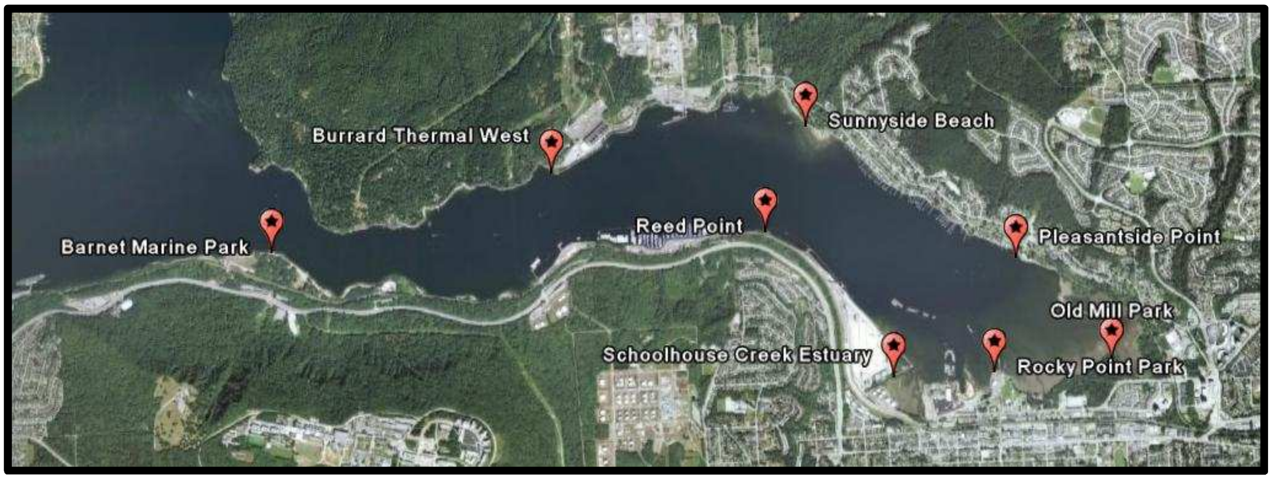


FIGURE 3:PROPOSED SHORELINE SAMPLE LOCATIONS

Open Water Sample Locations

One-hundred (100) and two-hundred (200)m (to be confirmed) from dredge scow in aligned in direction of tide, both upstream and downstream (daily NTU during operations). Similar to the 1995 monitoring program, sample would be taken at one (1) metre gradations to a depth of 5m. Turbidity limits can be the same as 1995: 75 NTU above background, 5m depth and 50m from the vessel.

Shoreline Sample Locations

North Side Port Moody Arm:

- ✓ Point of Headland at western margin of Burrard Thermal Plant.
- ✓ Sunnyside Beach.
- ✓ Pleasantside Point.
- ✓ Old Mill Park.

South Side of Port Moody Arm:

- ✓ Rocky Point Park.
- ✓ Schoolhouse Creek.
- ✓ Reed Point.
- ✓ Barnet Marine Park.

3.4.3 Sample Scheduling & Frequency

Sampling will be done over three (3) distinct phases:

- **Pre-Dredge:** to establish a baseline for measured parameters, representing the pre-effect condition.
- **Dredging:** to represent the effects condition (during operations, including placement).
- **Post-Dredge:** to represent the recovery phase, which, depending upon extent of recovery, will provide an indication of the severity of effects.

An initial sampling schedule is shown below in (Figure 4) which expands on the 1995 monitoring approach using criteria derived from the BC Water Quality Guidelines. Frequencies and parameters may be adjusted (with prior consultation and approval with DFO) pending field sampling results. It is proposed that field sampling teams will consist of approved monitors with professional credentials and experience and potentially interested members of local First Nations (e.g., Tsleil Waututh, Squamish and / or Musquem) for capacity building.

PARAMETER	DREDGE PHASE & SAMPLING FREQUENCY																			
	PRE-DREDGE		DREDGE & PLACEMENT							POST-DREDGE										
	Ocotber 1, 2013	October 15, 2013	Week 1 (November 1, 2013)	Week 2 (November 14, 2013)	Week 3 (November 21, 2013)	Week 4 (November 28, 2013)	Week 5 (December 5, 2013)	Week 6 (December 12, 2013)	Week 7 (December 19, 2013)	week 1 (January 2, 2014)	week 2 (January 9, 2014)	week 3 (January 16, 2014)	week 4 (January 23, 2014)	week 38 (October 1, 2014)	week 40 (October 15, 2014)	week 42 (October 29, 2014)	week 44 (November 12, 201	week 46 (November 26, 2014	week 48 (December 10, 2014)	week 52 (December 24, 2014)
Total Suspended Solids	✓	✓	✓	✓						✓						✓				
NTU	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							
Particle Size Distribution	✓	✓	✓	✓						✓	✓	✓	✓							
Sedimentation	✓	✓	✓	✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Areal Cover and Abundance	✓	✓					✓			✓			✓	✓	✓	✓	✓	✓	✓	✓

FIGURE 4:PROPOSED SAMPLING FREQUENCY

3.4.4 Post Dredge Bathymetry

Post dredge soundings will be taken in two locations:

- Channel, in order to verify depth achieved; and
- Placement Area, to verify sediment volume relocated.

Initial soundings for the channel and placement area will be done four weeks post dredge. Soundings will be obtained a second time in the placement area one year post dredge to assess further settlement (i.e., more accuracy in sediment volume placed).

4.0 HABITAT RESTORATION

4.1 INTRODUCTION

The placement of dredged material within the historic turning basin is compatible with the future placement of material conducted as part of a comprehensive work plan to create fish and wildlife habitats at this location. The plan defines an optional two-phased approach to habitat creation, whereby material is placed to achieve a construction milestone that produces an intermediary habitat that is more productive and supportive of local fish. This milestone may subsequently facilitate future development of an island complex (i.e., Phase 2) that creates upland, intertidal and sub-tidal features characteristic of estuarine environments of Port Moody and Indian arms. The proponent may seek approval for the island complex under a separate application process. Preliminary concepts for the island complex are provided in **Appendix VII**.

4.1.1 Construction Methodology

The first phase of the work plan would realize the placement of material dredged from the navigation channel and the existing turning basin into an historic turning basin that received dredged material in 1995. Approximately 280,000m^3 of marine sediments were dredged in the spring of 1995 to create a new turning basin at Pacific Coast Terminals (Tarbotton *et al.* 1999[7]).

The historic turning basin is located south of the existing turning basin. In 1995, a berm was constructed at the opening of the basin to retain dredged material. The berm was successful in retaining material, creating 130,000m^2 of seabed at an elevation of 4.5m (local chart datum) (Tarbotton *et al.* 1999[7]).

The 1995 dredging program tested the sediments to be dredged to identify physical properties. The properties of the sediments strongly influenced the methodology employed for the removal and placement of sediments. These properties included:

- higher than anticipated dredged material production or bulking factor;
- a high degree of sediment bulking; and,

  Diifficulty with dredge positioning and anchoring as the soft sediments had poor holding ability (Tarbotton *et al.* 1999[7]).

Upon discharge, sediments comprise a slurry that flocculates and settles rapidly as demonstrated by settling column tests (Tarbotton *et al.* 1999[7]). Three types of settlement behaviour were observed:

- **Zone settling (0 to about 8 hours)**: zone settling is the initial rapid and linear settling of the slurry/supernatant liquid interface. The mean rate of settling of the interface during zone settling was 0.11m per hour.
- **Consolidation settling (8 hours to about 150 hours)**: consolidation settling is the non-linear settling that occurs after the initial zone settling. During this settlement water is being squeezed out of lower layers of sediment as the weight of the overlying layers bear down. The bulking factor decreases with increasing settlement.
- **Consolidation (150 hours onward)**: consolidation is the final stage of settlement during which the settling essentially stops.

The settling column test results displayed a bulking factor of approximately 2 at 150 hours. In essence, for every cubic metre of sediment excavated, 2m^3 of material would prevail (settle) after 150 hours. Over time, settlement would proceed, with the bulking factor decreasing, and the volume of material placed at the disposal site approaching that initially dredged.

The material was placed within the basin in April 1995 to an elevation of 4.5m. The material was surveyed in April, 2012. Intuitively, after 17 years, it is expected that settlement would have resulted in a lower elevation, whereby the sea bottom is deeper than what was determined in 1995. Indeed, the 2012 survey data reveals that this has occurred, with a typical bed elevation of approximately 6.0m. Settlement has apparently manifested a decrease in the height of placed material of approximately 1.5m.

The dredging program comprising Phase 1 of the work plan would mirror that employed in 1995. The placement of material would generally occur within that area used for disposal in the 1995. A perimeter berm at a crest elevation of approximately 3.0m would be constructed to retain material. Initial disposal would consider the initial bulking factor of eight (8) associated with settling column test results of Tarbotton *et al.* (1999[7]). The bulking factor decreases dramatically to approximately 3.5 after 10 hours. As for the 1995 dredging program, the work plan will modify the rate of dredged material disposal to ensure that the retention berm is not overtopped by the unconsolidated slurry.

4.1.2 Habitat Creation / Restoration

Phase 1 of the work plan would create approximately 230,000m^2 of seabed at an elevation of 4.5m chart datum. A similar area of seabed predominantly within the elevation range of 5.0 to 6.0m would be impacted by the placement of dredged material.

The bed elevation of 4.5m set for disposal for the 1995 work program was selected "with the goal of increasing the area of biologically productive shallow sub-tidal seabed" (Tarbotten *et al.* 1999). Regulatory agencies accepted the premise of enhanced benthic productivity through approval of the work program. It is interpreted that the premise for enhanced benthic productivity is founded upon the increase in irradiance of the seabed, in terms of both intensity and duration, thereby increasing primary productivity (prospectively by green algae and eelgrass) and structurally complexity of benthic habitats (again by algae and eelgrass). Light attenuation through the water column decreases with decreasing depth.

The majority of the 1995 sea bed rests at 6.0m elevation. Typically, within waters of coastal British Columbia not unduly affected by suspended solids, green algae and eelgrass typically do not occur below 6.0m chart elevation. The lower limit for green algae and algae within Port Moody Arm is likely considerably less than 6.0m elevation. Port Moody Arm receives considerable loading of suspended solids from stormwater sewers and creeks. The catchment areas of these drainages are highly urbanized. As such, current benthic productivity is likely only marginally greater than the pre-1995 condition.

The proposed bed elevation of 4.5 m mitigates the influence of suspended solids upon the ability of the sea bed to sustain green algae and eelgrass. If the subsequent occurrence of algae and eelgrass were to appear constrained, it would be attributable to factors other than irradiance. Benthic productivity will be enhanced, even with consolidation of placed sediments to the 1.5m experienced for the 1995 sediments. If this were to occur, the resulting bed elevation of 1.5m is still within the light environment capable of sustaining green algae and eelgrass.

At the very least, green algae will occur upon the new sea bed. Unicellular, filamentous and foliose algae will be represented. Whereas the current condition is characterized by a detrivore-based benthic community, the presence of algae will introduce herbivores to benthic community. This will enhance productivity of the community. It is unlikely that detrivores will be displaced. The predators that currently feed upon the detrivores will also prey upon the herbivores.

4.2 Geotechnical Design Considerations

4.2.1 General Criteria

The geotechnical behaviour of hydraulically-placed fill in a marine environment is different from that experienced on terrestrial land. The density, gradation and plasticity of the fill significantly influence the strength of the materiel through shear. As consolidation and settlement take place, induced pore pressures in the fill dissipate and shear strength increases; the rate of consolidation is important in this regard and thus the method and rate of fill placement may need to be controlled. The fill thickness itself results in additional load on the native sub-base and thus bearing capacity and stability of the marine sediments must be addressed in terms of providing overall support for the earth structure. Lastly, in BC, the potential for liquefaction and seismic failure is also a design issue.

4.2.2 Conceptual Design of Containment Area

The conceptual design at present presumes containment of the fill with toe berms to local low water chart datum. Comprised of 150mm minus recycled concrete, the berms would be placed in bulk with a 2m crest width and minimum 2.5:1 (h:v) slopes. The berms would provide for 635,00m3 of containment to local low water chart datum.

This design minimizes geotechnical concerns significantly in that containment is provided, thus controlling the dispersion of the hydraulically-placed fill and ensuring minimal scour velocities as the water in the fill is displaced. The issues to be addressed narrow down mainly to stability and liquefaction.

4.2.3 Design Process

Initially, all available bathymetric and seabed information from our files and those available through PCT and the Port of Vancouver would be reviewed. A targeted offshore geotechnical investigation program would be implemented with focus on obtaining representative seabed core samples and evaluation of in-situ strength with CPT equipment. Select materials testing would then be performed and the geotechnical design parameters would be established for both static and seismic conditions. In the event that there are weak inter-beds in the ocean floor, the stability of the islands would be evaluated in terms of the shear strength of any weak subgrades, during and after fill placement. Direction would also be provided with respect to fill characterization, placement method (pumped vs. bulked) and in-place behavior of the dredgeate and future fills to ensure stability of the earth structures both during placement and long-term.

4.2.4 Hydraulic Design Considerations

The project area is in the upper reaches of Burrard Inlet and several ocean hydraulic concerns can be practically eliminated if not reduced in terms of importance. The principal need to conduct hydraulic analysis is related to tidal flow velocity and sediment transport. The containment area could alter tidal flows and local current conditions, which, in turn, may affect sediment drift and deposition mechanisms. The proximity of the structure to the marine mudflats to the east (south bank) and the estuarine deposits at the mouth of Schoolhouse Creek and other small streams could result in accretion or scour in these areas, thus affecting habitat. Through simulation and modeling, any such effects could readily be mitigated through engineered changes containment area, near surface and at depth.

5.0 PUBLIC COMMUNICATION AND FIRST NATIONS

5.1 Preliminary Communication Activities

Building on a history of open communication, PCT has taken several steps to date to inform and engage stakeholders as follows:

- Preliminary project disclosure to City of Port Moody council and mayor (2011).
- Preliminary project notification and meeting request to Musqueam, Squamish and Tsleil-Waututh Nations (letter issued December 2011).
- Project Information sharing meeting with Tselil-Waututh Nation July, 2012.
- Project notification on PCT website under “Growing Our Business/Terminal Improvements and Modifications” (http://www.pct.ca/code/navigate.asp?Id=71).
- PCT project circular and survey issued July 2012.
- A planned open house hosted by PCT in late summer 2012 to disclose expansion plans including the dredge project.
- Port Moody Ecological Society regarding habitat enhancement.

- Ongoing community notification and engagement activities:
  - ✓ Summer days July long weekend, where the public was invited to visit the site and observe the harbour from a tourboat.
  - ✓ Publishing "Currents", the PCT publication available online and in hard copy. The May, 2012 edition includes an article on maintaining a positive community report including an online survey to gauge PCT performance.

Communications with First Nations will also gauge potential interest in partnership and capacity building. Key activities may include water quality and on-shore monitoring and on-board observations during dredge and placement operations.

5.2 Planning Alignment

Through ongoing communications and project planning, PCT has designed the dredge and placement activities intended to align with numerous local and regional plans and initiatives represented by a wide variety of stakeholders as follows:

- PMV Project Application Process.
- Tsleil-Waututh Nation Stewardship Policy, Marine (and Salmon) Stewardship.
- City of Port Moody.
- Port Moody Ecological Society.

6.0 CONCLUSION

The PCT proposal to deepen the navigation channel is critical to long-term viability of our business and the safety of marine vessels that transit the Arm to and from our site. We have assembled the most logical approach that meets environmental, social and economic objectives. In summary, our approach:

- Improves on proven 1995 approach that achieved an estimated 83% material placement rate.
- Will effectively control and limit turbidity to short duration and remain predominantly within the immediate project area.
- Is reasonably not expected to generate a HADD or cause "serious harm to fish". The dredge cut will cause a temporary disturbance of low productivity community that is expected to recover in short period.
- Will provide beneficial end-use of material for habitat restoration instead losing material as "waste" through disposal at sea. Furthermore, it may become foundation for innovative island complex for additional habitat enhancement.
- Creates the shortest operational duration to limit potential noise and visual disturbance.
- Is the lowest of all options for generating GHGs (lowest CO_2e profile including berm placement).
- Provides an anticipated partnership with First Nation(s) for water quality monitoring.