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REMEDIAL COSTS FOR LADYSMITH HARBOUR

Ladysmith, BC

Submitted to:
Crown Land Opportunities and Restoration Branch
Ministry of Forests, Lands and Natural Resource Operations
780 Blanshard Street
PO Box 9361, Stn. Prov. Govt.
Victoria, BC V8W 2H1

REPORT

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The report is based on data and information collected during investigations conducted by Golder Associates Ltd.'s personnel and the review of reports prepared by others as listed in this report. It is based solely on the conditions of the subject property at the time of the site investigations conducted in 2005 and between 2009 and 2011, as described in this report. The data presented in this report represents soil, groundwater, and soil vapour conditions encountered at the sampling locations tested during this time period. Soil, groundwater, and/or soil vapour conditions may vary with location, depth, time, sampling methodology, analytical techniques and other factors. Golder Associates Ltd. makes no warranty, expressed or implied, and assumes no liability with respect to the use of the information contained in this report at the subject site, or any other site, for other than its intended purpose.

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If new information is discovered in the future, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this report and provide amendments as required prior to any reliance upon the information presented herein.

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by the Crown Lands Opportunities and Restoration Branch (CLORB) of the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) to conduct a Stage 1 Preliminary Site Investigation (Stage 1 PSI), Detailed Site Investigation (DSI), sediment investigation and preliminary geotechnical investigation at Ladysmith Harbour in the Town of Ladysmith, on Vancouver Island, British Columbia (the "Site"; see Figures 1 and 2).

It is understood that CLORB of MFLNRO and the Town of Ladysmith, as well as other stakeholders, desire to develop the Site for potential residential, park, and/or commercial land use. The primary objectives of the investigation activities were to refine remedial alternatives and associated remedial and geotechnical cost estimates for the Site. Authorization to proceed was provided by Mr. Geoff Sinnett of MFLNRO.

This report presents the updated remedial cost estimates for the Site. Results of the Stage 1 PSI and DSI, sediment sampling and preliminary geotechnical investigations are presented under separate covers.

1.1 Background

1.1.1 Location and Setting

The Site comprises approximately 37.25 hectares of uplands, waterfront and water lot properties located east of the Vancouver Island Highway (VIH) between Transfer Beach and Williams Point along Ladysmith Harbour in the Town of Ladysmith, BC (Figure 1). The Site includes Slack Point, which is a relatively open area extending into the harbour along the south part of the Site (Figure 1), that was constructed historically by infilling with coal wastes and other materials in the early to mid part of the last century..

Some areas of the site are currently undeveloped (for example Slack Point) and some portions of the Uplands (*i.e.,* the area of the Site between VIH) and the high-tide mark at the waterfront) are developed. The Site is understood to be zoned as a mix of park, residential, commercial and industrial land. There are existing roadways in the Uplands areas and southwest of Slack Point. A marina (Ladysmith Maritime Society Marina) is located adjacent to the Site within Ladysmith Harbour, to the northwest of Slack Point. Within the Uplands are existing rail tracks parallel to the Island Highway. Along the waterfront area, northeast of the Uplands, is an existing government wharf.

Slack Point is generally flat and relatively low lying, with isolated mounds of fill material at surface. Along the southwest side of Slack Point, the ground surface rises where it joins the Uplands areas. It has discontinuous vegetative cover, including trees, grass and shrubs.

The Foreshore is a relatively narrow strip of land extending some 600 m along the shore from the western inner corner of Slack Point to the government wharf at the far northwest end of the site. It comprises a parcel of filled foreshore land connecting Slack Point and the railway. The Foreshore consists of slope ground and beach, together with reclaimed land.

The Uplands comprise the areas southwest of Slack Point and the Foreshore. It extends approximately 1 km parallel to the Foreshore. The Uplands area of the Site forms a terrace some 10 m to 15 m higher in elevation than Slack Point and the Foreshore. The Uplands has low lying vegetation, shrubs and grass. There are also roadways and buildings present, including a former locomotive and railcar repair shop now occupied by Ladysmith Maritime Society and various businesses, a washroom, and various sheds. The former EN Railway siding extends through the lot.

Details of the property designations, their individual area, and summary descriptions are provided in Table 1, below.

Table 1: Property Details

Region	Legal Address	Associated PIDs	Approximate Area (ha)
Slack Point	DL 16G, Oyster District	009-695-001	5.329
Uplands	Lot 4 and Lot 1, Plan except for VIP64405, Oyster District (previously referred to as Lot 4 and Lot 1, Oyster District and DL 24 and DL 56, Cowichan District)	010-208-828, 023-652-926, 006-088-597, 006-088-571	8.5
Uplands	DL 2016 Block A and Block B, Oyster District (previously referred to as Blocks A and B BL 41G)	-	0.451
Foreshore	DL 8G, 11G and 17G, Oyster District	009-695-079	0.257
Water Lots	DL 2016 Block C DL 651		19.05

1.1.2 Historical Activities

Ladysmith Harbour was an industrial harbour for the majority of the last century. From the late 1800s to the mid-1930s it was used primarily to bring coal mined from the area to market. The upland area of the Site was serviced by rail, and a rail yard was established at the Site by the Esquimalt and Nanaimo Railway (ENR), Rail yard facilities included a roundhouse, a locomotive and rail car repair shop with underground maintenance pits, a fuelling area and a passenger train station. By the 1930s, coal mining in the area had declined, and the harbour saw greater use by the logging industry, serving mainly as a log sort facility for handling, dumping and storage of logs. Logging activities at the Site continued until about 1987, after which time the Site has laid relatively dormant, serving as a park in Slack Point. Rail yard facilities were decommissioned in the 1950s.

The main activities carried out historically at the Site were coal washing and transfer at a coal washing and load-out facility, logging activities (sorting, dumping, storing and shipping), and activities associated with the railway yard. Each of these industries generated and discharged waste to the environment at the Site that have left a subsurface legacy that can present challenges for Site development unless properly identified, characterized and remediated.

1.1.3 Previous Environmental Investigations and Assessments

Since 1990, several investigations have been undertaken to address environmental conditions at the Site. In 2005, Golder was retained to review the previous reports and to conduct an assessment of the environmental liabilities associated with Site re-development. Relevant soil, sediment and groundwater data were compiled and compared to regulatory standards/guidelines applicable at the time.

Based on the report review, several data gaps were identified respecting the presence and extent of contamination, and an opinion on the probable costs of remediation was developed. Cost estimates at the time were based on several assumptions that considered the data gaps and uncertainties, as well as broad Site re-development and remediation scenarios that could include a mix of residential, commercial and parkland uses.

As such, the range of opinion of probable costs was relatively large. Depending on the scenario, cost estimates ranged between $539,000 and $9,168,000 for the upland area, and between $525,000 and $34,175,000 for the sediments beneath the water lots. The report concluded that further investigation to address each of the data gaps would serve to refine the remediation cost estimates for identified areas of soil, groundwater, and sediment contamination.

Between 2009 and 2011, Golder completed a Stage 1 Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI) for the Site, in general accordance with the definitions and objectives for PSIs and DSIs, as defined by the Contaminated Sites Regulation (CSR) under the *Environmental Management Act*. The Stage 1 PSI and DSI served to address the data gaps identified in 2005 such that the remedial cost estimates could be refined and updated. Details of the PSI and DSI are reported under separate cover (Golder 2011). In addition, Golder completed a Marine Sediment Investigation and Management Options Assessment and a geotechnical overview assessment of Slack Point and surrounding areas of Ladysmith Harbour. The marine sediment investigation characterized the degree of sediment contamination in the harbour, the degree to which sediment contamination is bioavailable to marine organisms and possible causes of toxicity to marine organisms, and then integrated this information to assess the viability of sediment management options, including ocean disposal. The findings of the marine sediment investigation, including the assessment of feasibility of risk assessment and disposal at sea for dredged sediments were used to update the estimates of the remedial options and costs. Details of the marine sediment investigation are reported under separate cover (Golder, December 2011). The overview-level geotechnical investigation assessed the subsurface conditions at the Site to identify and comment on potential geotechnical hazards that could impact future development of the Site and provide preliminary geotechnical engineering input to planning of feasible forms of development and ground improvement options, including recommendations for additional investigation as development planning advances. The geotechnical overview level report was completed under separate cover (Golder, January 2012).

2.0 SCOPE OF WORK

The following scope of work was completed as part of the remedial cost estimate update:

1) Estimation of the approximate volumes and associated quality of soil and/or sediments at the Site that may require removal via excavation or dredging, and an assessment of disposal options (including ocean disposal) for the materials; and

2) Update of the remedial costs presented in the 2005 report for Ladysmith Harbour, including an evaluation and opinion of probable costs for remediation.

Geotechnical aspects of Site re-development, including potential geotechnical hazards that could impact Site re-development and preliminary geotechnical input to the planning of feasible forms of development and ground improvement options, are provided under separate cover.

3.0 REGULATORY FRAMEWORK

The proposed development area consists of both upland and foreshore areas, triggering several provincial and federal regulatory requirements and permitting issues that must be addressed prior to proceeding with development. Specific requirements can be defined once a development approach is selected, through consultation with the BC Ministry of Environment (MoE), Fisheries and Oceans Canada (DFO) and Environment Canada (EC). As part of this process, agreement on the remedial strategy will likely be necessary from all stakeholders.

It should be noted that the framework of environmental legislation will face considerable uncertainty as a result of planned changes at the federal level in major environmental legislation (*Fisheries Act)* and the environmental assessment process (*Canadian Environmental Assessment Act)*. As these changes also include provisions to integrate with provincial processes, uncertainty in provincial administration of environmental laws is also anticipated.

3.1 Provincial Regulations

In British Columbia, environmental matters pertaining to contaminated sites generally fall under the jurisdiction of the MoE, pursuant to the "*Environmental Management Act"* (EMA). Exceptions include federal lands and waters with migratory fish that fall under the jurisdiction of EC. The two key regulations under the *Environmental Management Act* relating to the assessment and remediation of contaminated sites are the CSR (BC Reg. 375/96, O.C. 1480/96 including amendments up to BC Reg. 97/2011, updated to May 31, 2011), and the Hazardous Waste Regulation (HWR), (BC Reg. 63/88, O.C. 268/88 including amendments up to BC Reg. 63/2009, updated to April 1, 2009).

As part of the Site development and approval process, an Approval in Principal (AiP) or Certificate of Compliance (CoC) may be required by the municipality to proceed with development of the Site, and a CoC may be required to obtain Site occupancy. An AiP can be granted following approval of a remediation plan, thereby allowing Site re-development and remediation to proceed until the objectives of the plan are achieved. A CoC can be issued once the Site is considered to be remediated in accordance with applicable risk-based or numeric standards. At the time of application for an AiP or CoC, investigation and remediation activities and reports would have to have been completed or updated, in order to meet MoE requirements for review. Since the foreshore sediments have been impacted from historical activities at the Site, it is likely that MoE will require either an AiP or CoC for the remediation of the sediments, or a CoC for the foreshore lots, prior to issuance of a CoC for the upland areas.

The CSR provides numerical concentration-based standards for the evaluation of soil, sediment and groundwater quality, and identifies remedial requirements.

3.1.1 CSR Soil Standards

The CSR soil standards are divided into five categories based on land use. As the potential future use of the Site has yet to be determined, the soil quality standards use in the DSI (Golder, 2011) are the residential (RL), park (PL), commercial (CL) and industrial (IL) land use standards, with consideration of groundwater flow to surface water bodies used by marine aquatic life (AW).

3.1.2 CSR Sediment Criteria

The CSR specifies sediment quality criteria for a) typical contaminated sites (SedQCTS), representing levels that provide moderate protection to sediment-dwelling organisms, and b) sensitive contaminated sites (SedQCSS), representing levels that provide a relatively high level of protection to sediment-dwelling organisms. Given the previous industrial state of Ladysmith Harbour and the likelihood that it will remain as a mixed use of industrial, residential and parkland, the SedQCTS were considered appropriate for the sediment investigation.

3.1.3 CSR Groundwater Standards

The CSR provides Generic Numerical Water Quality Standards for the assessment of groundwater quality at sites subject to investigation. The water quality standards are divided into four categories that include standards for the protection of aquatic life (AW) and for defined groundwater uses including irrigation water (IW), water for livestock (LW) and drinking water (DW). Standards for the protection of aquatic life (AW) contain subcategories applicable on a site-specific basis where the proximity of the Site to receiving freshwater (F) and marine water (M) bodies must be considered.

A recent technical guidance document issued by the MoE entitled *"Technical Guidance No.6 on Contaminated Sites – Water Use Determination"* (effective February 1, 2011) outlines a revised procedure for determining the water use for a Site, and takes into account not only present water use but also future water use. Site-specific factors for drinking water apply to all sites, unless the applicability of future drinking water is assessed, by evaluating the hydraulic conductivity, yield, natural quality (including hardness), and presence of confining units in the aquifer.

The Site is located adjacent to and within Ladysmith Harbour, and groundwater from the uplands part of the Site is likely to discharge to the northwest towards and into Ladysmith Harbour. Groundwater at the Site is not withdrawn for any use, and drinking water is supplied to the surrounding properties by a municipal water supply system. Since groundwater at the Site is not used for drinking, irrigation or livestock watering, the principle regulatory standards for the evaluation of groundwater quality at the Site are the CSR Aquatic Life (AW) marine (M) standards.

Drinking water standards could be considered applicable to the Site if the hydraulic conductivity or yield of the subsurface fill or fractured rock is found to exceed 1×10^{-6} m/s or 1.3 litres per minute, respectively. In absence of such testing, and based on the Site's close proximity to a marine water body, it is inferred that under the future development the Site will be supplied by the municipal system, and therefore DW standards were not considered applicable. As part of Site re-development, it is expected that a risk-based remediation program will be required to manage groundwater quality issues at the Site, and that one of the management options will include a restriction on the use of Site groundwater as a potable water supply.

3.2 Federal Regulations and Guidance

3.2.1 Surface Water

Ladysmith Harbour and streams that feed the harbour have historically served as habitat for migratory fish, including several species of salmon. As such, these surface water bodies are regulated by the *Fisheries Act*, and fall under the jurisdiction of DFO. Environment Canada may be called upon to assess environmental compliance. Federal guidance on environmental quality goals for surface waters is provided in the Canadian Council of the Ministers of the Environment ("CCME") Canadian Environmental Quality Guidelines.

3.3 Foreshore Infilling and Ocean Disposal Requirements

Ocean disposal may be a viable option for low-risk soils or sediments that otherwise might require landfilling. Three federal *Acts* and associated regulations address the permitting of potential ocean disposal options and foreshore infill areas. The legislation includes:

- The *Disposal at Sea Regulation*, which is part of the "*Canadian Environmental Protection Act*" (CEPA). This legislation would regulate the disposal of dredged sediments at ocean disposal sites;
- The "*Navigable Waters Protection Act*" (NWPA). This legislation would have to be addressed for any in-water development that might create a hazard for vessel traffic. Features that would require NWPA approval associated with ocean disposal include any shoreline infilling; and
- The federal "*Fisheries Act*"[1]. This legislation regulates development activities in and around aquatic habitat. Features that would be regulated by this act include dredging of fish habitat, infilling of marine areas, and possibly the physical disturbances associated with such work (*e.g.,* turbidity plumes). Depending on the nature of the project, disturbances to backshore vegetation may also be considered by DFO as part of overall project permitting.

As a first step in the ocean disposal permitting process, the chemistry of the material is examined. In general, materials that are considered suitable for disposal at sea are native geological materials that are uncontaminated. However, other materials may be suitable for such disposal but it is necessary to demonstrate suitability, initially on the basis of the chemistry of those materials. Should the materials be higher than the chemical screening values, bioassay testing is necessary. A supplemental investigation program would be developed, and the plan is submitted to EC. Acceptability for ocean disposal would be dependent on the outcome of those tests/analyses.

Because the issuance of an ocean disposal permit constitutes the exercise of a federal regulatory function, it is a trigger for an assessment under the "*Canadian Environmental Assessment Act*" (CEAA). Therefore, assuming that the subsequent data will be favourable for a permit, it is advisable that CEAA issues be considered and addressed early on in the project. Furthermore, for reasons of efficiency, such issues should be coordinated under a whole-of-project "umbrella" that would include, for example, shoreline disturbances such as would be included in a *Fisheries Act* habitat Authorization application.

[1] The *Fisheries Act* is in transition of amendments, and uncertainty in federal and provincial administration of environmental laws is anticipated (refer to Section 3.0)

The conceptual development plan includes a large area of the foreshore that may be filled. Based on this conceptual plan, we anticipate that an Authorization (Section 35 of the "*Fisheries Act*") will be required from DFO. A Section 35 Authorization is a law-list trigger for the CEAA which would, therefore, be triggered. Additionally, while it is not clear from the conceptual development scenario, it would appear that the cut/fill balance required by the development will necessitate the construction of compensatory off-site (but nearby) fish habitat, as the project would not be self-mitigating. The identification of issues in a comprehensive manner (see above reference to dredging and disposal at sea considerations) enhances the likelihood that overall environmental and project costs are lower, and permitting timelines are reduced.

4.0 SUMMARY OF APECS AND AECS

The following provides a summary of the conclusions of the Stage I PSI and DSI (Golder 2011). For consistency, the numbering scheme for identifying the areas of potential environmental concern (APECs) and areas of environmental concern (AEC) is the same as that used in the Golder 2011 DSI report. As such, this report should be read in conjunction with the Golder DSI.

The Stage 1 PSI identified 21 on-Site and four off-Site APECs or AECs. The identification of these APECs was based on the review of historical information available for the Site. In some cases, historical information included results from soil and or groundwater investigation programs, and where applicable these were confirmed investigation. Following the completion of the Stage 1 PSI, a DSI program was developed to assess the potential for presence of contamination at APECs, and confirm and delineate soil and groundwater contamination at AECs. Between 2009 and 2011, the DSI was completed in several stages, such that AECs were confirmed and subsequent investigation was completed to generally delineate identified contamination. Where the investigation of an APEC did not identify soil or groundwater contamination, the APEC was no longer retained. Refer to the DSI report for details on the extent of contamination. At the conclusion of the DSI, eight of the areas were confirmed as AECs (*i.e.,* contamination as identified) and two APECs remained. Depending upon the nature and extent of contamination identified, some of the APECs/AECs, were grouped together. Where appropriate, the APECs/AECs were grouped together for clarity and ease of discussion of the results, and remedial options evaluation and costing.

The following table (Table 1) provides the summary for each of the APECs and AECs identified by the Stage 1 PSI. The table summarizes whether contamination was confirmed and the APEC was retained as an AEC, or whether it was grouped with another APEC or AEC. The table also summarizes the constituents of concern (COCs) confirmed at the AECs.

Table 2: Summary of APECs and AECs

Area		Comments (Summary of PSI and/or DSI)	COCs
Slack Point			
AEC1	Coal Fill at Slack Point.	The area is confirmed as an AEC as soil and groundwater contamination was identified.	Soil: naphthalene LEPH and HEPH Soil vapour: naphthalene
AEC 2 and 3	Surficial Fill from Non-Coal Sources at Slack Point and Former Woodwaste and Dredgate Stockpile.	The area is confirmed as an AEC as soil and groundwater contamination was identified.	Soil: LEPH, HEPH, metals

Area		Comments (Summary of PSI and/or DSI)	COCs
Slack Point			
APEC 4	Former Boat Repair Shop on Slack Point.	Elevated concentrations of petroleum hydrocarbons were identified in fill materials in the area, which did not appear to be consistent with boat repair activities (Golder, 2005); as such, this area was not retained as an APEC.	
AEC 5	Buried Refuse and Possible Abandoned Landfill.	The area is confirmed as an AEC as soil contamination was identified in the area of the landfill (containing buried metal debris and refuse). Concentrations of contaminants were unique relative to other fill areas on Slack Point; therefore, this area has been retained as an AEC.	Soil: LEPH, HEPH, metals
APEC 6	Stockpiles of Imported Sand and Gravel.	Stockpiles (of approximately 500 m^3 of material of unknown origin) were observed on Slack Point in 2005. Sampling of the stockpiles indicated the material met the CSR PL and RL standards; therefore, these were not retained as an APEC. The stockpiles were not observed during the 2009 and 2011 field activities.	
APEC 7	Former Buildings Associated with Logging Activities.	The former buildings generally occupied the northern portion of Slack Point. Metal and hydrocarbon concentrations of surface materials in this area had characteristics similar to APEC 2 and do not specifically indicate a separate surface source of contamination. Therefore, APEC 7 has not been retained.	
Uplands			
APEC 8	Fill Material in the Uplands.	Fill samples collected during DSI activities indicated concentrations of metals or hydrocarbons that were similar to those identified at, and characteristic of, AEC 10 and AEC 12. However, some fill samples contained unique detections of constituents of concern, including volatile components. Because none of these constituents exceeded CSR standards, APEC 8 was not retained.	Soil vapour: BTEX, VPH, naphthalene

Area		Comments (Summary of PSI and/or DSI)	COCs
Slack Point			
APEC 9	Former Scale Pit and Possible PCB Storage.	Sampling during the DSI indicated that the soil and groundwater meets the CSR standards; therefore, this area was not retained as an APEC or AEC.	
AEC 10 and APEC 11	Former Pump Islands, ASTs and Possible PCB Storage and Historic Fuel Pipelines from Uplands to the Harbour.	The area is confirmed as an AEC as soil and groundwater contamination was identified.	Soil: VPH, HEPH Groundwater: VPH Soil Vapour: VPHv, xylene, naphthalene
AEC 12	Former Maintenance Area and Current Boat Repair and Construction Operations.	The area is confirmed as an AEC as soil and groundwater contamination was identified.	Soil: LEPH, styrene
AEC 13	Former Waste Oil Storage Area and Compressor Storage Area.	The area is confirmed as an AEC as soil contamination was identified.	Soil: LEPH
APEC 14	Former Location of Oil Drum, Scrap Metal Storage, and Stockpiles of Unknown Quality.	Historical and DSI sample results indicated that the soil and groundwater meets the CSR standards; therefore, this area was not retained as an APEC or AEC.	
APEC 15	Former Cable Splicing Shed.	Sampling during the DSI indicated that the soil and groundwater meets the CSR standards; therefore, this area was not retained as an APEC or AEC.	
APEC 16	Suspected UST Adjacent to Washroom Building.	Hydrocarbon concentrations were observed in groundwater in the vicinity of the suspect UST (also located within the area of AEC 12). The Stage 1 PSI concluded that the UST is used as a sewage pump-out facility connected to the Town of Ladysmith's municipal sewage system. The suspected UST is therefore, not considered an APEC or AEC. The contamination in this vicinity is incorporated into AEC 12.	

Area		Comments (Summary of PSI and/or DSI)	COCs
Filled Foreshore			
APEC 17 and 18	Fill Material at Block B and D of DL 2016 (former Location of the Shingle Mill).	Sampling during the DSI indicated that the soil and groundwater meets the CSR standards. However, the sampling program was limited and additional sample collection would provide greater certainty. Therefore, this area has been retained as an APEC.	Potential COC: Soil: LEPH/HEPH, PAH, and metals Groundwater: LEPH/HEPH, PAH, metals Soil Vapour: VPHv, BTEX, naphthalene
AEC 19	Former Log Dump (Lot 17G).	The area is confirmed as an AEC as soil and groundwater contamination was identified.	Soil: VPH, LEPH Groundwater: PAH Soil Vapour: VPHv
APEC 20	Former Location of ASTs at the Foreshore.	During the DSI activities, contamination along the log dump area (AEC 19) was observed to extend to APEC 20. The contamination appeared to be associated with the log dump and/or former filling activities along the foreshore and not from former ASTs. Contamination in the vicinity APEC 20 is incorporated into AEC 19, and APEC 20 is no longer retained.	
Sediments			
AEC 21	Foreshore Sediments – Quality of Sediment, Marina Activities, Sewage Outfall and Pressure Treated Piles.	The area is confirmed as an AEC as sediment contamination was identified.	Sediments: metals, PAH, LEPH/HEPH
Off-Site			
APEC 22	Off-Site Service Stations at 435 and 728 Esplanade.	Sampling during the DSI indicated that the soil and groundwater meets the CSR standards; therefore, this area was not retained as an APEC or AEC.	
APEC 23	Tyee Copper Smelter.	Historical report references indicated that a copper smelter was established in the port; Because smelter slag was potentially used as fill at the Site, APEC 23 has been incorporated into APEC 17.	

Area		Comments (Summary of PSI and/or DSI)	COCs
Off-Site			
APEC 24	Burleith Log Sort Facility.	Historical assessment activities were conducted at the Burleith log sort facility located north of the Site (across Ladysmith Harbour). A thick layer of wood debris was observed in the intertidal and subtidal regions of the area. Due to the distance from the Site and the hydraulic separation between the area and the Site, it was concluded that the Burleith Log Sort is no longer considered an APEC.	
APEC 25	Iron Foundry.	One historical report reference indicated that an iron foundry was established in the port in the late 1800s; however, no further references were identified during the Stage 1 PSI. Because foundry slag was potentially used as fill at the Site, APEC 25 has been incorporated into APEC 17.	

Notes: BTEX/VPH= benzene, toluene, ethylbenzene, xylene and volatile petroleum hydrocarbons.
MTBE = methyl tert butyl ether
LEPH = light extractable petroleum hydrocarbons
PAH = polycyclic aromatic hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
UST = underground storage tank
AST = above-ground storage tank

The following sections present a summary of the data for each of the APECs and AECs carried forward, and provides a summary of volume estimates.

4.1 Slack Point

4.1.1 AEC 1 – Coal Fill at Slack Point

The coal fill material underlying Slack Point is characterized as having concentrations of naphthalene, phenanthrene, LEPH, and HEPH above the CSR RL/PL standards, but below the CSR CL/IL standards, and can be classified as “commercial quality” material (Golder 2005). The observed depth of the coal fill ranged from 6.5 to 10 metres below ground surface (m bgs) in the most southwestern (upland) portion of Slack Point, to 16.6 m bgs in the remainder of the area.

Though there are no applicable standards, this material also contains elevated concentrations of sulphur. The presence of sulphur and observations of hydrogen sulphide (H_2S) odours in groundwater samples from the base of the coal fill suggests that dissolved sulphide and sulphate may be present in groundwater at concentrations of potential concern. However, the sulphides appear to be related to the naturally occurring conditions associated with the native sediments and seawater underlying the coal waste, rather than the coal material, itself.

Other than the possibility of sulphides, no groundwater impacts were detected, and additional groundwater sampling during the DSI activities in 2009 confirmed that no constituents exceeded applicable CSR standards for groundwater beneath Slack Point. Because soil contamination was identified in the coal fill above the CSR RL/PL standards but below CSR CL/IL standards this area has been retained as an AEC for RL/PL use. However, Slack Point would not be considered an AEC for commercial or industrial use.

It is estimated that the total volume of coal fill present at Slack Point is approximately 725,000 m^3 (roughly one million tons), and that an additional 100,000 m^3 to 225,000 m^3 (140,000 to 300,000 tons) of coal fill likely extends into the sediments of the harbour (based on an angle of repose of 15° to 30°).

4.1.2 AEC 2 and 3 – Surficial Fill from Non-Coal Sources at Slack Point and Former Woodwaste and Dredgate Stockpile

Golder's investigations in 2005 identified surface fill materials (not including coal fill) as discontinuous units across Areas 2 and 3, ranging in thickness up to a maximum of 3 m. Little to no surface fill was observed above the coal fill unit in the south corner of the Slack Point.

In soil, concentrations of LEPH, HEPH, molybdenum, nickel and tin greater than the CSR RL/PL standards, and concentrations of zinc greater than the CSR CL/IL standard were identified in the fill. Of the elevated concentrations of petroleum hydrocarbons (LEPH, HEPH) indicated as present in surficial fill in Slack Point, it is possible that naturally occurring hydrocarbons in wood, which was observed in some of the fill the samples, may have yielded false positive results.

No groundwater constituents were identified above the CSR AW standards in 2005, and no groundwater impacts were detected during the DSI in 2009.

Based on the soil contamination exceeding CSR CL/IL in the surface fill (non-coal source) in Slack Point, this area has been retained as an AEC. The volume of surface fill materials in AECs 2 and 3, as well as the concentrated regions of buried metal debris and refuse in AEC 5, (Section 4.1.3) are estimated to range between 34,000 m^3 and 67,000 m^3.

4.1.3 AEC 5 – Buried Refuse and Possible Abandoned Landfill

In 2005, Golder identified regions of concentrated buried metal debris and refuse on Slack Point, but no underground storage tanks were identified. Groundwater sampling in 2005 and during the DSI in 2009 confirmed that no groundwater impacts have been detected.

The buried waste comprised metal debris, car parts, bricks, wire cable, oil and paint cans, and wood waste. Soil samples collected in 2005 contained concentrations of LEPH and HEPH, molybdenum, nickel and tin above the CSR RL/PL standard, and concentrations of HEPH and antimony, arsenic, barium, cadmium, chromium, copper, lead and zinc above the CSR CL/IL standard. As such, this area has been retained as an AEC. The volume of surface fill materials in AECs 2 and 3 (Section 4.1.2), as well as the concentrated regions of buried metal debris and refuse in AEC 5, are estimated to range between 34,000 m^3 and 67,000 m^3.

4.2 Upland Area

4.2.1 APEC 8 – Fill Material in the Uplands

Fill materials in the Upland areas are of variable thickness and composition. The materials generally consist of silt, sand and gravel, cobbles and boulders. In addition, organic material (roots and woody debris), isolated coal waste, and anthropogenic materials including concrete and metal, were encountered in the fill layers. The thickness of the fill ranges from approximately 0.1 m to 3.4 m bgs and, on average, extends to about 1.3 m bgs.

Several boreholes, monitoring wells and test pits have been advanced in the Uplands during previous investigations, and results have indicated elevated concentrations of petroleum hydrocarbons in some locations. During the DSI, several fill samples were submitted for laboratory analysis for metals and hydrocarbons. With the exception of three surface soil samples, no concentrations of metals or hydrocarbons exceeded applicable CSR standards. However, some locations contained detectable concentrations of volatile components.

Of the three soil samples where concentrations exceeded standards, they were specifically placed to characterize AEC 10 (the former pump island and PCB storage area), and AEC 12 (the former railway yard and current boat construction area). The data from the samples are consistent with historical activities AEC 10 and 12, rather than a soil quality issue associated with fill placement. Therefore, while AEC 10 and 12 are retained, APEC 8 is not considered an AEC and is no longer retained as an APEC.

4.2.2 AEC 10 and APEC 11 – Former Pump Islands, Former ASTs, Historical Fuel Pipelines, Pump House and PCB Storage Areas

Prior to the DSI, investigations identified contamination at one location in AEC 10 and APEC 11, where ethylbenzene and toluene concentrations exceeded applicable soil standards. In addition, contamination was observed in the foreshore filled area (results along the foreshore are discussed for AEC 19). For the purposes of the DSI, AEC 10 was retained as an AEC, and an investigation was completed to delineate soil and confirm groundwater quality. During the DSI, which included surficial soil sampling, testpitting, drilling and groundwater sampling, indications of hydrocarbon contamination were identified and step-out sampling was subsequently conducted to delineate the contaminated area.

In general, petroleum hydrocarbon contamination (VPH and HEPH) was identified in the southern part of AEC 10 in soils overlying bedrock. Specifically, VPH in the area exceeded the CSR CL/IL standard, and xylene, naphthalene, LEPH and HEPH were detected but were below standards. Elsewhere in AEC 11, two surficial soil samples contained HEPH concentrations exceeding the CSR RL/PL and/or CL/IL standards. The HEPH encountered by the latter samples appears to be limited to a surficial area adjacent to a concrete slab, and was defined in extent based on chemistry and soil observations. The extent of soil contamination in AEC 10 has been delineated.

In groundwater, one sample, in the southern area of AEC 10, contained VPH concentrations exceeding the CSR standards. The sample is coincident with the defined area of soil contamination and, although the groundwater contamination has not been delineated, it is expected to be limited to the area of soil contamination.

AEC 10 is considered an AEC. The extent of the contamination is generally shallow in nature, and limited to depths of approximately 2.4 m bgs or less. The approximate volume of contaminated soil is 1,000 m^3.

4.2.3 AEC 12 – Former Railway Yard Area and Current Boat Repair and Construction Operations

Prior to the DSI, one soil sample in the area of the former railway yard (AEC 12) encountered ethylbenzene and toluene concentrations above applicable standards. For the purposes of the DSI, this area was retained as an AEC, and investigations were completed to delineate the soil contamination and confirm groundwater quality. During the DSI, indications of petroleum hydrocarbon contamination were observed in shallow soils (depths up to approximately 2 m bgs) on the northwest side of the former maintenance building area. The contamination appeared to be patchy, and not associated with one contiguous source.

A series of testpits was excavated to delineate contamination in soil to the northwest and southeast, and a borehole completed as a monitoring well was drilled hydraulically downgradient of the contamination to delineate the area to the northeast. Soil contamination was not delineated towards the west (upgradient); however, based on the review of the data and the heterogeneous nature of the contamination, the western extent is inferred to be limited in area and depth.

This area is considered an AEC. The extent of contamination in this area is generally shallow, to depths up to 4 metres. The volume of contaminated soils in the area (*i.e.,* to the northwest of the former maintenance building) is estimated to be 2,000 m^3.

4.2.4 AEC 13 – Former Waste Oil Storage Area and Compressor Storage Area

Historical investigations in AEC 13 identified near-surface soil contamination and some hydrocarbon concentrations (EPH10-19) in groundwater. Soil contamination was delineated vertically; however, further work was necessary to confirm the extent of the contamination.

As part of the DSI, an additional monitoring well was installed downgradient of AEC 13 to the northeast, and another installed to the southeast to investigate off-Site APECs. Petroleum hydrocarbon concentrations met the CSR standards in new and existing wells in the area.

AEC 13 is confirmed as an AEC because of the presence of soil contamination. However, the area of contamination appears quite localized. The volume of contaminated soils is estimated to be about 20 m^3

4.2.5 APEC 17 and 18 – Small Saw Mill and Fill Material at Block B and D of DL 2016 (former Location of the Shingle Mill)

The foreshore lots include Blocks B and D of DL 2016, which were created by infilling the water lot in an area previously occupied by the shingle mill wharf. Historical investigations indicated that a small sawmill was located in the northwest corner of the Site near Block B and D of DL 2016 and adjacent to the government wharf (there has been no other reference or evidence of a sawmill at this location).

Golder infers this area to be the location of the former shingle mill. There is potential for fill quality issues associated with the shingle mill; therefore, APEC 18 (former sawmill) was combined with APEC 17 (former shingle mill).

No previous investigations have occurred at Blocks B and D. The DSI included soil and groundwater sampling at one location in the APEC. Results indicated that the fill soil and groundwater did not contain metals or hydrocarbon concentrations exceeding the CSR standards. It is noted, however, that because of the limited nature of the sampling program, additional sample collection may provide greater certainty as to the absence of contamination. This area is not considered an AEC; however, it is retained as an APEC.

4.2.6 AEC 19 – Former Log Dump (Lot 17G)

The former log dump on Lot 17G (AEC 19) was established in the 1930s and used to transport logs from railcars to the harbour for bundling and shipping. The area is an extension of the natural foreshore and, therefore, contains fill materials of unknown quality. Historical investigations indicated that hydrocarbon parameters (including mineral oil & grease) may, by comparison, be present at concentrations exceeding the CSR standard. As such, additional investigation was undertaken.

The planned DSI included drilling and installation of a monitoring well at AEC 19. At the time of the investigation, soil samples were observed to have hydrocarbon-like odours, sheen and oil droplets; likely indicative of contamination. As such, several boreholes and subsequent monitoring wells were completed as step outs along the shoreline to the northwest. Soil and groundwater contamination was confirmed at several of these locations.

Based on the results of the DSI and historical investigation activities, the contamination has been delineated along the shoreline. In addition, as part of the sediment sampling program in Ladysmith Harbour, several sediment samples were collected near the shoreline adjacent to the log dump area, to assess the possibility of contamination extending into the harbour. No indication of hydrocarbon contamination were observed during the sediment sampling program (Golder 2011c), and the contamination is inferred to be limited to the near-shore filled area.

The source of the oil contamination is uncertain, as it appears that it may have originated from the former log dump, filling activities, or subsurface migration to the area from the former railway yard activities. To address this issue, a deep groundwater well was completed in the bedrock, on the bedrock terrace located up gradient from the former log dump, and down gradient of the former maintenance building. This well was installed at a depth intersecting the elevation of the contamination observed at the log dump.

While no evidence of contamination was observed while drilling the well, some hydrocarbon parameters were measured in groundwater at concentrations exceeding the CSR standards. Concentrations were insufficiently high to suggest the presence of petroleum product. Consequently, it is concluded that the contamination at the former log dump appears to be associated with log dump or filling activities in the filled foreshore area, rather than the former railway maintenance area. As such, the area is generally delineated to the southwest. However, it is not known whether contamination extends onto Lot 5.

The former log dump area has been retained as an AEC. The extent of the contamination in this area of the Site was observed to be between 2.5 and 5.5 m bgs. The contamination is estimated to have an approximate volume of 5,800 m^3.

4.3 Foreshore Sediments (AEC 21)

AEC 21 comprises sediment quality and activities or structures that may affect sediment quality in the two waterlots of Ladysmith Harbour, including marina activities, the sewage outfall, and pressure-treated piles. Sediments in the waterlots of Ladysmith Harbour have been affected by the various activities at the Site. Previous investigations indicated that concentrations of numerous PAHs in sediments are above the CSR $SedQC_{TS}$ and above the ocean disposal limits (ODLs). In addition, concentrations of cadmium were observed above the ODLs in several locations, and concentrations of other metals (copper or lead) were found above CSR $SedQC_{TS.}$

The details of the sediment quality results are discussed in the sediment investigation report (Golder 2011).

An overall objective of the sediment investigation (Golder 2011) was to allow refinement of remedial costs and options, including an assessment of whether ocean disposal or risk assessment might be a viable option (depending on project needs) for potential re-development of the waterlots in Ladysmith Harbour. The investigation characterized the degree of sediment contamination in the harbour, the degree to which sediment contamination is bioavailable to marine organisms, and possible causes of toxicity to marine organisms. The assessment then integrated this information to assess the viability of sediment management options.

The feasibility of disposal at sea of dredged sediments and risk-based management of sediment contamination was evaluated as these options are understood to be elements of a conceivable sediment management strategy for Ladysmith Harbour. The ultimate strategy selected will depend on the specific project component needs of concepts for the waterfront that have not yet been developed.

4.3.1 Disposal at Sea

A “Disposal at Sea” application for dredged sediments from the waterlots in Ladysmith Harbour would require a program of sampling and analysis developed in consultation with Environment Canada, based on a specified development plan for the harbour. A preliminary evaluation, based on existing data, was conducted to provide insight into the possible findings of studies carried out to support such an application; however, uncertainty remains because the results of future investigations cannot be predicted with confidence.

The feasibility of Disposal at Sea of dredged sediments and risk-based management of sediment contamination were evaluated as these are understood to be elements of a conceivable sediment management strategy for the waterlots in Ladysmith Harbour, depending on the specific project component needs of as yet to be developed concepts for the waterfront. The results of the evaluation resulted in assignment of areas of the portion of the harbour comprising the navigational footprint comprising the two waterlots (Block C of DL 2016 and DL 651) plus adjacent affected sediments that may also require management, into one of four categories. The category assignments were as follows:

- **Category 1:** Small portions of the harbour west of Slack Point and in the northwest corner of the harbour can be categorized as having conditions favourable for Disposal at Sea, with low uncertainty;
- **Category 2:** More than half of the harbour can be categorized as having conditions favourable for Disposal at Sea, but uncertainty was considered high due to data gaps regarding sediment toxicity;
- **Category 3:** Less than half of the harbour was categorized as having conditions potentially unfavourable for Disposal at Sea. Over much of this area uncertainty was considered high due to data gaps regarding contaminant bioavailability and sediment toxicity; and
- **Category 4:** In the westernmost corner of the harbour and in an area on the east side of Slack Point, conditions were considered unfavourable and uncertainty was low because observed toxicity to amphipods provides an indication that sediments are likely to fail Disposal at Sea approval guidelines.

These areas are illustrated on Figure 4 and presented in Table 3 together with estimated areas and volumes associated with dredging for a site development scenario. For costing purposes, the sediment category areas were compared to the zones that potentially would require dredging for navigational or geotechnical purposes for the development scenario presented in Phoenix (2002) and references therein. Volume estimates were calculated for each sediment category within the potential dredge zones, and disposal costs were then estimated for each volume. Of the categories, it was assumed that, following additional investigation activities (Golder, 2011), approximately 1/3 of the volume of sediment identified within Category 3 could be eligible for ocean disposal, with the remainder requiring offsite (non-ocean) disposal.

Table 3: Estimated Areas of Contaminated Sediments, and Estimated Areas and Volumes for Dredging Scenario

Item	Estimated Area (m^2) (Figure 4)	Estimated Area (m^2) within dredge zones	Estimated Volume (m^3) within dredge zones*
Category 1	22,700	2,400	2,400
Category 2	251,460	72,500	185,000
Category 3**	67,900	16,900	11,300
Category 4	5,550	4,300	4,300

Note: * Estimates are provided for volumes of contaminated sediments that may be dredged for navigational purposes (based on Phoenix, 2002, and references therein).
** Volumes for Category 3 were reduced by 5,600 m^3, assuming that 1/3 of the volume would be considered eligible for ocean disposal (transferred to category 2) following additional investigation, as recommended (Golder 2011).

In addition to the above volumes totalling approximately 203,000 m^3, it is assumed that there is an estimated 20,000 m^3 of woodwaste in the sediments that could require disposal (Westmar, 2001), thus yielding a total dredge volume of approximately 223,000 m^3.

4.3.2 Risk-Based Management Approach

The viability of a risk-based management approach was considered to be high for the entire navigational footprint of the water lots and adjacent sediments in the harbour. A sediment risk assessment for the harbour could be based on integrating an assessment of benthic invertebrate communities with the chemistry, toxicity and bioavailability data. One of the main purposes of the sediment risk assessment option would be to reduce and better understand the influence of uncertainty on the assessment of potential effects to marine organisms in Ladysmith Harbour. It should be noted that while the methods used in the sediment study were in many ways similar to a sediment risk assessment, additional lines of evidence that would normally be considered in a sediment risk assessment (*i.e.*, benthic community structure) have not been included. Thus, sediment risk assessment is considered a viable and appropriate next step to address this uncertainty.

5.0 OPINION OF PROBABLE COSTS

It is understood that the conceptual development plan is subject to change. The rationalization of remedial strategies into an overall development plan would yield the greatest overall economy to the remediation process; therefore, the development of opinions of probable costs was based on formulated remedial strategies and assumptions. The final development of the Site will likely consist of a mixture of parkland, residential and commercial land uses. We have outlined the opinion of costs in two sections:

1) Upland area and Slack Point; and

2) Ladysmith Harbour water lots.

5.1 Upland and Slack Point Areas

Following completion of the DSI, the nature and extent of the contamination at the Site is relatively well understood. Much of the soil contamination in the upland areas of the Site is generally shallow, accessible, and relatively small in area and could be remediated by removal. However, some of the contaminated areas are known to be present at depth in the upland area and widespread across Slack Point. In Slack Point, the contamination includes coal fill (AEC 1), surficial fill (in addition to coal) (AEC 2 and 3) and buried refuse (AEC 5).

The following sections provide details for each of the AECs. It is unlikely that remediation can be achieved by complete excavation and removal of all contamination. For example, complete removal of coal fill is unlikely to be considered as a remedial option for Slack Point because of its proximity to the harbour, its relatively low environmental risk, and the magnitude of soil and coal fill that would require removal. As such, it is expected that, regardless of the development options, much of the contamination would remain in place and would be managed through risk-based remediation.

5.1.1 2005 Scenarios and Cost Estimates for Upland and Slack Point Areas

In the 2005 cost estimate, four scenarios for the upland area were evaluated:

- OPTION 1: Remediation completed to meet RL/PL numerical standards at all upland areas:
  - With the exception of the coal waste fill, all impacted soil on Slack Point and in the Uplands is remediated to meet RL/PL standards;
  - All woodwaste and metal debris are removed from Slack Point;
  - An ecological and human health risk assessment is completed for the coal waste fill; and
  - No groundwater impacts are assumed in the uplands, and groundwater remediation is not required.
- OPTION 2: Remediation completed to meet CL numerical standards at all upland areas:
  - All impacted soil on Slack Point and in the Uplands is remediated to meet CL/IL standards;
  - All woodwaste and metal debris are removed from Slack Point; and
  - No groundwater impacts are assumed in the uplands, and groundwater remediation is not required.

- OPTION 3: Completion of a risk assessment, assuming approximately 10% of the estimated volume of contaminated soils is removed during development activities:
  - Any impacted soil, woodwaste, or metal debris removed during development activities is required to be disposed of at an authorized facility; the volume removed is assumed to comprise approximately 10% of the total volumes; and
  - Completion of a terrestrial ecological, groundwater ecological and human health risk assessment.
- OPTION 4: Completion of a risk assessment for all upland areas:
  - Completion of a terrestrial ecological, groundwater ecological and human health risk assessment; and
  - All waste soil, woodwaste and metal debris to remain on-Site.

The 2005 cost estimate (Golder 2005) ranged from a low estimate ($539,000) for Option #4 to a high estimate ($9,168,000) for Option #1.

5.1.2 Current Approach

Based on the findings of the DSI, a risk-based approach, likely with some limited soil removal, is considered feasible and potentially cost-effective for managing the contamination in the uplands and Slack Point. The DSI soil and groundwater sampling program identified several localized areas at depth in the upland areas where petroleum hydrocarbon contamination was present. The near-surface contamination was often characterized by volatile (*e.g.*, ethyl benzene, toluene, styrene, VPH) and/or semi-volatile (LEPH, naphthalene) constituents in soil that were expected to have associated vapour concentrations potentially above applicable CSR standards. Given the near-surface nature of the soil contamination, it is assumed that these areas would likely be remediated as part of any future Site development activities. However, the nature of the contamination, topography and geology of the Site preclude simple excavation as a means to achieve numerical standards, as was contemplated previously in options #1 and #2 above. Locations where full excavation may not be practical (*i.e.* former log dump area and Slack Point), contamination would likely remain in place and a risk-management approach would likely be adopted. For example, at Slack Point, it would be cost prohibitive to remove the coal waste fill form the Site, and with the exception of coal fill (AEC 1), and over $10,000,000 to attempt to remediate the remaining AECs to meet numerical standards. For the development of the remedial options, risk-based remediation would be the preferred approach.

As such, and as part of this update, the revised cost estimate for Slack Point has focused on Option #3, risk assessment with 10% soil removal to accommodate construction activities, and Option #4, risk assessment with no soil removal. Similarly, the revised cost estimate for the uplands area has also focused on Option #3 and Option #4.

The following table presents a summary of the estimated costs, itemized for each APEC and AEC, for the upland remediation strategies.

Table 4: Opinion of Probable Costs (+/- 25%) for Remediation Options of Slack Point and Upland Areas, Ladysmith Harbour, Ladysmith, BC

ITEM	3: Risk Assessment and Removal Debris/Waste Soil Volumes to Accommodate Construction Activities	4: Risk Assessment (No Remedial Activities)
RISK ASSESSMENT FOR SLACK POINT AND UPLANDS AREA		
Further Investigation of APEC 17/18.	$25,000	$25,000
Screening-level risk assessment for Slack Point (terrestrial HHERA for coal waste, and surficial fill in Uplands area).	$175,000	$175,000
Supplementary Groundwater and Vapour Sampling.	$75,000	$75,000
Detailed-level terrestrial ecological and human health risk assessment.	$75,000	$75,000
Subtotal	$350,000	$350,000
SLACK POINT, Capping and/or Removal of Debris/Waste Soil Volumes to Accommodate Construction Activities		
Cap Near-Surface Soil Contamination with 1 m clean fill at Slack Point.	$1,875,000	$1,875,000
AEC 2, 3 & 5: Excavation, transport and disposal of up to 10% of 34,000 m^3 metal debris for Option #3.	$25,000	n/a
AEC 2, 3 & 5: Excavation, transport and disposal of up to 10% of 7,400 m^3 woodwaste for Option #3.	$200,000	n/a
AEC 2, 3 & 5: Excavation, transport and disposal of up to 10% of 18,700 m^3 CL soil for Option #3.	$120,000	n/a
AEC 2, 3 & 5: Excavation, transport and disposal of up to 10% of 37,500 m^3 waste soil for Option #3.	$638,000	n/a
Consulting (field monitoring and sampling during excavation activities, including laboratory fees).	$75,000	n/a
Subtotal	$2,933,000	$1,875,000
UPLANDS, Risk Assessment, Removal and/or Capping		
AEC 10/AEC11: Former Pump Islands, AST, Fuel Pipelines, PCB Storage - Excavation, transport and disposal of 1,000 m^3 of waste soil under Option #3.	$205,000	n/a
AEC 12: Former Railway Yard and Current Boat Repair and Maintenance Area - Excavation, transport and disposal of 2,000 m^3 of waste soil under Option #3.	$365,000	n/a
AEC 13: Former Waste Oil Storage Area - Excavation, transport and disposal of 20 m^3 of waste soil under Option #3.	$17,000	n/a
APEC 17/18: Saw Mill and Fill Material at Clock B & D.	n/a	n/a

ITEM	3: Risk Assessment and Removal Debris/Waste Soil Volumes to Accommodate Construction Activities	4: Risk Assessment (No Remedial Activities)
AEC 19: Former Log Dump Area - Excavation, transport and disposal of up to 10% of 5,800 m^3 of waste soil under Option #3.	$140,000	n/a
Consulting (field monitoring and sampling during excavation activities, including laboratory fees).	$50,000	n/a
Reporting for Remedial Activities (Slack Point, Uplands and Foreshore).	$75,000	n/a
Subtotal	$852,000	n/a
Subtotals	**$4,135,000**	**$2,225,000**
Contingency (25%)	**$1,035,000**	**$555,000**
Total	**$5,170,000**	**$2,780,000**

5.2 Ladysmith Harbour Water Lots

5.2.1 2005 Remediation Scenarios and Cost Estimates for the Water Lots

In 2005, four remedial strategies were reviewed for the Ladysmith Harbour area water lots. For costing purposes, it was assumed that the area considered for remediation comprised an estimated 223,000 m^3 of sediment that would be dredged to between 1 m and 3 m depth for navigational or geotechnical purposes for a conceptual development alternative described in Phoenix (2002) and presented in Westmar (2001). The options examined included:

- OPTION 5: Removal and offsite disposal of all impacted sediments plus removal of non-contaminated sediments that require removal for navigational or geotechnical considerations:
  - Sediment investigation is undertaken to obtain data for ocean disposal evaluation;
  - All impacted sediments are dredged, and sediments are transported for disposal offsite (not ocean disposal); and
  - Sediments are dredged for navigational and geotechnical purposes for the conceptual development plan fill areas.
- OPTION 6: Removal and offsite disposal of all impacted sediment plus removal of non-contaminated sediments that require removal for navigational or geotechnical considerations:
  - All impacted sediments are dredged, and sediments are transported for ocean disposal; and
  - Sediments are dredged for navigational and geotechnical purposes for the conceptual development plan fill areas.
- OPTION 7: Risk assessment of all impacted sediments, assuming that dredging is completed only for navigation and geotechnical purposes, with combination of ocean disposal and offsite disposal of the sediments as applicable:

- Sediment investigation is undertaken to obtain data for risk assessment and ocean disposal evaluation;
- Impacted sediments are to be dredged, and sediments are transported for disposal offsite (not ocean disposal); and
- Sediments are dredged for navigational and geotechnical purposes for the conceptual development plan fill areas.

- OPTION 8: Risk assessment of all impacted sediments:
  - Sediment investigation is undertaken to obtain data for risk assessment; and
  - All sediments are to remain in place in the foreshore area as no dredging is required for development, or navigational purposes.

The 2005 cost estimate ranged from a low estimate ($525,000) for Option #8 to a high estimate ($34,175,000) for Option #5.

Based on the results of the marine sediment investigation, the viability of a risk-based management approach was considered to be high for the entire water lots of the harbour. A sediment risk assessment for the harbour could be based on integrating an assessment of benthic invertebrate communities with the chemistry, toxicity and bioavailability data included in the marine sediment investigation report. One of the main purposes of a sediment risk assessment option would be to reduce and better understand the influence of uncertainty on the assessment of potential effects to marine organisms in Ladysmith Harbour. Thus, sediment risk assessment is considered a viable and appropriate next step to address this uncertainty.

As such, and as part of this update, we have revised the cost estimate for Option #7, risk assessment with some sediment removal (with a combination of ocean disposal and offsite disposal of the sediments depending upon the sediment category) and Option #8, risk assessment with no dredging activities.

The following table presents a summary of the estimated costs for the foreshore remediation strategies. Unit rates for sediment disposal were assumed to be $310/m^3 for off-site (non-ocean) disposal of wood waste, $25/m^3 for ocean disposal (including contractor and consulting fees), and $400/m^3 of off-site (non-ocean) disposal of sediment.

Table 5: Opinion of Probable Costs for Remediation Options Ladysmith Harbour, Ladysmith, BC

Item	7: Risk Assessment, Removal of Sediments for Navigational and Geotechnical Purposes	8: Risk Assessment (No Dredging Activities)
REMEDIAL OPTIONS FOR SEDIMENTS		
Preparation of sediment sampling plan for Environment Canada (assessment for Ocean Disposal).	$12,000	n/a
Assessment of sediments for viability of ocean disposal and permit application.	$100,000	n/a
Transport and disposal of woodwaste (20,000 m³).	$6,200,000	n/a
Dredging of sediments > CSR sediment standards, and for navigational purposes (total: 223,000 m³)		
2,400 m³ Category 1	$60,000	n/a
185,000 m³ Category 2	$4,625,000	n/a
11,300 m³ Category 3	$4,520,000	n/a
4,300 m³ Category 4	$1,720,000	n/a
Sediment risk assessment	$100,000	$140,000
Subtotal	**$17,337,000**	**$140,000**
Contingency (25%)	**$4,334,000**	**$35,000**
Total	**$21,671,000**	**$175,000**

5.3 Assumptions and Uncertainties

The following sections provide information on our assumptions regarding the development of the opinions of probable cost.

5.3.1 Slack Point

The estimates of volumes of contamination, and therefore remediation costs, are limited by uncertainties . In addition, the following have not been included in the development of the opinions of remedial cost:

- Backfilling of excavated areas;
- MoE review fees for CoC application;
- Live-out cost allowance during field activities; or
- Removal of trees/vegetation.

For remedial strategies including excavation activities, it is assumed that the remedial activities could be completed at the time of development; therefore, costs for backfilling have not been included. For the remedial strategies, it is assumed that the coal waste fill on the site (Slack Point) would remain in place, and that an

ecological and human health risk assessment (EHHRA) will likely be required to support a remediation/risk management plan for this location if it is intended for PL/RL use. Our experience at other locations with similar patterns of contamination suggests that risk management may be a viable option, with a provision including in the costing to place 1 m of clean fill. This is, in part, because the proposed development plan will involve installation of impervious surfaces that will limit the exposure of humans and wildlife to elevated contaminant concentrations in soil.

As outlined in Table 4, we have assumed that, for one remedial strategy, up to 10% of the volume of contamination of near surface soil on Slack point will be removed to facilitate development activities. As such, the remedial costs to remove this material have been included.

5.3.2 Uplands

For remedial strategies including excavation activities, it is assumed that the remedial activities could be completed at the time of development; therefore, costs for backfilling have not been included.

As outlined in Table 4, we have assumed that near surface soil contamination at three of the APECs will be excavated, transported off-site for disposal. Contamination identified along the former log dump area (AEC 19) was at depths greater than 2 m bgs, therefore we have assumed that this contamination would remain in place (with the exception of removal of a nominal 10% of the volume) and that ecological risk assessment is required. For remedial strategies 3 and 4, it is assumed that groundwater does not meet aquatic life standards (further to the findings for the DSI (Golder. 2011) and an ecological risk assessment is required.

For the purposes of costing, we have assumed that one (1) human health and ecological risk assessment would be completed for the upland areas and that this risk assessment is separate from the risk assessment for Slack Point. Owing to the differences in the nature of contamination between the upland AECs and Slack Point AECs, it is assumed that separate risk assessments will be required. There may be some cost savings should these risks assessment be completed in parallel.

5.3.3 Sediments

We have assumed that the data collected to date (in the marine sediment investigation program) would be utilized to support both the risk assessment for the harbour and be acceptable for inclusion in the ocean disposal application. As part of the 2009 and 2011 marine sediment sampling program, samples have been preserved and archived for future assessment of benthic invertebrate communities. For costing purposes, we have assumed that a limited field sampling program would be required, and that these archived samples will be utilized for the risk assessment activities.

While we have assumed that the data collected would be accepted by Environment Canada for the ocean disposal application, we anticipate that Environment Canada will require a nominal chemistry and toxicity sampling program to supplement some of the data collected to date.

5.3.3.1 Environmental Compensation

We have not included those costs associated with environmental permitting related to the physical works that are part of the development aspirations. These may vary widely depending on the extent of innovation and incorporation of fish habitat features in the ultimate design or the need to develop off-site habitat which could include securing land tenure elsewhere.

6.0 RECOMMENDATIONS

The estimates of volumes of contamination, remedial approach, are limited by the assumptions described in Section 5. These estimates have been prepared without a known development concept for the Site. The risk based remedial approach for Slack Point and the Upland areas, and the feasibility of Disposal at Sea of dredged sediments and risk-based management of sediment contamination were considered as these are understood to be elements of a conceivable sediment management strategy for Ladysmith Harbour. However, the final remedial approach and associated scope of work are dependent upon the specific project component needs for the development concepts for the harbour and upland areas. While the next steps involve completing risk based remedial activities for the harbour, the uplands and Slack Point areas, it is recommended to develop the detailed scope of work for these tasks in conjunction with the development concept for the Site.

7.0 CLOSURE

We trust the information herein is sufficient for your needs at this time. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 604-296-4200.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Dawn Flotten, P.Eng.
Associate

ORIGINAL SIGNED

Guy Patrick, P.Eng.
Principal, Project Director

DMF/GCP/mrw

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8.0 REFERENCES

Golder Associates Ltd. 2005. "Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC". Dated July 19, 2005.

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Golder Associates Ltd. 2011. "Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation, Ladysmith Harbour, Ladysmith, BC."

Golder Associates Ltd. 2011. "Marine Sediment Investigation and Management Options Assessment, Ladysmith Harbour, Ladysmith, BC."

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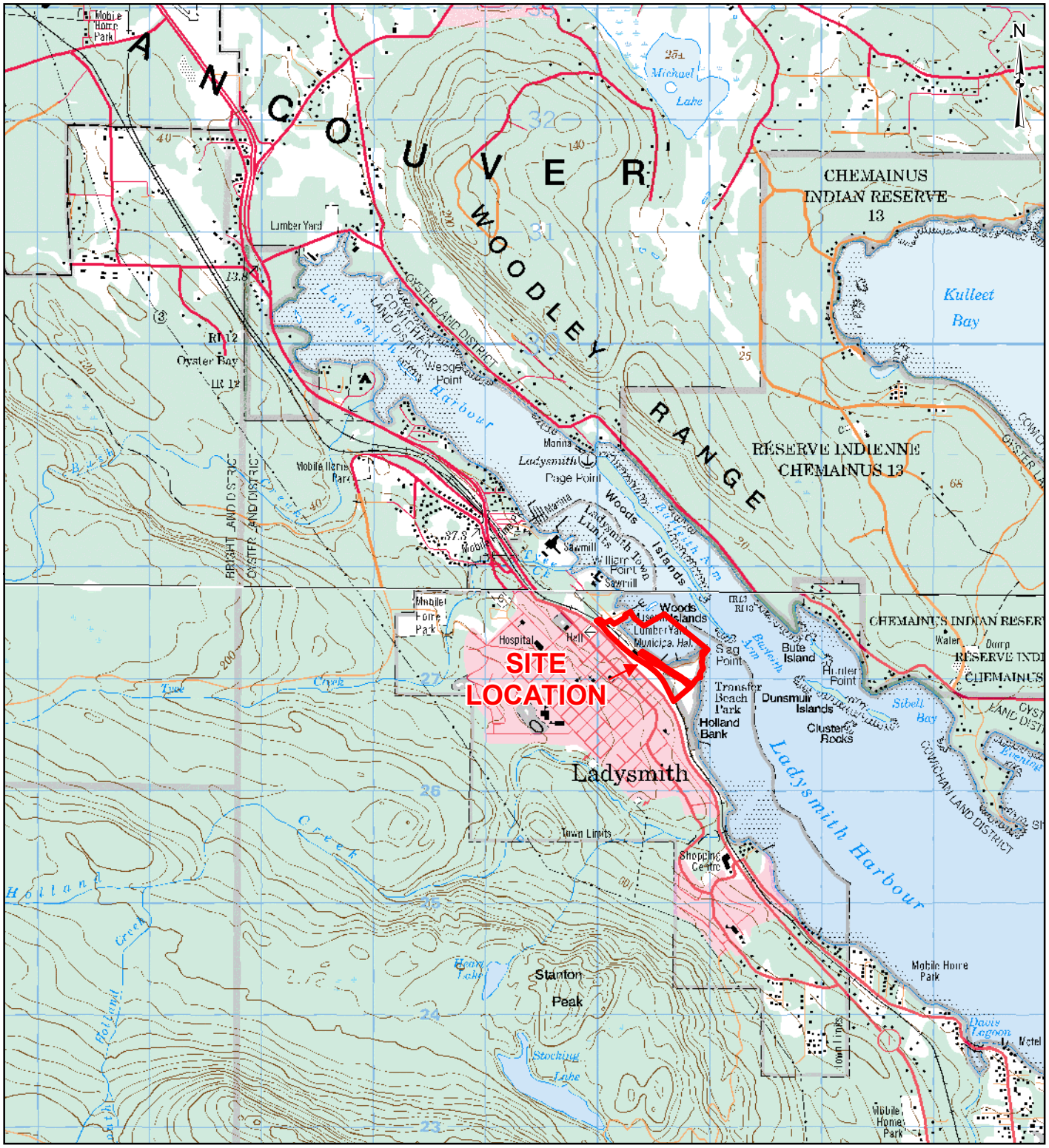
Westmar Consultants Inc. 2001. "Town of Ladysmith, Report for Waterfront Redevelopment". Dated June 2001.



LEGEND

Site Boundary

REFERENCE

NTS Mapsheet 092G04/092B13 obtained from Natural Resources Canada.
Projection: UTM Zone 10 Datum: NAD 83

PROJECT	CROWN CONTAMINATED SITES PROGRAM, CROWN LAND OPPORTUNITIES AND RESTORATION BRANCH B.C. MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS LADYSMITH HARBOUR, LADYSMITH, B.C.
TITLE	**KEY PLAN**

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 8800		
DESIGN	LK	02SEP10	SCALE AS SHOWN		REV. 0
GIS	JP	12JAN12	**FIGURE 1**		
CHECK	LK	11JUL12			
REVIEW	DMF	11JUL12			

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LEGEND

- Site Boundary
- Filled Foreshore
- Uplands
- Water Lot

150 0 150

SCALE 1:6,004 METRES

* Lot sizes derived from Baker & Osland Appraisals Ltd. (2002)

REFERENCE

Image © 2009 TerraMetrics: Captured from Google Earth Pro © 2009.
Other basedata obtained from WMS in the Province of British Columbia.
Projection: UTM Zone 10 Datum: NAD 83

PROJECT: CROWN CONTAMINATED SITES PROGRAM, CROWN LAND OPPORTUNITIES AND RESTORATION BRANCH
B.C. MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE

SITE PLAN SHOWING LEGAL LOTS

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 8800	
DESIGN	LK	02SEP10	SCALE AS SHOWN	REV. 1
GIS	JP	12JAN12		
CHECK	LK	11JUL12		
REVIEW	DMF	11JUL12		

FIGURE 2

N:\Bur-Graphics\Projects\2009\1436\09-1436-5008\GIS\projects\8800\figure-02_siteplan.mxd

AEC 1	Coal Fill at Slack Point
AEC 2	Surficial Fill from non-coal sources at Slack Point
APEC 3	Former Woodwaste and Dregate Stockpile (combined with AEC 2)
APEC 4	Former Boat Repair Shop on Slack Point
AEC 5	Buried Refuse and Possible Abandoned Landfill.
APEC 6	Stockpiles of Imported Sand and Gravel
APEC 7	Former Buildings Associated with Logging Activities
APEC 8	Fill Material in the Uplands
APEC 9	Former Scale Pit and Possible PCB Storage
AEC 10	Former Pump Islands, ASTs and Possible PCB Storage
APEC 11	Historic Fuel Pipelines from Uplands to the Harbour (Combined with AEC 10)
AEC 12	Former Maintenance Area and Current Boat Repair and Construction Operations
AEC 13	Former Waste Oil Storage Area and Compressor Storage Area
APEC 14	Former Location of Oil Drum, Scrap Metal Storage, and Stockpiles of Unknown Quality
APEC 15	Former Cable Splicing Shed
APEC 16	Suspected UST Adjacent the Washroom Building
APEC 17	Fill Material at Block B and D of DL 2016 (former Location of the Shingle Mill)
APEC 18	Small Saw Mill (combined with APEC 17)
AEC 19	Former Log Dump (Lot 17G)
APEC 20	Former Location of ASTs at the Foreshore
AEC 21	Foreshore Sediments – Quality of Sediment, Marina Activities, Sewage Outfall and Pressure Treated Piles.
APEC 22	Off-Site Service Stations at 435 and 728 Esplanade
APEC 23	Tyee Copper Smelter:
APEC 24	Burleith Log Sort Facility
APEC 25	Iron Foundary (combined with APEC 17)

LEGEND

- AEC'S (AREAS OF CONFIRMED CONTAMINATION)
- APPROXIMATE APEC BOUNDARY
- APPROXIMATE SITE BOUNDARY

GOLDER 2009 TEST HOLE AND SAMPLE LOCATIONS:

- BOREHOLE
- MONITORING WELL
- MONITORING WELL (DESTROYED)
- TEST PIT
- SEDIMENT SAMPLE
- SURFACE SOIL SAMPLE

HISTORICAL SAMPLING LOCATIONS SHOWN IN BLACK

REFERENCES

1. RECENT BOREHOLE SURVEY LOCATIONS OBTAINED FROM McELHANNEY ASSOCIATES LAND SURVEYING LTD.
   FILE NO. 2232-91501-1
   DRAWING NO. 91501-1 SLACK POINT.DWG
2. OTHER FEATURES OBTAINED FROM W.R.HUTCHINSON LAND SURVEYING LTD.
   FILE NO. 0-15G-1
3. IMAGE OBTAINED FROM GOOGLE EARTH PRO.
   DATE: JULY 17, 2005.
   PROJECTION: UTM ZONE 10 DATUM: NAD 83

0 30 60 90 120 150
SCALE IN METRES

PROJECT
CROWN CONTAMINATED SITES PROGRAM,
CROWN LAND OPPORTUNITIES AND RESTORATION BRANCH
B.C. MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
LADYSMITH HARBOUR, LADYSMITH, BC

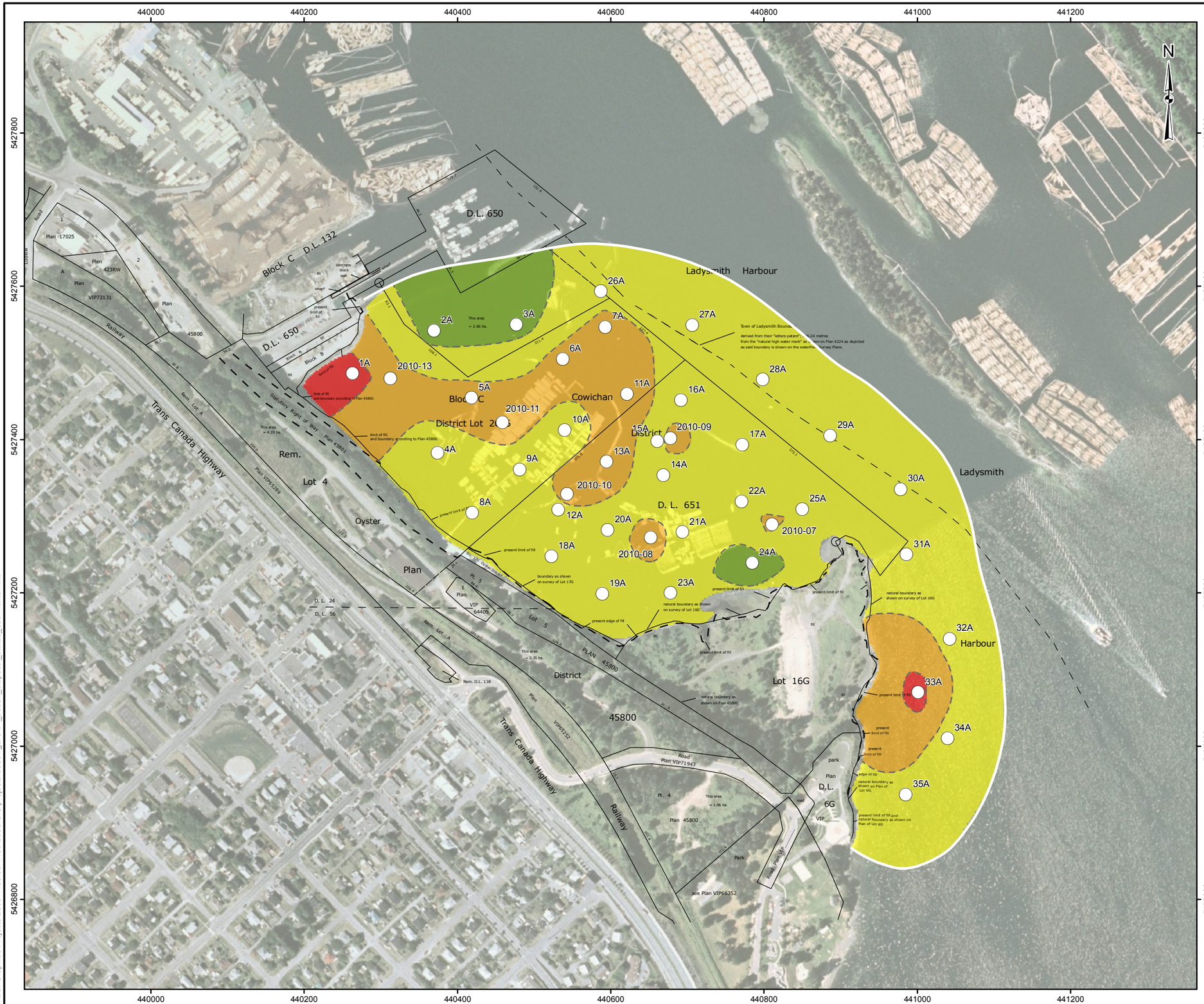
TITLE

LOCATIONS OF AECs

Golder Associates
Greater Vancouver Office, BC

PROJECT No. 09-1436-5008			PHASE No. 8800
DESIGN	DF	12JAN12	SCALE AS SHOWN / REV. –
CADD	TS	12JAN12	
CHECK	LK	11JUL12	**FIGURE 3**
REVIEW	DMF	11JUL12	

Drawing File: N:\Bur-Graphics\Projects\2009\1436\09-1436-5008\Drafting\8800\09143565008-8800_01.dwg Wednesday, July 11, 2012 4:57:43 PM By: tsemino



LEGEND

- Water Lot Boundary
- Surface Sediment Location (2009-2010)
- Anticipated Approval Status Contour

Anticipated Approval Status

- Category 4
- Category 3
- Category 2
- Category 1

REFERENCE

Background image copyright GoogleEarth. Samples and contours created by Golder.
Projection: UTM Zone 10 Datum: NAD 83

125 0 125
SCALE 1:5,000 METRES

PROJECT
MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
LADYSMITH HARBOUR - ANTICIPATED DISPOSAL AT SEA STATUS FOR SURFACE SEDIMENTS

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 8800	
DESIGN	VM	19AUG11	SCALE AS SHOWN	REV. 0
GIS	JP	12JAN12		
CHECK	RS	11JUL12		
REVIEW	ADB	11JUL12		

FIGURE 4

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Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
500 - 4260 Still Creek Drive
Burnaby, British Columbia, V5C 6C6
Canada
T: +1 (604) 296 4200

Golder Associates