AGENDA INFORMATION	
☐ Regular Meeting	Date:____________________
☐ Workshop (open to public)	Date:____________________

Dept. Manager	GM/ Director	CAO

The District of North Vancouver
REPORT TO COUNCIL

March 20, 2014
File: 3060-20/28.13

AUTHOR: Doug Allan, Community Planner

SUBJECT: **BYLAWS 8024 AND 8025 – OCP AMENDMENT AND REZONING FOR A MIXED APARTMENT/TOWNHOUSE PROJECT AT 3829/3919 DOLLARTON HIGHWAY**

RECOMMENDATION:

It is recommended that Council receive this report for information.

REASON FOR REPORT:

On January 6, 2014, Council introduced an OCP amendment (Bylaw 8024), a rezoning bylaw (Bylaw 8025) and a Housing Agreement Bylaw (Bylaw 8030) for a multi-family residential project on the Dollarton Shipyard and McKenzie Barge and Marineways sites at 3829/3919 Dollarton Highway. Bylaws 8024 and 8025 were referred to a public hearing, however, before setting a public hearing date, Council requested additional information on several issues. This report is provided in response to Council's direction.

SUMMARY:

During the discussion on the project, Council raised the following issues:

- public access to the waterfront and connection to Cates Park/Whey-au-Wichen;
- plans for the remediation of the Port Metro Vancouver foreshore lands;
- port nuisances;
- absence of a commercial component in the project; and
- loss of waterfront industrial lands.

Staff and Port Metro Vancouver have continued discussions regarding the foreshore lands and Port permitting. A public hearing date on Bylaws 8024 and 8025 has been set for Tuesday, April 8, 2014.

ANALYSIS:

Public Access:

As illustrated on the following plan, public access to the waterfront is encompassed by:

- a public pathway with two view points, located immediately upland of the foreshore lands. This path will connect to the existing waterfront path to the west and the existing trail network in Cates Park/Whey-au-Wichen; and
- a public path, leading from Dollarton Highway adjacent to the Roche Point Creek riparian area to the internal driveway with a connection down to the waterfront trail, west of Roche Point Creek.

Connection to Cates Park/Whey-au-Wichen:

Staff and the applicant are currently working with the Tsleil Waututh Nation to define a specific alignment for the extension of the waterfront path to the existing trail network in Cates Park/Whey-au-Wichen. As this has not yet been established, staff will report on this connection at the development permit stage if the project proceeds.

Dock Proposal:

Under the initial scheme, as presented at bylaw introduction, Polygon had proposed to reconfigure the existing western pier for boat moorage (15 slips) for project residents. The public would also have had access to a portion of the dock. However, Polygon has advised staff that, due to significant costs, the pier has been eliminated from the project.

Port Foreshore Remediation:

Concept Plan

Polygon has submitted a proposal for the remediation of the foreshore lands to Port Metro Vancouver. The conceptual plan, illustrated below, involves the removal of the existing industrial structures, reshaping and armouring the shoreline and introducing marsh and intertidal planting. At this point, Polygon is continuing to work with Port staff to develop a final foreshore enhancement plan.

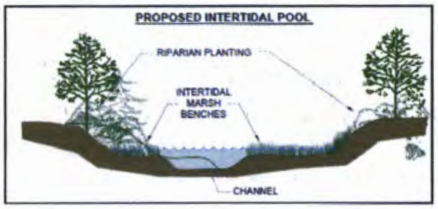
The developer will be responsible for monitoring and correcting any deficiencies for a period of 3-5 years following which, the Department of Fisheries and Oceans will assume responsibility.

Foreshore Enhancement Plan Concept

Foreshore Access and Planting:

As illustrated on the concept plan above and detailed in the plan included as Attachment A, the plan will create several layers including an intertidal marsh up to the high tide line with a riparian bench from that point to the global high tide line. The intention is that the public will not have access beyond the waterfront pathway to the remediated lands. The cross sections included as Attachment B illustrate the relationship between the path and the remediated and enhanced foreshore lands.

The following images from the detail plan illustrate cross sections at various points on the foreshore to illustrate the different components of the remediation plan.



The following photographs are examples of what the foreshore lands could look like once they are re-contoured and planted/armoured.

Rip Rap Shoreline

Tidal Pool

Marsh Bench

Marsh Bench

Industrial Uses in Burrard Inlet:

Port Metro staff have advised that, in the event of contamination of the foreshore lands due to port- or ship-related activities, the responsibility for the clean up rests with the polluter.

Council raised the issue of port-related nuisances such as noise and odors. Staff considered the registration of a nuisance easement on the property. However, the municipal solicitor recommended against an easement (or covenant) which had the potential to draw the municipality into a dispute on issues over which we have no control. If the project proceeds, the development covenant will require that the disclosure statement identify that purchasers will be buying a home adjacent to a working port.

For Council's reference, the accompanying image illustrates the location of the subject site and the existing Westridge Terminal on the south side of the harbour which are approximately 1.6km apart.

Commercial Uses:

At the public information meeting there were comments relating to the provision of a small commercial component in the project and this was also noted in comments from both the Seymour Community Association and the Seymour Local Plan Monitoring Committee. In response, the applicant provided a report assessing the viability of a small commercial outlet on the site such as a coffee shop but the study concluded that there were not enough residents in the area or parking to make a potential commercial use viable.

Loss of Waterfront Industrial Lands:

In a letter dated August 2, 2013 (Attachment C), the Port indicated that while its mandate is to protect waterfront port lands, there was benefit in remediating and restoring the foreshore lands that would result from the redevelopment of the upland property. On that basis, the Port was not opposed to the proposal. This was re-affirmed by the Port in February 2014.

Under the draft Port Land Use Plan, the foreshore lands are designated 'Commercial'. The Port has advised that this will not preclude the remediation of the foreshore as a habitat restoration area and will allow for the consideration of a future dock facility upon application.

Conclusion:

This report has been prepared in response to the issues raised by Council on January 6, 2014 when Bylaws 8024 and 8025 were given First Reading. A Public Hearing on the two Bylaws has been established for Tuesday, April 8, 2014.

Respectfully submitted,

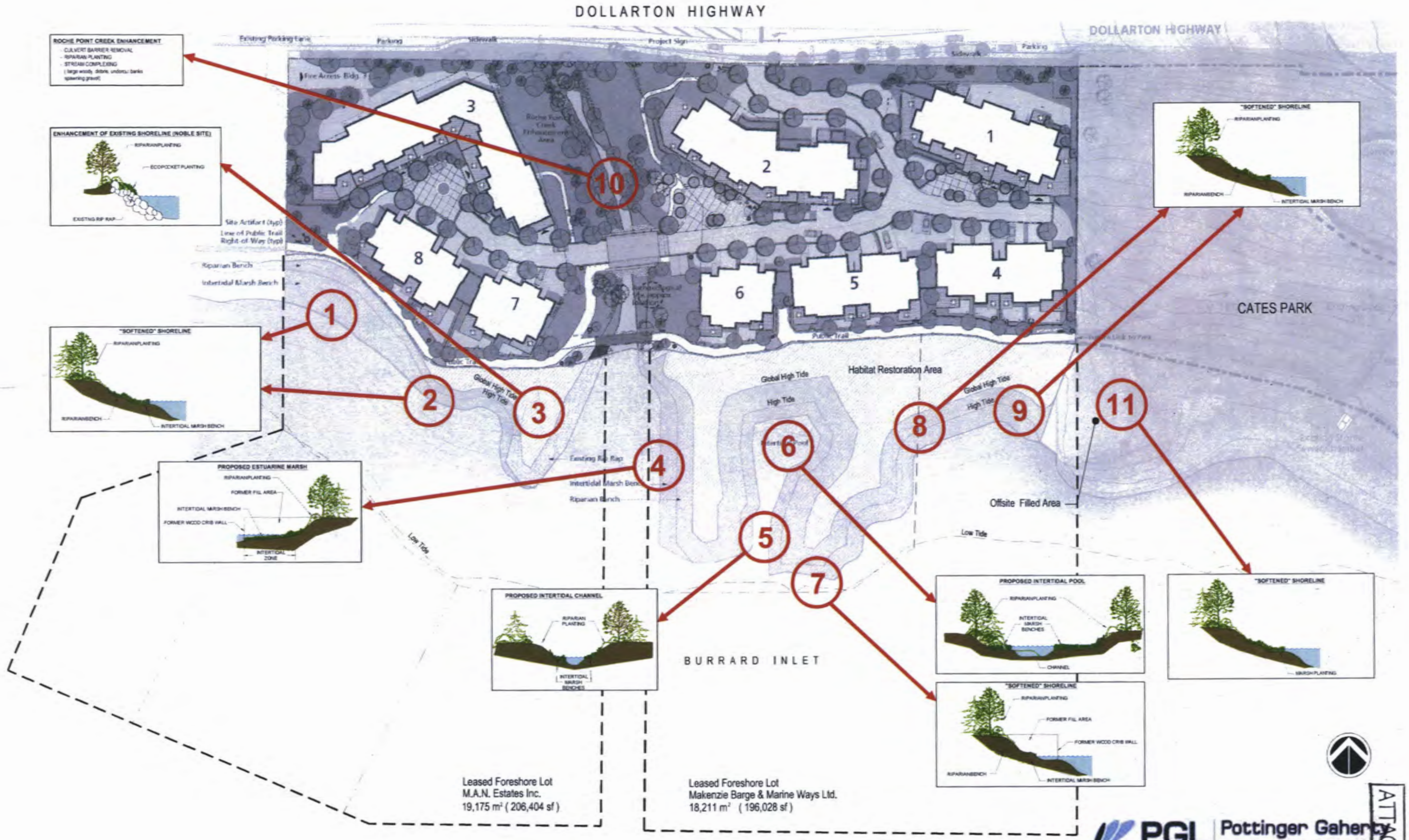
Doug Allan
Community Planner
da/
attach.

REVIEWED WITH:

- ☐ Sustainable Community Dev. ____
- ☐ Development Services ____
- ☐ Utilities ____
- ☐ Engineering Operations ____
- ☐ Parks & Environment ____
- ☐ Economic Development ____
- ☐ Human resources ____
- ☐ Clerk's Office ____
- ☐ Communications ____
- ☐ Finance ____
- ☐ Fire Services ____
- ☐ ITS ____
- ☐ Solicitor ____
- ☐ GIS ____

External Agencies:

- ☐ Library Board ____
- ☐ NS Health ____
- ☐ RCMP ____
- ☐ Recreation Com. ____
- ☐ Museum & Arch. ____
- ☐ Other: ____



PGL Pottinger Gaherty
ENVIRONMENTAL CONSULTANTS

ATTACHMENT A

Rositch Hemphill Architects
120 Powell Street, Unit 10 Vancouver, BC Canada V6A 1G1
t 604.669.6002 f 604.669.1091 www.rharchitects.ca

P+A

PROJECT:
DOLLARTON RZ
3829 & 3919 Dollarton Highway,
North Vancouver, BC

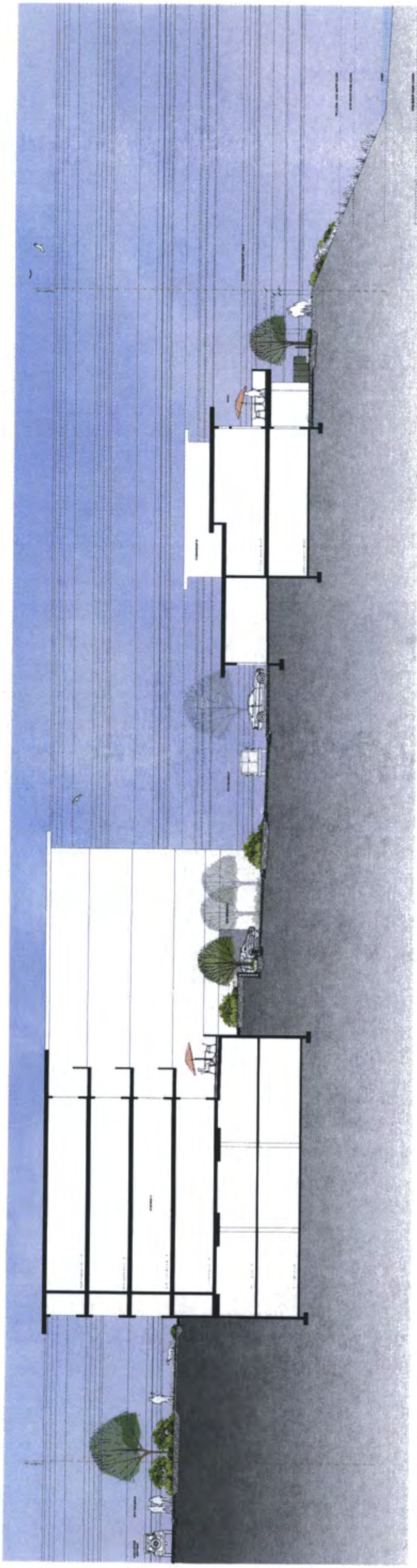
DRAWING TITLE :
HABITAT RESTORATION PLAN
WITH REFERENCE IMAGES

POLYGON
Suite 900 - 1333 West Broadway, Vancouver, BC,
Canada V6H4C2 T (604)877-1131 F (604)871-4120

DATABASE: 1033.1.2
PROJECT NO: 1033
DATE: 04 MARCH 2014
SCALE:

12

ATTACHMENT B



A SECTION THROUGH BUILDINGS 3 AND 8 & FORESHORE
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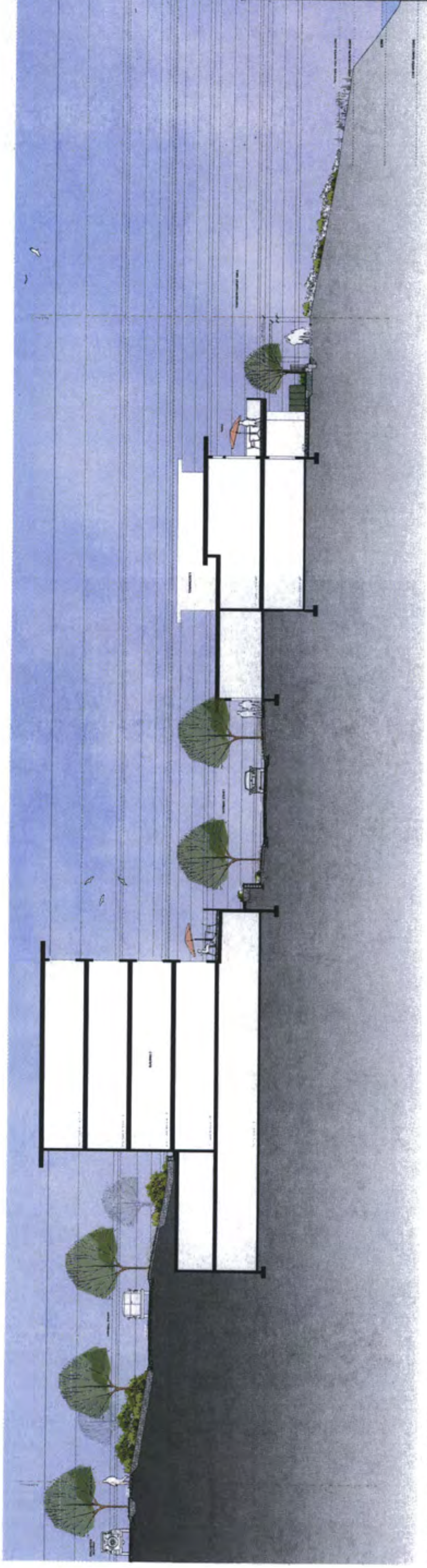

B SECTION THROUGH BUILDINGS 2 AND 5 & FORESHORE
1:100

ATTACHMENT C

PORT METRO
vancouver

August 2, 2013

VIA E-MAIL & MAIL

Doug Allan
District of North Vancouver
355 West Queens Road
North Vancouver, BC V7N 4N5

Dear Mr. Allan,

Re: Preliminary Application – Mixed Apartment/Townhouse Project 3829/3919 Dollarton Highway (Polygon Development 270 Ltd.)

Thank you for your letter of June 4, 2013, regarding a preliminary application by Polygon Development for the redevelopment of 4 legal lots at 3829 and 3919 Dollarton Highway with 95 multi-family residential units. As described in your letter, a key component of the project involves the development of a public amenity and recreational area along the foreshore, some of which is land under the jurisdiction of Port Metro Vancouver (PMV). PMV staff have reviewed the material provided and have the following preliminary comments.

In general, Port Metro Vancouver encourages the retention of industrial lands, which are a critical resource not just for the port but for the regional as whole. In this particular case, consideration of non-industrial uses as proposed presents an opportunity to rehabilitate a valuable waterfront site and address other important issues related to the riparian area and, potentially, public access to the waterfront, though in the broader context, PMV would like to ensure that there is no net loss to industrial land. Part of this would involve remediation of any site contamination arising from historic industrial uses to standards appropriate for the intended use.

It would be important to ensure that future residents of the new development be fully aware of the on-going industrial activity in the working port, including the noise and other potential impacts. This can be addressed through a variety of means, including project marketing, disclosure statements on title, etc.

The development is associated with a separate proposal for redevelopment of the (currently industrial) foreshore area for public access and recreational use. This portion of the overall development would have to be carefully designed to allow public access and activity and ensure the protection of riparian and habitat values. Considerable discussion between the District, project proponents and Port Metro Vancouver will be required on matters of tenure, use and associated conditions for the foreshore area. We look forward to continued productive dialogue between the parties in this regard.

...2.

Thank you for the opportunity to comment on this proposal. We would appreciate further opportunities to provide input to this proposal as it proceeds. If you have any questions or concerns, please do not hesitate to contact Colleen Wickstrom at 604-665-9047 or colleen.wickstrom@portmetrovancouver.com.

Sincerely,

PORT METRO VANCOUVER

Colleen Wickstrom for
Sarah Farina
Planner

Cc: Christine Eriksen, Property Administrator, PMV
Greg Yeomans, Manager, Planning, PMV
Cari St. Pierre, Planner, PMV

PGL Pottinger Gaherty
ENVIRONMENTAL CONSULTANTS

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P+A
Perry + Associates
Landscape Architecture
Site Planning

PROJECT:
DOLLARTON RZ
3829 & 3919 Dollarton Highway,
North Vancouver, BC

DRAWING TITLE :
HABITAT RESTORATION PLAN
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SCALE:

12

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RHA

Rositch Hemphill Architect

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V6A 1G1

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f 604.669.1091

www.rharchitects.ca

ISSUED:	DATE:
1. REZONING / D.P.A.	30 APRIL 2013
2. RESPONSE DWG.	11 SEPT 2013

ISSUED FOR

NO. REVISION: DATE:

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PROJECT:

DOLLARTON REZONING
3829 & 3919 Dollarton Highway,
NORTH VANCOUVER, B.C.

DRAWING TITLE:

SITEPLAN

DATABASE : 1033-A1.0.dwg
SCALE : 1/32"= 1'-0"
PLOT DATE : 04 MAR 2014
DRAWN : RN
CHECKED : KSH

PROJECT NO.
1033

DWG. NO.
A1.0

D.P.A. No. :
B.P.A. No. :

P+A
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Revision No. Date

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Client:

Polygon Development

Project Title:

Dollarton Highway

Drawing Title:

Site Plan

Project North:

Drawn By: JW

Checked By: RB

Scale: 1:400

Job No.: 10-077

Sheet No.:

L0.0

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Perry + Associates
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PROJECT:
DOLLARTON RZ
3829 & 3919 Dollarton Highway,
North Vancouver, BC

DRAWING TITLE :
PUBLIC PEDESTRIAN ACCESS PLAN

POLYGON
Suite 900 - 1333 West Broadway, Vancouver, BC,
Canada V6H4C2 T:(604)877-1131 F:(604)871-4120

DATABASE: 1033_1.0
PROJECT NO: 1033
DATE: 04 MARCH 2014
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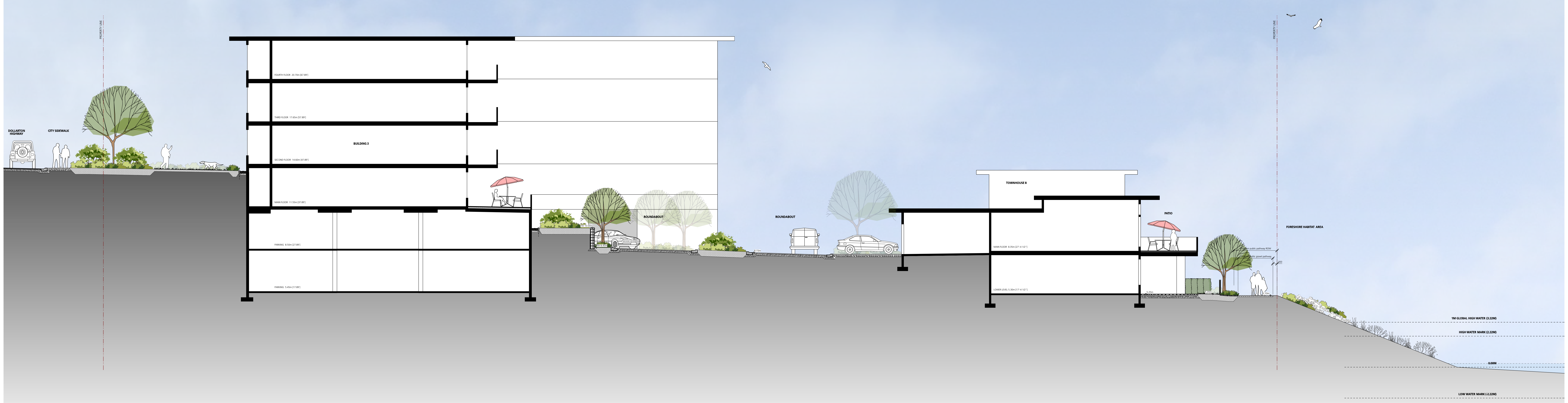

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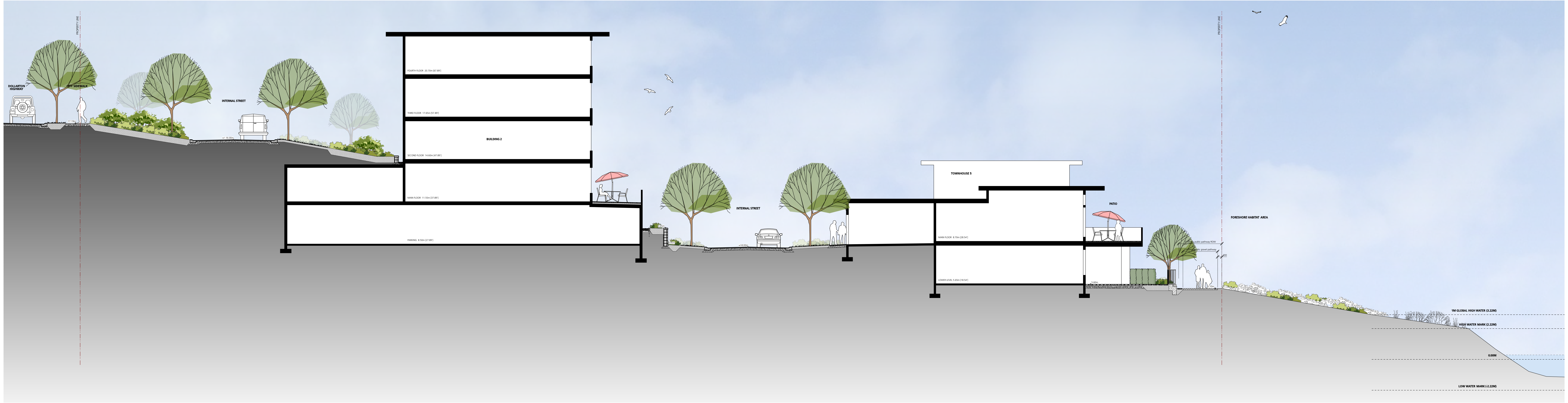

B

SECTION THROUGH BUILDINGS 2 AND 5 & FORESHORE
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PORT METRO
vancouver

MEMO:
District of North Vancouver
Planning Department
PP-2014-039
Process Update
April 2, 2014

Background

DNV staff requested additional information clarifying:

1. The PMV permit application process and the status of the Polygon application.
2. Information regarding the remediation and restoration proposal.
3. Clarification as to the reasoning that public access is generally not supported in restoration areas.

PP-2014-039 Status and Permit Process

Polygon submitted a Project application to Port Metro Vancouver in January which is currently being assessed by Port Metro Vancouver to ensure all required documentation; information and reports are available to support technical review. The application outlines a number or studies and reports underway that will be delivered to PMV by early summer for review. The PMV project application process for this project has 6 main steps, as follows:

1. Review and approval of the remediation and habitat restoration plans by PMV's Environmental Programs and Habitat Enhancement Program Departments
2. PMV community and First Nations consultation requirements
3. Project permit review and decision
4. Remediation Implementation review
5. Confirm lease exit requirements met, post remediation and inspection
6. Ongoing habitat restoration monitoring requirements

We are currently in the early stages of steps 1 and 2 of the process and are unable to speak to remediation or restoration plans and design specifics at this time.

We do not expect a decision on the permit application will be made for the proposed habitat work and remediation in the Port's jurisdiction within the larger project until approximately fall of 2014 when we will be referring final plans and designs to DNV staff before approval.

The Port's Land Use Plan (LUP) Update

The draft PMV land use plan is undergoing public consultation until April 13th.

The proposed land use plan designation for the two site areas within PMV's jurisdiction is "commercial", which is a change from the "industrial" designation in the existing plan as a result of feedback from the 2013 stakeholder consultation process. After April 2014, we will be reviewing and assessing all public and stakeholder feedback to determine final designations for all PMV lands and waters. We expect the final Land Use Plan will be adopted in the fall of 2014.

The Port Metro lands and water known as the M.A.N. Estates and McKenzie Barge site have been contaminated through a century of industrial use. A requirement of lease agreements with Port Metro is that before a lease exit can occur, the area needs to be returned to as close to its original state as is possible.

Polygon, with PGL has applied to Port Metro Vancouver to conduct remediation and habitat enhancement and restoration works at the site. The proposal under consideration would require Polygon to conduct habitat monitoring for a period of approximately five-years following the completion of the works in order to ensure that the habitat is viable and functioning as intended. Should the habitat not function as intended, Polygon will be required to mitigate.

Polygon and PGL are still in the early stages of the application process and consideration of their plan by PMV. Consequently, we are unable to discuss the plan specifics at this time, other than the concept plans Polygon has submitted to the District of North Vancouver. Once the plan has been reviewed and meets PMV environmental requirements, we will be formally referring the project to DNV staff for review and comments.

Benefits of Habitat Remediation, Restoration & Enhancement Works

- Port Metro Vancouver (PMV) supports habitat enhancement and restoration works that are focused on creating and restoring fish and wildlife habitat.
- PMV understands the proposed Polygon habitat restoration works are expected to create the following benefits:
    - Rearing, refuge and spawning habitat for salmonids and other fish species;
    - Additional sources of leaf litter and insect drop for fish; and,
    - Higher quality habitat for shore birds and small mammals

Public Access to Restoration Works

- Public access to environmentally sensitive areas containing valuable fish and wildlife habitat is generally discouraged by habitat biologists and regulatory agencies for a number of reasons.
- Port Metro Vancouver supports prohibiting public access to the proposed Polygon Dollarton restoration areas for a number of reasons, including:
    - Potential destruction of intertidal and riparian native plants/ecosystems as a result of human and/or dog presence (trampling sensitive areas);
    - Potential for impacts to salmonid rearing/refuge activity; and,
    - Potential for impacts to shore activity and relevant bird species.

Cari St.Pierre, M.A., Urban Design
Planner
Planning and Development
604-665-9558
Cari.St.Pierre@portmetrovancouver.com

PORT METRO VANCOUVER
100 The Pointe, 999 Canada Place
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CC: **Greg Yeomans**, MCIP, RPP
Acting Director, Planning and Development

Brown, Carrie
Manager, Environmental Programmes
Environmental Programs

PGL

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April 23, 2013
PGL File: 1543-09.01

Via E-mail: cmelosky@polyhomes.com

Polygon Development 270 Ltd.
Suite 900, 1333 West Broadway
Vancouver, BC
V6H 4C2

Attention: Cynthia Melosky, VP Development

RE: ENVIRONMENTAL ISSUES – TOWNHOUSE/APARTMENT PROJECT AT 3829/3919 DOLLARTON HIGHWAY, NORTH VANCOUVER, BC

Pottinger Gaherty Environmental Consultants Ltd. (PGL) is pleased to provide this report on environmental issues at the above-mentioned site. This report has been prepared as a response to the topics raised by the District of North Vancouver (DNV) in their November 8, 2012 review of your preliminary application for an Official Community Plan Amendment, Rezoning, and Development Permit to redevelop the site into a mix of housing. This report addresses a number of environmental topics raised by the DNV, including:

- Roche Point Creek setbacks and restorative work;
- DNV's Green Building policy;
- An arborist report addressing all bylaw-applicable trees onsite and offsite within 5m of proposed excavation/construction;
- A Pacific Water Shrew habitat assessment report; and
- A summary of all proposed habitat restoration concepts.

Other environmental topics such as site remediation will be addressed separately.

ROCHE POINT CREEK SETBACKS AND RESTORATIVE WORK

Roche Point Creek at one time provided spawning and rearing habitat for resident and anadromous cutthroat trout (*Oncorhynchus clarki*) and coho salmon (*Oncorhynchus kisutch*). Resident cutthroat trout continue to populate Roche Point Creek upstream of Dollarton Highway, albeit at much reduced numbers and sizes. Coho salmon habitat is limited to the short creek section downstream of the Dollarton Highway, as the culvert under the highway currently acts as an impassable barrier to any upstream migration.

This project presents a unique opportunity to significantly enhance the Roche Point Creek instream and riparian habitat areas on this parcel of land, and re-establish the opportunity for anadromous fish passage between the lower Roche Point Creek and the upper watershed areas. The potential for successful re-establishment of anadromous fish populations in Roche Point Creek will be further increased with the creation of a significant amount of estuarine and marine riparian and intertidal marsh habitat on Port Metro Vancouver land (discussed below).

All residential buildings proposed for this project have been located outside the 15m Roche Point Creek riparian setback area. As a result of challenging site constraints, the fire truck hammerhead, pedestrian walkway, and a portion of the concrete foundation of the existing house will remain within the 15m setback area. Both the fire truck hammerhead and concrete foundation of the existing house will be located outside the 5m setback area. Please note that a preliminary Riparian Areas Regulation assessment of the lower Roche Point Creek indicated that, under the Riparian Areas Regulation, the minimum setback of 10m would apply to this area of the creek.

As compensation for the fire truck hammerhead and grandfathered concrete foundation of the existing house (both minor incursions into the 15m setback area), a wide range of instream and riparian habitat restoration and enhancements activities are proposed for Roche Point Creek. It is our opinion that the environmental benefits of these restoration and enhancement efforts far outweigh the minor impacts of localized reductions of the 15m setback. Proposed restoration and enhancement activities for Roche Point Creek include:

- Building up the streambed to the existing culvert invert in order to provide fish access to that culvert, and ultimately to the entire Roche Point Creek watershed;
- Adding baffles to the culvert to assist with fish passage;
- Complexing the stream by creating undercut banks and adding boulders, spawning gravel, and large woody debris;
- Daylighting a portion of the creek currently underneath a building;
- Removing invasive plant species and developing a long-term invasive species management plan for the site; and
- Creating a healthy riparian environment consisting of native fern, shrub, and tree species.

Proposed Roche Point Creek restoration and enhancement activities are presented in Creus Engineering Ltd. Figure R-2 and Table 1 (attached). As indicated in Table 1, creation of over 1,200m^2 of native riparian habitat is proposed for the lower Roche Point Creek. A two-phased successional approach is recommended for the Roche Point Creek riparian restoration program, which would likely include the following native plant species:

- Phase 1 – Pioneering Woody Plant Community
    - ➢ Red alder (*Alnus rubra*);
    - ➢ Sitka alder (*Alnus viridis*);
    - ➢ Black cottonwood (*Populus balsamifera*);
    - ➢ Red-osier dogwood (*Cornus stolonifera*);
    - ➢ Willow (*Salix* sp.);
    - ➢ Common snowberry (*Symphoricarpos albus*);
    - ➢ Oceanspray (*Holodiscus discolor*);
    - ➢ Indian plum (*Oemleria cerasiformis*);
    - ➢ Thimbleberry (*Rubus parviflorus*); and
    - ➢ Bracken fern (*Pteridium aquilinum*).

- Phase 2 – Pioneering Coniferous Plant Community
    - ➢ Douglas-fir (*Pseudotsuga menziesii*);
    - ➢ Western hemlock (*Tsuga heterophylla*);
    - ➢ Western redcedar (*Thuja plicata*);
    - ➢ Red elderberry (*Sambucus racemosa*);
    - ➢ Salmonberry (*Rubus spectabilis*);
    - ➢ Red huckleberry (*Vaccinium parvifolium*); and
    - ➢ Swordfern (*Polystichum munitum*).

Please note that PGL will consult with DNV staff prior to finalizing detailed restoration plans for the Roche Point Creek riparian area.

District of North Vancouver Green Building Policy

The approach we are taking with the green building strategy for this project is to develop an energy strategy and demonstrate Built Green gold equivalency to meet the DNV's Green Building Policy. We have had an initial review of the BuiltGreen 2012 checklist with the project architect and Polygon to determine potential credits to be targeted as the project progresses. Energy performance targets for the apartment buildings have also been developed. Our Green Building Strategy report for this project is presented in Appendix 1.

Arborist Report

PGL conducted a detailed tree survey of all trees measuring 10cm diameter at breast height or greater at the site (including the Roche Point Creek protected area). Our arborist also conducted an overview assessment of the health and condition of all trees located onsite, and developed a preliminary tree retention plan. Details of the above-mentioned activities are presented in Appendix 2.

Pacific Water Shrew Report

PGL conducted an overview assessment of potential Pacific water shrew (*Sorex bendirii*) habitat in the Roche Point Creek corridor. The results of this overview assessment are presented in Appendix 2.

Habitat Restoration on Port Metro Vancouver Lands

A significant amount of habitat restoration and enhancement is proposed for Port Metro Vancouver lands, including:

- Enhancement of the existing shoreline through riparian planting and creation of ecopockets/ecobenches planted with native vegetation species within existing riprap banks;
- Softening of the existing shoreline by removing wood cribs and creating estuarine marshes planted with native aquatic species; and
- Creating an intertidal channel and pool to provide rearing/refuge habitat for salmonids. Marsh benches and riparian areas within these features will be vegetated with native plant species.

Proposed restoration and enhancement activities planned for the Port Metro Vancouver lands are presented in Rositch Hemphill Architects Figure 12 and Table 1 (attached). As indicated in Table 1, creation of over 5,700m^2 of native riparian habitat and 1,350m^2 of native intertidal marsh habitat is proposed for the Port Metro Vancouver lands.

A two-phased successional approach is also recommended for the estuarine and marine riparian restoration and enhancement program on Port Metro Vancouver lands, which would likely include the following native plant species:

- Phase 1 – Pioneering Woody Plant Community
  - Red alder (*Alnus rubra*);
  - Sitka alder (*Alnus viridis*);
  - Black cottonwood (*Populus balsamifera*);
  - Red-osier dogwood (*Cornus stolonifera*);
  - Willow (*Salix sp.*);
  - Common snowberry (*Symphoricarpos albus*);
  - Oceanspray (*Holodiscus discolor*);
  - Indian plum (*Oemleria cerasiformis*);
  - Thimbleberry (*Rubus parviflorus*); and

  - Bracken fern (*Pteridium aquilinum*).

- Phase 2 – Pioneering Coniferous Plant Community
  - Douglas-fir (*Pseudotsuga menziesii*);
  - Western hemlock (*Tsuga heterophylla*);
  - Western redcedar (*Thuja plicata*);
  - Red elderberry (*Sambucus racemosa*);
  - Salmonberry (*Rubus spectabilis*);
  - Red huckleberry (*Vaccinium parvifolium*); and
  - Swordfern (*Polystichum munitum*).

Potential native plant species to be used in intertidal estuarine and marine restoration and enhancement efforts will depend significantly on detailed designs, hydrological regimes, relative exposure to fresh and saline conditions, substrate/growing medium, and availability of nursery plant stock and/or salvage/harvest opportunities. At this stage, we anticipate that the project should be able to incorporate several native species, including:

- Lyngby's sedge (*Carex lyngbyei*);
- Tule (*Scirpus lacustris*);
- Common rush (*Juncus effuses*);
- Silverweed (*Potentilla egedii*);
- Eelgrass (*Zostera marina*);
- Sea arrow-grass (*Triglochin maritimum*); and
- Pacific ninebark (*Physocarpus capitatus*).

Please note that PGL will consult with the DNV and Port Metro Vancouver staff prior to finalizing detailed planting plans for the Port Metro Vancouver riparian and intertidal areas. Please note that planting plans will take into account proposed marine engineering restoration works (i.e., hard-scape features), and ensure that the shoreline is protected from erosion.

We trust that this meets your needs. If you have any questions or require clarification, please contact Bruce Nidle at 604-895-7609.

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.
Per:

Bruce Nidle

Bruce H. Nidle, B.Sc., R.P.Bio.
Senior Environmental Scientist

Susan Wilkins

Susan P. Wilkins, M.Sc., P.Geo., LEED AP
Vice President, Operations

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Attachments: Appendix 1 – PGL Green Building Strategy Report
Appendix 2 – PGL Environmental Report (Arborist and Pacific Water Shrew)
Table 1 – Habitat Restoration Plan
Rositch Hemphill Architects – Figure 12
Creus Engineering Ltd. – Figure R-2

Appendix 1

PGL Green Building Strategy Report

PGL

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April 23, 2013
PGL File: 1543-09.01

District of North Vancouver
355 West Queens Road
North Vancouver, BC
V7N 4N5

RE: GREEN BUILDING STRATEGY FOR THE POLYGON NOBLE COVE PROJECT

Pottinger Gaherty Environmental Consultants Ltd. (PGL) has been retained by Polygon Development 270 Ltd. (Polygon) to assist with their green building strategy for the Noble Cove project. The approach we are taking is to develop an energy strategy and demonstrate Built Green gold equivalency to meet the District of North Vancouver's Green Building Policy. We have had an initial review of the BuiltGreen 2012 checklist with the architect and Polygon to determine potential credits to be targeted as the project progresses. Energy performance targets for the apartment buildings have also been developed.

Due to the apartment buildings being under five storeys and having building footprints of over 600 square metres, the most applicable energy modelling systems are the Model National Energy Code for Buildings (MNECB) or the American Society of Heating, Refrigeration, and Air-Conditioning Engineers programs. For the apartment buildings, Polygon is committed to targeting a 23% cost improvement in energy compared with the MNECB 1997 reference building. This energy target meets the Leadership in Energy and Environmental Design Canada 2009 new construction requirements.

As the project progresses to the building permit phase, a completed BuiltGreen Gold-level checklist will be submitted. A Certified Energy Advisor will be retained and energy modelling will be completed to ensure that the apartment buildings meet a 23% cost improvement in energy compared with the MNECB 1997 reference building. A report demonstrating that the apartment buildings will meet the MNECB target above will also be submitted.

If you have any comments or questions, please contact Damien Crowell or Susan Wilkins at 604-895-7658 and 604-895-7621, respectively.

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.

Per:

for Damien Crowell, B.Sc., MCIP, P.Ag., CPESC, LEED AP
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Susan Wilkins
Susan Wilkins, M.Sc., P.Geo., LEED AP
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Appendix 2

PGL Environmental Report (Arborist and Pacific Water Shrew)

PGL

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Via E-mail: **cmelosky@polyhomes.com**

Polygon Development 270 Ltd.
Suite 900 – 1333 West Broadway
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Attention: **Cynthia Melosky**
Vice President, Development

RE: ENVIRONMENTAL REPORT
ROCHE POINT CREEK, NOBLE COVE SITE, NORTH VANCOUVER

Pottinger Gaherty Environmental Consultants Ltd. (PGL) is pleased to provide this report summarizing our environmental consulting services provided for the Noble Cove project on Dollarton Highway in North Vancouver, BC (the Site). Specifically the following assessments were completed and are detailed in this report:

1. An inventory of bylaw-applicable trees on the Site and an arborist assessment.
2. An overview assessment of potential Pacific water shrew (*Sorex bendirii*) habitat in the Roche Creek corridor on the Site.

BACKGROUND

Polygon Development 270 Ltd. (Polygon) is proposing to redevelop the Noble Towing and McKenzie Barge sites at 3829 and 3919 Dollarton Highway, respectively. The plan is to create a multi-family residential community, which will include a waterfront walkway and passive waterfront park (the Noble Cove project). The development will incorporate the Roche Point Creek corridor which currently runs between the Noble Towing and McKenzie Barge sites.

Polygon previously submitted a preliminary application to the District of North Vancouver (DNV), for an Official Community Plan Amendment, Rezoning and Development Permit, to redevelop the Site. The DNV completed a review of Polygon's preliminary application which is detailed in its November 8, 2012, *Preliminary Application Summary Letter – Townhouse/Apartment Project at 3829/3919 Dollarton Highway*. The DNV's letter outlines steps required to proceed with a detailed application for the Noble Cove project.

The following report is to provide preliminary information addressing the DNV's requests outlined in its July 16, 2012 letter regarding tree retention, removal and replacement, as well as specific habitat concerns related to the Pacific water shrew (PWS). As per the DNV's letter, the following report provides:

- A detailed tree survey of all trees measuring 10cm diameter at breast height (dbh) or greater;
- An overview assessment of health and condition of all trees located onsite; and
- A preliminary tree retention plan.

In addition to this, the assessments detailed in this report provide a PWS habitat assessment which specifically discusses the following items:

- Potential that PWS is inhabiting the current Site;
- Potential of PWS utilizing new or restored habitat associated with the development; and
- Any specific measures that have been considered or designed for PWS.

TREE INVENTORY AND ASSESSMENT

The objective of this section is to provide a basic outline of the type and condition of tree resources on the Site. It is our intention to provide a preliminary Site-wide tree removal and retention strategy to be contemplated by Polygon during the design process. This assessment is completed based on current concept designs.

As the project evolves and additional details are prepared regarding designs, construction and operation/occupancy, a more detailed qualitative and quantitative assessment of impacts to existing trees located should be prepared.

Method

For this assessment all trees measuring 10cm dbh or greater were inventoried, as defined in the DNV Tree Protection Bylaw (#7671). Standard inventory and analysis procedures were followed to record all bylaw trees located on or within close proximity to the Site. Trees were assessed using Visual Tree Assessment (VTA) procedures. Inventoried trees were marked with a numbered tag as designated in Table 1; tag numbers will be used for future reference in the design, approval, and construction phases of the project.

The location of inventoried trees was recorded using a hand-held GPS unit, as shown in Figure 1. As there are inherent errors in GPS data (i.e., +/- 3m or more), it is recommended that tagged trees be surveyed to provide more accurate tree locations[1]. Accurate tree locations will be increasingly important through the detailed design process in assessing and confirming suitable candidates for retention.

Within the tree inventory (Table 1), specific data and observations for each recorded tree is provided. The condition of the trees has been rated based on health and structural factors, as determined from the VTA. This information is important for identifying suitable retention candidates based on current design concepts, and will help guide ongoing assessments of the value and viability of retained trees as detailed designs are developed. This information has also been used to determine tree protection needs (i.e., Tree Protection Zones) in order to ensure successful retention.

Optimum Tree Protection Zones (TPZs) have been calculated for all inventoried trees. This calculation is based on tree species tolerance to disturbance, age, and dbh, as described in detail in *Arboriculture – Integrated Management of Landscape Trees, Shrubs, and Vines, 4th Edition* (Harris et al., 2004). The TPZ defines the area surrounding the trunk of a tree where disturbances should be minimized, wherever possible, to ensure future tree health and stability. The TPZs

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[1] Some trees onsite were previously tagged by other parties. It is possible that these tree locations have already been surveyed by a qualified professional land surveyor and data is available. This should be confirmed before an additional survey is completed to avoid duplication,

shown on Figure 1 are considered ideal buffer zones and do not account for existing structures (i.e., buildings, roads) that may limit ecological conditions that influence tree health, morphology, condition, and stability (i.e., restrict root system morphology, influence hydrological regimes, etc.). In actuality, the extent of an applicable TPZ may be much less than those estimates listed in Table 1 and shown in Figure 1. Once tree locations are accurately surveyed relative to existing buildings and structures, TPZs can be refined to better reflect Site conditions.

Within each TPZ is the Critical Root Zone (CRZ), which is defined in the DNV's bylaw as the minimum portion or extent of a tree's root system that is required to maintain the health and stability of a tree. Determination of the CRZ is based on specific tree characteristics and growing conditions (i.e., proximity to permanent structures, significant grade changes, etc.). As a general guideline, the CRZ may be defined by the canopy dripline of an individual tree. This approach, however, may not reflect actual growing conditions and/or be suitable for all trees (i.e., leaning/swooping trees, trees with limited canopy form, trees influenced by significant root barriers).

For planning purposes, designers are encouraged to accommodate the prescribed optimum TPZ for retained trees, wherever possible. If encroachments within specific TPZs are unavoidable, specific assessments of those trees should be completed to determine the CRZ and assess opportunities for design modifications or retention suitability.

This study has also provided a preliminary assessment rating of risks associated with all trees inventoried. The assessment has been completed using Certified Tree Risk Assessor methods (Dunster, 2009), which implement a standardized assessment and rating system, and is based primarily on current conditions with some consideration of known development design concepts. The risk assessment considers the severity of defects (if any), tree condition, growing site condition, the size of the tree component anticipated to fail (if any), the mode of failure, the probability of failure, and the use of the lands within striking range. Where risks are deemed high or extreme, immediate action is required to reduce risk of personal injury or property damage.

As per the Certified Tree Risk Assessor standards, the validity of the assessment is limited due to rapidly changing conditions in urban areas and at the urban/rural interface. Efforts were taken to assess trees based on current understandings of the new circumstances that will be established by the proposed development. However, inherent alterations to Site conditions and our potential targets will differ both during construction and after occupation. In addition to this, development designs are likely to change as the detail design and approval process evolves. It is recommended that future assessments be completed for trees intended to be retained as a component of final approval submissions (i.e., Development Permit stage), prior to construction and before occupancy. This assessment program will allow for adaptive management strategies to be implemented, and ensure potential risks associated with retained trees are mitigated and/or managed appropriately as Site conditions evolve.

Observations and Results

The results of our tree inventory and assessment are provided in Table 1. Approximate tree locations based on GPS data are provided in Figure 1, and those trees anticipated to be retained are identified. Trees identified for removal are those anticipated to be in direct conflict with the proposed development, and/or were designated high-risk trees based on the risk assessment completed.

It is our understanding that all trees located onsite outside of the Roche Point Creek riparian corridor (i.e., 15m from top of bank) will require removal to accommodate the development plans. Many of the bylaw-sized trees within the property boundaries and outside of the riparian corridor are early seral deciduous trees such as red alder (*Alnus rubra*), black cottonwood (*Populus* *balsamifera*), and bigleaf maple (*Acer macrophyllum*). Typically, red alder and black cottonwood trees are not considered ideal retention candidates in an urban, residential environment. These trees grow tall and fast and invest little energy into structural stability, which can result in unpredictable failures. In addition to this, several of the trees located adjacent to Dollarton Highway have been topped to accommodate existing overhead infrastructure (Photograph 1). This type of pruning can compromise tree structure and stability in the long term, rendering these individuals unsuitable for retention.

Several large-diameter veteran coniferous trees occur within the Roche Point Creek riparian corridor. Notably, a significant veteran Douglas-fir and western redcedar occur here measuring 155cm and 86cm dbh, respectively [Tag # 4541 (DH) and 4542 (DH), respectively] (Figure 1) (Photograph 2). The large-diameter veteran trees occurring in the riparian corridor appear to be in good health and condition. They are open-grown and appear windfirm because of this. Based on our preliminary VTA, the large-diameter conifers in and around Roche Point Creek are suitable candidates for retention. A diligent monitoring program will be required to ensure all measures are implemented to protect these trees.

In addition to the trees listed in Table 1, a small stand of early seral deciduous trees was observed in the western portion of the Site (Figure 1) (Photograph 3). This stand was dominated by red alder with lesser amounts of bigleaf maple (*Acer macrophyllum*) and regeneration western redcedar (*Thuja plicata*), all of which ranged between 5 and 20cm dbh. The stand contained a total of 22 bylaw-sized red alder (>10cm dbh). Understorey plant communities observed in this location were dominated by invasive Himalayan blackberry (Rubus armeniacus) with lesser amounts of periwinkle (*Vinca minor*) and English ivy (*Hedera helix*). Several clusters of Japanese knotweed (*Polygonum cuspidatum*) were also observed occurring in this location.

Invasive Plants

Significant populations of non-native English ivy were observed throughout the Site (Photograph 4). English ivy is an aggressive invasive species that can cause significant impacts to trees and ecosystems alike. English ivy has the ability to completely engulf standing trees (Photograph 5) adding weight and increasing risk of failure when exposed to strong winds. This invasive species also has the ability to girdle and inhibit growth of trees, as well as smother the understorey and prevent the growth of native shrubs, herbs, ferns, and regeneration tree seedlings.

In addition to the English ivy, several other invasive plant species were confined onsite. As previously mentioned, Himalayan blackberry, Japanese knotweed, and periwinkle were also observed onsite, as well as Scotch broom (*Cytisus scoparius*) adjacent to the Dollarton Highway. Preparation and diligent implementation of a Site-specific invasive plant management plan will work to ensure the long-term retention of existing trees, and successful establishment of any habitat compensation/restoration initiatives.

Tree Removal Summary

Based on our findings, a total of 24 trees listed in Table 1 have been identified for removal: 13 bigleaf maple, 9 red alder, 2 western redcedar (*Thuja plicata*), and 1 western hemlock (*Tsuga heterophylla*). Of these 24 trees, 17 require removal due to conflict with the proposed development concepts. The additional seven trees have been assessed as high risk and recommended for removal and/or wildlifed to a safe height (Table 1) in order to mitigate associated risks while retaining some element of wildlife habitat values.

In addition to the 24 tree removals identified in Table 1, the 22 bylaw-sized red alder in the small stand of early seral deciduous trees occurring in the western portion of the Site (Figure 1) will be removed to accommodate the proposed development. Therefore, a total of 46 trees will require removal based on this preliminary assessment and current project design concepts.

Tree Replacement

Guidelines for tree replacement are provided under Part 5, Section 15 of DNV's Tree Protection Bylaw (#7671). The guidelines for replacement trees are specific to large-diameter trees, which are defined as trees having a dbh of 75cm or greater. In total, there are six trees inventoried that would qualify as large-diameter trees; only two of these are currently identified as requiring removal [Tag #1620 and 4530(DH)]. Assuming the percentage of large-diameter trees lost roughly correlates with canopy cover, we estimate that roughly 66% canopy cover associated with large-diameter trees will remain.

Overall, 90 trees were inventoried for this project. Of the 90 trees inventoried, a total of 46 trees will require removal. Assuming again that the number of trees lost roughly correlates with canopy cover, we can assume that about 49% canopy cover will remain on the Site once removals have been completed.

The DNV Tree Protection Bylaw indicates that if the Site has more than 20% canopy cover after completion of tree removal, then no replacement trees will be required. Based on the above canopy cover estimates and our interpretation of the bylaw, we do not anticipate that replacement trees will be required. Polygon, however, is committed to restoring the Roche Point Creek riparian corridor, which would include substantial revegetation efforts. The natural ecological approach to restoration proposed will include successional strategies involving a number of new tree plantings. In time, we anticipate that the benefits and habitat values inherent in the Roche Point Creek riparian restoration will far exceed the loss of trees proposed

PACIFIC WATER SHREW HABITAT ASSESSMENT

The Noble Cove Site falls within the range of PWS, which is listed as endangered on Schedule 1 of the *Species at Risk Act*, the official list of species-at-risk in Canada. PWS is also provincially red-listed which includes species that already are, or are in danger of being extirpated, endangered, or threatened in BC.

The Roche Creek Watershed is suspected of having a small population of PWS. A historical record dating from 1977 for PWS exists in the vicinity of Roche Point Creek northwest of the Site (BC Conservation Data Centre, 2013).

A PWS habitat assessment was completed for the DNV in November 2010 along the Roche Point Creek corridor in Roche Point Park in an area located approximately 250m upstream of the Site. The November 2010 PWS assessment concluded that the Roche Point Creek drainage, within Roche Point Park, was highly suitable for the species (Dupuis, 2010). As a follow-up to the November 2010 habitat assessment, PWS trapping was also completed in the summer and fall of 2011 along Roche Point Creek in Roche Point Park. Although PWS was not encountered during the 2011 trapping program, due to the availability of highly suitable habitat within Roche Point Park PWS may occur there in low densities (Dupuis, 2011).

Since the Noble Cove Site is located downstream of Roche Point Park, which contains habitat deemed highly suitable for PWS, a habitat assessment of the Roche Point Creek corridor on the Site was warranted to assess potential habitat suitability for PWS.

Methods

The methods used to conduct the PWS assessment were based on:

- Craig, V.J., R.G. Vennesland and K.E. Welstead. (2009) Best Management Practices for Pacific Water Shrew in Urban and Rural Areas. Version September 2009. Prepared for the Pacific Water Shrew Recovery Team. pp. 41 (WORKING DRAFT);
- Craig, V.J. (2007) Species Account and Preliminary Habitat Ratings for Pacific Water Shrew (*Sorex bendirii*) Using TEM Data v. 2. Prepared for Ministry of Environment. (DRAFT);
- Craig, V.J. (2006) Species Account and Preliminary Habitat Ratings for Pacific Water Shrew (Sorex bendirii) Using SHIM Data v.2. Prepared for Ministry of Environment. (DRAFT);
- Craig, V.J. (2007) Habitat Suitability/Capability Modelling for Pacific Water Shrew. Prepared for Ministry of Environment (DRAFT);
- Professional judgment considering Site-specific context;
- Green, R.N. and K. Klinka (1994) A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region. Prepared for BC Ministry of Forests; and
- Field Manual for Describing Terrestrial Ecosystems (1998). Co-published by the BC Ministry of Forests and Ministry Environment, Lands and Parks (now Ministry of Environment).

Two PGL Registered Professional Biologists (R.P.Bio.) surveyed the reach of Roche Point Creek identified on the Site in Figure 2, including riparian areas to identify:

- Presence of habitat requirements for PWS, which included collection of Sensitive Habitat Inventory Map (SHIM) habitat data;
- Site-specific factors influencing the relative habitat value; and
- Opportunities for habitat enhancement.

The surveyed reach included the length of Roche Point Creek from Dollarton Highway south to the confluence of Roche Point Creek and Burrard Inlet.

Habitat Description

The Noble Cove project is within the Coastal Western Hemlock dry maritime (CWHdm) biogeoclimatic subzone. However, the Site has been highly modified by existing land uses (i.e., Noble Towing and McKenzie Barge operations), and onsite vegetation conditions do not reflect those of naturally occurring forest ecosystems.

Roche Point Creek Riparian Area

The onsite Roche Point Creek riparian area is a narrow vegetated corridor which is confined by the adjacent developments (i.e., pavement, buildings). On the north half of the Site the riparian area is situated next to a single-family home and as a result of this, some modification (e.g., landscaping) has occurred within the riparian area. Here, vegetation is dominated by English ivy on the east bank and non-native grasses (i.e., lawn species) on the west bank (Photograph 6). There were no trees or shrub cover, or woody debris observed within the riparian area on the north half of the Site.

On the south half of the Site, the riparian area is less modified relative to the north half of the Site, but is still heavily influenced and confined by adjacent land uses. The riparian area on the south half of the Site exhibits some characteristics of a mixed forest community. The riparian ecology is disturbed and limited to a narrow corridor (Photograph 7). Tree species in the riparian area included western redcedar (*Thuja plicata*), and red alder. The most common native shrub species was salmonberry (*Rubus spectabilis*) but non-native invasive Himalayan blackberry (*Rubus discolor*) was also very prominent. Ground-level vegetation was dominated by English ivy.

On the south half of the Site the structural stage of the east bank within the riparian area was dominated by tall shrubs (i.e., 2–10m) with a shrub density ranging between 34 and 66%. The structural stage of the dominant riparian vegetation on the west bank falls within the low shrubs (<2m) category, with shrub density ranging between 5 and 33%. Some small woody debris, making up less than 1% of the ground cover, was observed in this area.

Roche Point Creek

Roche Point Creek has been highly modified in the project area by residential and industrial development, and the placement of Dollarton Highway. Immediately upstream of the Site, Roche Point Creek passes through a large concrete culvert underneath Dollarton Highway before entering the Site (Photograph 8). A small waterfall exists at the north end of the Site due to the raised outfall of the concrete culvert.

Roche Point Creek flows south across the Site for approximately 80m before entering Burrard Inlet. In the centre of the Site, the creek channel passes underneath a short vehicle bridge and the northeast corner of a building, before resurfacing at the south end of the Site (Photograph 9).

On the Site, Roche Point Creek had a bankfull width ranging from 1 to 6m and a mean bankfull depth of 60cm. Stream gradient ranged between 5 and 9%. Channel substrate was comprised of cobbles, boulders, gravel and sand.

Habitat Suitability Rating

Habitat suitability for PWS was assessed using the SHIM-based habitat ratings system in Craig (2006). This model determines the overall habitat suitability for PWS based on a combination of upland habitat and watercourse suitability. Upland habitat suitability considers the riparian class of the dominant vegetation, structural stage and shrub density of the vegetation on both banks. It also incorporates qualifiers for the riparian class (e.g., urban residential development). Watercourse suitability considers the primarily stream class, stream gradient, bankfull width, and bankfull depth (Craig, 2006).

Using this rating system, the overall habitat suitability for PWS was considered low. Watercourse suitability was determined to be moderate for the Site, however when combined with the low suitability of upland habitat, the overall outcome was low.

A number of Site factors contribute to the overall low suitability of habitat for PWS. Although high suitability habitat was identified upstream of the Site, within Roche Point Park, the Site is separated from upstream riparian habitat by Dollarton Highway. At Dollarton Highway, Roche Point Creek flows through a culvert. Culverts are generally not considered suitable habitat for PWS and in the SHIM model are given a Nil rating.

Within the Site itself, the available habitat is limited (i.e., restricted to a narrow corridor) and has been degraded by adjacent developments. The riparian area is further fragmented by the bridge and building in the centre of the Site. There is also a lack of shrub cover on the north half on the Site and a general absence of woody debris throughout the riparian area. Dense shrubs or downed wood typically contribute to continuity of cover, which is an important habitat component for PWS.

Riparian Area Enhancement Methods for PWS

It is our understanding that as part of the Noble Cove project, a remediation program will be implemented to rehabilitate the habitat conditions of Roche Point Creek. This includes increasing the riparian zone on either side to 15m, which would increase the amount of terrestrial habitat for riparian wildlife.

A number of enhancement activities can be implemented to improve habitat conditions specifically for PWS. The enhancement program should emphasize connectivity (i.e., contiguous cover). Habitat fragmentation should be reduced by removing structures currently situated over the creek.

Also, increasing shrub cover and placing significant amounts of woody debris within the riparian area can provide possible refuge, feeding and nesting habitat for PWS. Large woody debris can also be used to create travel corridors for this species.

Use of heavy machinery and grubbing should be avoided within the existing riparian corridor to eliminate risk to potentially present riparian wildlife.

PWS Habitat Conclusion

Although, high suitability habitat was identified upstream of the Site within Roche Point Park by Dupuis in 2010, the overall habitat suitability of the Noble Cove Site for PWS is rated low. This is due to habitat degradation caused by adjacent development, habitat fragmentation from structures situated over the creek channel, and a lack of continuous cover in the riparian area. Increasing connectivity within the riparian area can improve habitat suitability for PWS, however the Site is still disconnected from habitat upstream of the Site by the Dollarton Highway. Therefore, the potential of PWS utilizing new or restored habitat associated with the development is likely low.

We trust that this report meets your needs. If you have any questions or require clarification, please contact Keven Goodearle or Bruce Nidle at 604-895-7646 and 604-895-7609, respectively.

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Attachment: Table 1: Preliminary Tree Inventory, Risk Assessment and Tree Retention Summary
Figures 1 and 2
Photographs

REFERENCES

BC Conservation Data Centre, 2013. Occurrence report for the Pacific water shrew in the vicinity of Roche Point, North Vancouver. CDC, Victoria, BC.

Craig, V.J, 2006. Species account and Preliminary Habitat Ratings for Pacific Water Shrew (*Sorex bendirii*) Using SHIM DATA. Version 2. Report to the Ministry of Environment. Surrey, BC.

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Table

Table 1
Preliminary Tree Inventory, Risk Assessment and Tree Retention Summary
Roche Point Creek, Noble Cove Site, North Vancouver, BC
Polygon Development 270 Ltd., PGL File: 1543-09.02

Tag #	Tree Code	Common Name	Scientific Name	DBH (cm)	Approximate Height (m)	Tree Protection Zone (TPZ) Multiplier[1]	Optimum TPZ Radius (m)[2]	General Comments & Short-Term Recommendations	Overall Health/ Condition	Risk Assessment[3]					Retain?
										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
1607	Mb	bigleaf maple	*Acer macrophyllum*	32 & 18	12	0.09	3	- double stemmed, union below dbh - located on steep slope **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	2	2	3	7	Moderate	No
1608	Mb	bigleaf maple	*Acer macrophyllum*	22	11	0.09	2	- swoop at base, self-corrected - notable deadwood in canopy **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	2	1	2	5	Moderate	No
1609	Mb	bigleaf maple	*Acer macrophyllum*	16	10	0.09	1	**- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	1	1	2	4	Low	No
1610	Mb	bigleaf maple	*Acer macrophyllum*	15, 13, 13 & 13	10	0.09	1	- multi-stemmed, union at base **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	2	2	4	8	Moderate	No
1611	Mb	bigleaf maple	*Acer macrophyllum*	16, 22, 14 & 11	10	0.09	2	- cluster of 4 stems, plus additional <10cm dbh **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	2	2	4	8	Moderate	No
1612	Mb	bigleaf maple	*Acer macrophyllum*	41 & 31	8	0.09	4	- multi-stemmed, union at base - both stems topped at roughly 5m above grade - significant English ivy population growing up main stem **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Poor	2	2	3	7	Moderate	No
1613	Mb	bigleaf maple	*Acer macrophyllum*	34	10	0.09	3	- topped at roughly 5m above grade - significant English ivy population growing up main stem	Poor	2	2	4	8	Moderate	Yes
1614	Mb	bigleaf maple	*Acer macrophyllum*	22	12	0.09	2	- significant English ivy population growing up main stem	Moderate	1	2	4	7	Moderate	Yes
1615	Mb	bigleaf maple	*Acer macrophyllum*	32	7	0.09	3	- topped at roughly 5m above grade - significant English ivy population growing up main stem	Poor	2	2	4	8	Moderate	Yes
1616	Mb	bigleaf maple	*Acer macrophyllum*	57	20	0.09	5	- X2 stems, union at base, growing very close together with no separation at dbh - included bark observed - significant English ivy population growing up main stem	Moderate	2	2	4	8	Moderate	Yes
1617	Mb	bigleaf maple	*Acer macrophyllum*	32	18	0.09	3	- significant English ivy population growing up main stem	Moderate	2	2	4	8	Moderate	Yes
1618	Mb	bigleaf maple	*Acer macrophyllum*	34	18	0.09	3	- significant English ivy population growing up main stem	Moderate	2	2	4	8	Moderate	Yes
1619	Mb	bigleaf maple	*Acer macrophyllum*	50	20	0.09	5	- significant English ivy population growing up main stem	Moderate	2	2	4	8	Moderate	Yes
1620	Mb	bigleaf maple	*Acer macrophyllum*	77, 63 & 27	20	0.09	7	- x3 stems union at base - smaller stem has a broken top with new leader, union appears stable but likely point of decay and possible failure - significant English ivy population growing up all stems - tree also has Tag #4547 (DH) **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Poor	3	2	4	9	**High**	No

Table 1
Preliminary Tree Inventory, Risk Assessment and Tree Retention Summary
Roche Point Creek, Noble Cove Site, North Vancouver, BC
Polygon Development 270 Ltd., PGL File: 1543-09.02

Tag #	Tree Code	Common Name	Scientific Name	DBH (cm)	Approximate Height (m)	Tree Protection Zone (TPZ) Multiplier[1]	Optimum TPZ Radius (m)[2]	General Comments & Short-Term Recommendations	Overall Health/ Condition	Risk Assessment[3]					Retain?
										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
1621	Mb	bigleaf maple	*Acer macrophyllum*	33	16	0.09	3	- slight lean to SSW over existing building - significant English ivy population growing up main stem **- REMOVE AS A PRECAUTION**	Moderate	3	2	4	9	**High**	No
1622	Cw	western redcedar	*Thuja plicata*	11.5	7	0.09	1		Good	1	2	3	6	Moderate	Yes
1623	Mb	bigleaf maple	*Acer macrophyllum*	13.5 & 33	15	0.06	2	- 33cm dbh is actually x2 stems with union below dbh but no separation between stems at dbh - 13.5cm dbh stem is standing dead **- REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Moderate	4	2	3	9	**High**	No
1624	Dr	red alder	*Alnus rubra*	13, 23.5, 20.5, 20,5 & 31	15	0.06	2	- multi-stemmed swooping out from creek bank - canopy extends over creek to other side - some broken tops and some standing dead stems	Moderate	3	2	0	0	Zero	Yes
1625	Dr	red alder	*Alnus rubra*	88	15	0.09	8	- swoop out from creek bank	Moderate	2	3	1	6	Moderate	Yes
1626	Dr	red alder	*Alnus rubra*	24	8	0.06	1	- growing out from creek bank	Good	1	2	1	4	Low	Yes
1627	Ep	paper birch	*Betula papyrifera*	16 & 13	10	0.06	1	- growing out from top of bank - appears in good health with no significant die-back in upper canopy	Good	1	2	1	4	Low	Yes
1628	Dr	red alder	*Alnus rubra*	23	15	0.06	1	- wound at base of tree with evidence of decay - some English ivy growing up main stem	Moderate	3	2	0	0	Zero	Yes
1629	Dr	red alder	*Alnus rubra*	23	10	0.06	1	- x2 stems, union at base - wounds with decay on both stems at base	Poor	3	2	0	0	Zero	Yes
1630	Dr	red alder	*Alnus rubra*	28	18	0.06	2	- dead leader at top - some English ivy growing up main stem - some canopy pruning observed in lower branches	Poor	2	2	3	7	Moderate	Yes
1631	Dr	red alder	*Alnus rubra*	23	15	0.06	1	- growing out from creek bank - some English ivy growing up main stem	Moderate	2	2	3	7	Moderate	Yes
1632	Dr	red alder	*Alnus rubra*	20	8	0.06	1	- growing out from creek bank rip rap - lean to ESE - wound with decay on upslope side of main stem	Poor	3	2	0	0	Zero	Yes
1633	Dr	red alder	*Alnus rubra*	13	8	0.06	1	- growing out from top of bank with lean to ESE	Moderate	3	2	1	6	Moderate	Yes
1634	Dr	red alder	*Alnus rubra*	20	8	0.06	1	- growing out from top of bank with lean to SSE - some visible stress in tree at base - wound with decay ~3m above grade on main stem	Poor	3	2	1	6	Moderate	Yes
1635	Dr	red alder	*Alnus rubra*	15	4	0.06	1	- significant lean out from top of bank to ESE	Moderate	2	2	1	5	Low	Yes
1636	Dr	red alder	*Alnus rubra*	18	8	0.06	1	- slight lean out from top of bank to ESE	Good	2	2	1	5	Low	Yes
1637	Mb	bigleaf maple	*Acer macrophyllum*	26, 19, 11 & 18	20	0.09	2	- multi-stemmed with significant English ivy population growing up stems	Moderate	2	2	4	8	Moderate	Yes
1638	Mb	bigleaf maple	*Acer macrophyllum*	25, 18, 5, 24, 5 & 22	20	0.09	2	- multi-stemmed with significant English ivy population growing up stems	Moderate	2	2	4	8	Moderate	Yes
1639	Mb	bigleaf maple	*Acer macrophyllum*	36, 25 & 25	20	0.09	3	- multi-stemmed with significant English ivy population growing up stems	Moderate	2	2	3	7	Moderate	Yes
1640	Dr	red alder	*Alnus rubra*	28	18	0.06	2	- lean in WNW direction towards Dollarton Highway **- REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Moderate	3	2	4	9	**High**	No
1641	Mb	bigleaf maple	*Acer macrophyllum*	54	25	0.09	5	- slight lean to W	Moderate	2	3	3	8	Moderate	Yes

Table 1

Preliminary Tree Inventory, Risk Assessment and Tree Retention Summary
Roche Point Creek, Noble Cove Site, North Vancouver, BC
Polygon Development 270 Ltd., PGL File: 1543-09.02

Tag #	Tree Code	Common Name	Scientific Name	DBH (cm)	Approximate Height (m)	Tree Protection Zone (TPZ) Multiplier[1]	Optimum TPZ Radius (m)[2]	General Comments & Short-Term Recommendations	Overall Health/ Condition	Risk Assessment[3]					Retain?
										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
1642	Mb	bigleaf maple	*Acer macrophyllum*	66	25	0.09	6	- some larger deadwood in canopy - branch in upper canopy (W side) has a significant wound with decay **- CONFIRM PROPERTY BOUNDARY; REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Poor	4	2	3	9	**High**	No
1643	Mb	bigleaf maple	*Acer macrophyllum*	44	25	0.09	4	- multi-stemmed with union ~4m above grade	Good	1	2	3	6	Moderate	Yes
1644	Dr	red alder	*Alnus rubra*	17.5	10	0.06	1		Good	1	2	2	5	Low	Yes
1647	Act	black cottonwood	*Populus balsamifer*	12	10	0.06	1		Good	1	2	1	4	Low	Yes
1648	Dr	red alder	*Alnus rubra*	15	8	0.06	1	- on bank of foreshore	Good	1	2	1	4	Low	Yes
1649	Act	black cottonwood	*Populus balsamifer*	24	12	0.06	1	- on bank of foreshore	Good	1	2	1	4	Low	Yes
1650	Dr	red alder	*Alnus rubra*	19.5	10	0.06	1		Good	1	2	1	4	Low	Yes
1651	Dr	red alder	*Alnus rubra*	22	12	0.06	1		Good	1	2	1	4	Low	Yes
1652	Dr	red alder	*Alnus rubra*	25	12	0.06	2	**- DIRECT CONFLICT WITH DEVELOPMENT REMOVE**	Good	1	2	1	4	Low	No
1653	Dr	red alder	*Alnus rubra*	12	15	0.06	1	- leaning on and over existing building - swoop out from slope with some self-correction apparent **- CONFIRM PROPERTY BOUNDARY; REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Moderate	3	2	4	9	**High**	No
1654	Dr	red alder	*Alnus rubra*	38.5	20	0.06	2	- significant swoop horizontal to ground and around existing platform structure - self-corrected beyond the platform structure **- CONFIRM PROPERTY BOUNDARY; REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Poor	4	2	3	9	**High**	No
1655	Mb	bigleaf maple	*Acer macrophyllum*	69	25	0.09	6	- multi-stemmed with union ~2m above grade - one stem is dead - one stem is topped/broken **- CONFIRM PROPERTY BOUNDARY; REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Poor	4	2	3	9	**High**	No
033 (HWM)	Dr	red alder	*Alnus rubra*	39	20	0.06	2	- growing out from slope with lean in WSW direction towards site **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	3	2	2	7	Moderate	No
4530 (DH)	Cw	western redcedar	*Thuja plicata*	87	25	0.12	10	- in good/stable condition, located at top of slope - x2 secondary leaders in canopy; unions appear stable from ground - double leader in upper canopy **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	1	1	2	4	Low	No
4531 (DH)	Act	black cottonwood	*Populus balsamifer*	66	25	0.09	6	- growing at top of bank with ESE lean over creek - some English ivy growing up main stem	Moderate	3	3	0	0	Zero	Yes
4532 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	28, 15 & 81	20	0.09	7	- x3 stems with union below dbh - significant English ivy population growing up largest stem	Moderate	2	3	3	8	Moderate	Yes

Table 1
Preliminary Tree Inventory, Risk Assessment and Tree Retention Summary
Roche Point Creek, Noble Cove Site, North Vancouver, BC
Polygon Development 270 Ltd., PGL File: 1543-09.02

Tag #	Tree Code	Common Name	Scientific Name	DBH (cm)	Approximate Height (m)	Tree Protection Zone (TPZ) Multiplier[1]	Optimum TPZ Radius (m)[2]	General Comments & Short-Term Recommendations	Overall Health/ Condition	Risk Assessment[3]					Retain?
										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
4533 (DH)	Dr	red alder	*Alnus rubra*	51	20	0.09	5	- lean to SSW over creek - significant English ivy population growing up main stem	Moderate	3	2	1	6	Moderate	Yes
4534 (DH)	Dr	red alder	*Alnus rubra*	59	20	0.09	5	- lean to SE over existing building - significant English ivy population growing up main stem **- REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Moderate	3	3	3	9	High	No
4535 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	85	18	0.09	8	- x3 stems with union below dbh, but no separation of stems at dbh - included bark evident, but appears stable - significant English ivy population growing up main stems	Moderate	2	2	3	7	Moderate	Yes
4536 (DH)	Dr	red alder	*Alnus rubra*	45	18	0.09	4	- self-corrected swoop to SSW - significant English ivy population growing up main stem	Moderate	2	2	3	7	Moderate	Yes
4537 (DH)	Dr	red alder	*Alnus rubra*	38	20	0.06	2	- located on top of bank of creek with slight lean - open-grown and appears stable	Moderate	2	2	1	5	Low	Yes
4538 (DH)	Cw	western redcedar	*Thuja plicata*	47	20	0.09	4	- minor English ivy population growing up main stem - thin canopy, possibly due to climate or other stresses	Moderate	1	2	4	7	Moderate	Yes
4539 (DH)	Cw	western redcedar	*Thuja plicata*	43	20	0.09	4	- moderate English ivy population growing up main stem - broken top ~5m above grade with two new leaders, union appears stable **- RETAIN AND MONITOR**	Moderate	1	2	4	7	Moderate	Yes
4541 (DH)	Fd	Douglas-fir	*Pseudotsuga menziesii*	155	40	0.15	23	- stable, appears windfirm and open-grown - some deadwood and "widow-makers" in upper canopy - significant English ivy population growing up main stem, most of which was dead, but some alive and re-establishing on tree - some sap-staining down main stem, from possible defect in upper canopy (inconclusive) **- RETAIN AND MONITOR**	Moderate	2	2	4	8	Moderate	Yes
4542 (DH)	Cw	western redcedar	*Thuja plicata*	86	28	0.12	10	- stable, appears windfirm and open-grown - secondary leader with union ~4m above grade **- RETAIN AND MONITOR**	Good	1	2	4	7	Moderate	Yes
4543 (DH)	Cw	western redcedar	*Thuja plicata*	37 & 24	15	0.09	3	- x2 trees, separate at base - on steep slope, in good conditions, slight swoop at base from slope	Good	1	1	2	4	Low	No
4544 (DH)	Dr	red alder	*Alnus rubra*	40	14	0.09	4	**- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	1	2	4	7	Moderate	No
4545 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	69	18	0.09	6	- x2 stems with union just above dbh - significant English ivy population growing up main stem **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	1	2	4	7	Moderate	No

Table 1
Preliminary Tree Inventory, Risk Assessment and Tree Retention Summary
Roche Point Creek, Noble Cove Site, North Vancouver, BC
Polygon Development 270 Ltd., PGL File: 1543-09.02

Tag #	Tree Code	Common Name	Scientific Name	DBH (cm)	Approximate Height (m)	Tree Protection Zone (TPZ) Multiplier[1]	Optimum TPZ Radius (m)[2]	General Comments & Short-Term Recommendations	Overall Health/ Condition	Risk Assessment[3]					Retain?
										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
4546 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	26	16	0.09	2	- significant English ivy population growing up main stem **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	1	2	4	7	Moderate	No
4549 (DH)	Hw	western hemlock	*Tsuge heterophylla*	21.5, 13, 18.5, 35 & 18	10	0.09	3	- topped and cut-back with significant pruning likely due to overhead utilities - pruning has resulted in multiple leaders and compacted canopy - growing along top of a retaining wall **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Poor	2	2	4	8	Moderate	No
4550 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	63 & 39	18	0.09	6	- actually x3 stems growing very close together with included bark - 63cm dbh is actually x2 stems with no separation at dbh	Moderate	2	2	3	7	Moderate	Yes
920 (HWM)	Dr	red alder	*Alnus rubra*	23.5	15	0.06	1	- growing out from slope with lean in WSW direction towards site **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	3	2	2	7	Moderate	No
922 (HWM)	Dr	red alder	*Alnus rubra*	40	18	0.09	4	- growing out from slope with lean in WSW direction towards site **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	3	2	2	7	Moderate	No

1) TPZ Multiplier determined based on guidelines provided in *Arboriculture - Integrated Management of Landscaper Trees, Shrubs, and Vines, 4th ed.* (Harris et al., 2004).
2) Where multiple stems were recorded, the recommended TPZ was calculated based on largest dbh.
3) Risk assessment completed based on guidelines outlined in *Tree Risk Assessment in Urban Areas and the Urban/Rural Interface* (Dunster, J., 2009).
4) If a target-rating is 0 (i.e., no targets present), then there are no risks associated with that tree (i.e., Zero Risk).
5) 0-2pts = Zero Risk; 3-5pts = Low Risk; 6-8pts = Moderate Risk; 9-11pts = High Risk; 12pts = Extreme Risk.

Figures

March 22 2013

Map ID: 1543-09.02_002

PGL Pottinger Gaherty Environmental Consultants Ltd.

Figure 1: Preliminary Tree Retention Plan

Map produced by Spicker GIS Services (spickergis@shaw.ca)

March 21 2013

Map ID: 1543-09.02_001

PGL | Pottinger Gaherty Environmental Consultants Ltd.

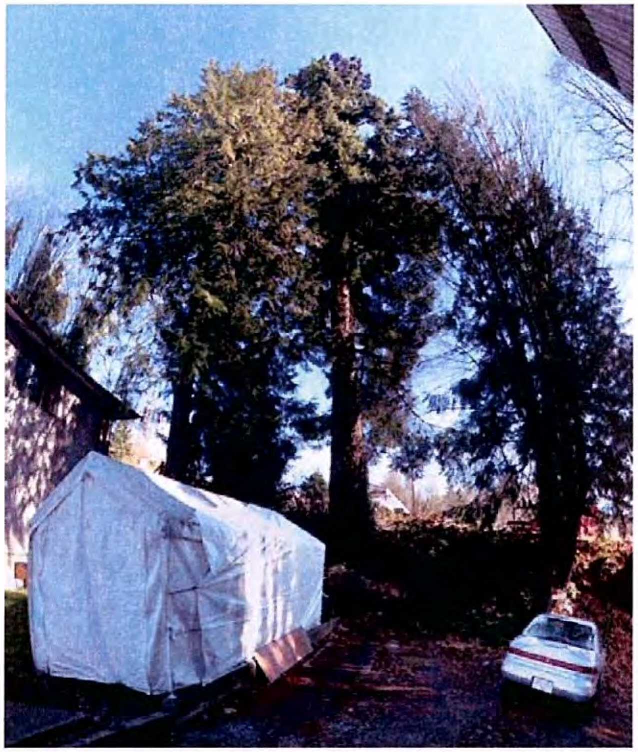
Figure 2: Site Plan

Map produced by Spicker GIS Services (www.spickergis.com)

Photographs

Photograph 1:

Topped bigleaf maple trees adjacent to Dollarton Highway with significant populations of English ivy on main stems



Photograph 2:

Large-diameter, veteran western redcedar and Douglas-fir in the Roche Point Creek riparian environment [Tag #4541(DH) and 4542(DH)]

Photograph 3:

Small stand of early seral deciduous trees in the western portion of the Site (Figure 1)

Photograph 4:

Significant population of English ivy occurring in the Roche Point Creek riparian environment

Photograph 5:

Significant populations of English ivy engulfing deciduous trees onsite

Photograph 6:

Riparian area habitat conditions on the north half of the Site. Facing downstream, east bank on the left, west bank on the right.

Photograph 7:

Riparian area habitat conditions on the south half of the Site. Facing downstream, east bank on the left, west bank on the right.

Photograph 8:

Dollarton Highway culvert, facing south towards the Site

Photograph 9:

Creek channel passing underneath the bridge and building in the centre of the Site.

Table 1

Habitat Restoration Plan

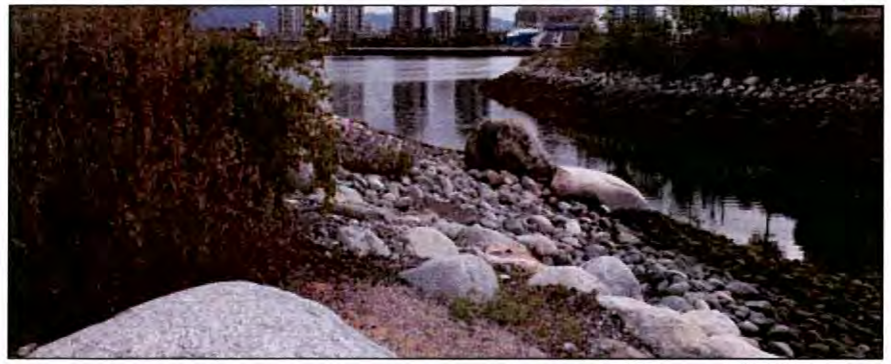
PGL

Table 1
Habitat Restoration Plan
3829/3919 Dollarton Highway, North Vancouver, BC
Polygon Development 270 Ltd., PGL File: 1543-09.01

Area	Description	Riparian (m2)	Intertidal Marsh (m2)	Intertidal Pool and Channel (m2)
1	Replace beach with marsh	38	100	
2	"Softened" shoreline + Riparian planting	80		
3	Enhancement of existing shoreline + Riparian planting	970		
4	Estuarine marsh			
5	Intertidal channel			
6	Intertidal pool	4,643	1,250	510
7	"Softened" shoreline + Riparian planting			
8	"Softened" shoreline + Riparian planting			
9	"Softened" shoreline + Riparian planting			
10	Roche Point Creek Enhancement (includes culvert barrier removal, instream enhancements and riparian planting)	1,210		
	Total	**6,941**	**1,350**	**510**
	Total Area (m^2)	**8,801**		

Rositch Hemphill Architects

Figure 12



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120 Powell Street, Unit 10 Vancouver, BC Canada V6A 1G1
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P+A
Perry + Associates
Landscape Architecture

PROJECT:
NOBLE COVE
3820 & 3910 Dollarton Highway

DRAWING TITLE :
HABITAT RESTORATION PLAN
WITH REFERENCE IMAGES

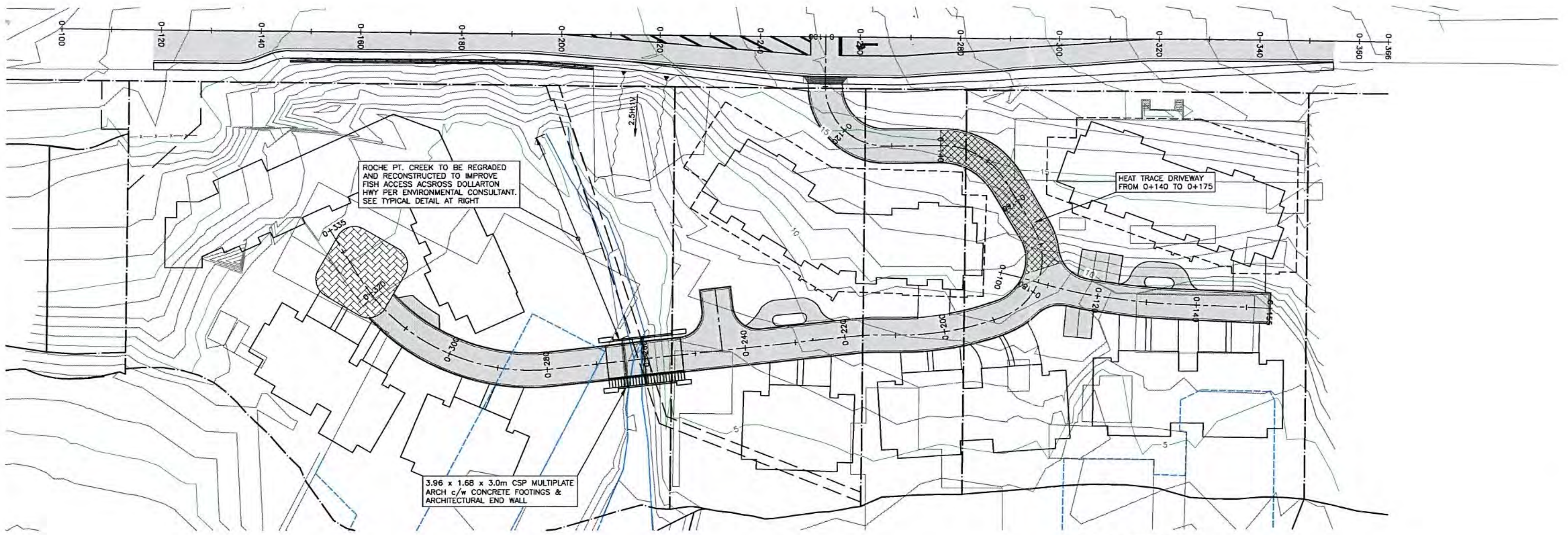
POLYGON
Suite 900 - 1333 West Broadway, Vancouver, BC, Canada V6H4C2 T:(604)877-1131 F:(604)871-4120

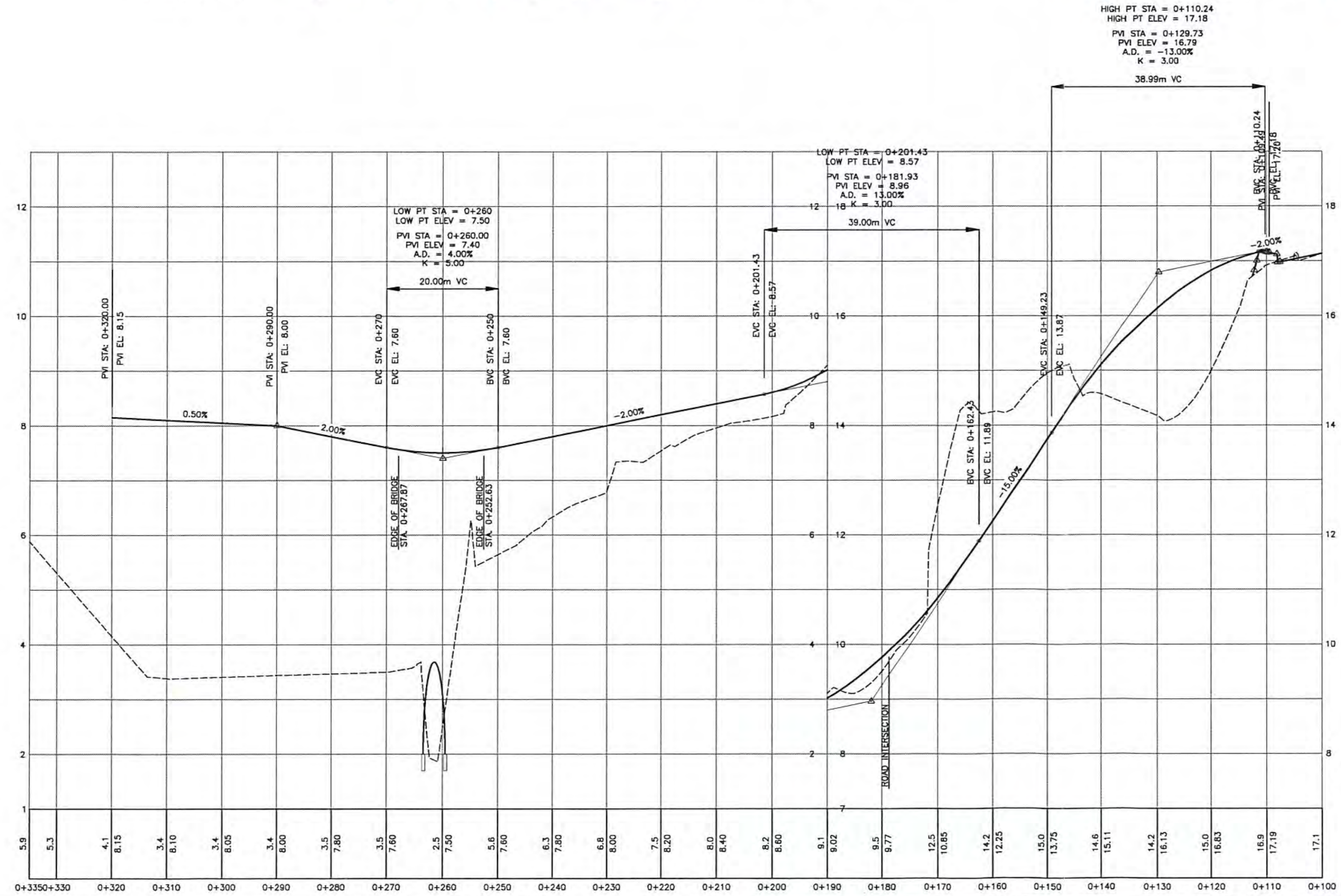
DATABASE:	1033.1.2
PROJECT NO:	1033
DATE:	23 APR, 2013
SCALE:	

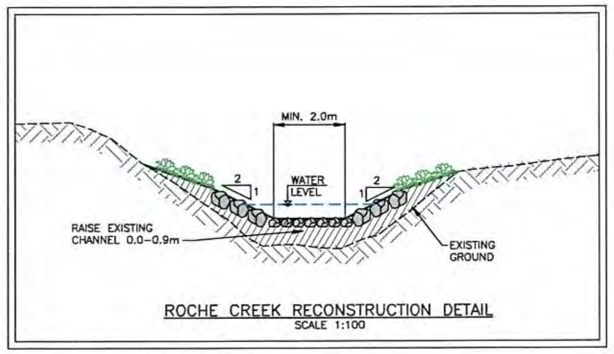
12

Creus Engineering Ltd.

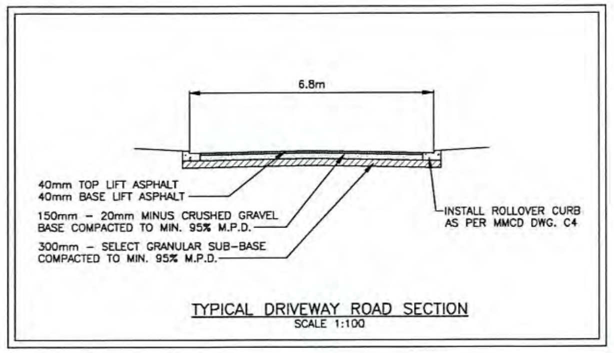
Figure R-2







ROCHE CREEK RECONSTRUCTION DETAIL
SCALE 1:100



TYPICAL DRIVEWAY ROAD SECTION
SCALE 1:100

1	APR.11.13	ISSUED FOR DP SUBMISSION	AFG

client
POLYGON DEVELOPMENT

project
DOLLARTON NOBLE COVE
NORTH VANCOUVER, BRITISH COLUMBIA

www.creus.ca

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approved
designed by R.A.W.
drawn by D.K.D.
checked by F.M.C.
date FEB 28.13

title
ROADWORKS
DRIVEWAY

scales
hor: 1:500 vert: 1:50
file no. 12123
drawing no. R-2
rev. 1

PGL
Pottinger Gaherty
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October 4, 2013
PGL File: 1543-09.02

Via E-mail: cmelosky@polyhomes.com

Polygon Development 270 Ltd.
Suite 900 – 1333 West Broadway
Vancouver, BC
V6H 4C2

Attention: Cynthia Melosky
Vice President, Development

RE: ENVIRONMENTAL REPORT – ADDEDUM
ROCHE POINT CREEK, NOBLE COVE SITE, NORTH VANCOUVER, BC

Pottinger Gaherty Environmental Consultants Ltd. (PGL) is pleased to provide this addendum package to supplement our April 23, 2013 report provided for the Noble Cove project on Dollarton Highway in North Vancouver, BC. Specifically this package addresses the District of North Vancouver's (DNV's) request for additional information related to the tree inventory and assessment.

BACKGROUND

PGL's April 23, 2013 report provided preliminary information addressing the DNV requests outlined in its July 16, 2012 letter regarding tree retention, removal and replacement, as well as specific habitat concerns related to the Pacific water shrew (PWS). The tree assessment of our report included:

- A detailed tree survey of all trees measuring at least 10cm in diameter at breast height (dbh);
- A preliminary tree risk assessment of existing trees located onsite and immediately adjacent to the site (east property line); and
- A preliminary tree retention plan based on handheld GPS data.

SUPPLEMENTAL INFORMATION

As requested by the DNV, inventoried tree locations were surveyed by a qualified professional land surveyor and used to provide a detailed tree retention plan (attached). The tree survey data has been added to the proposed site plan and included optimal tree-protection zones, as determined in our April 2013 report. For ease of review, we have included our tree assessment summary table originally provided in the April 2013 report (attached).

In addition to this, we can confirm that the preliminary tree risk assessment provided in the April 2013 was prepared by Keven Goodearle, who is both an ISA Certified Arborist (Certification No. PN-6291A) and ISA Certified Tree Risk Assessor (Certification No. 110).

We trust that this addendum package will meet DNV requirements at this time. If you have any questions or require clarification, please contact Keven Goodearle or Susan Wilkins at 604-895-7646 and 604-895-7621, respectively.

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.
Per:

Susan Wilkins

Keven Goodearle, B.Sc., R.P.Bio.
ISA Certified Arborist
Environmental Scientist

Susan P. Wilkins, M.Sc., P.Geo., LEED AP
Vice President, Operations

KMG/SPW/mtl
P:\1400-1599\1543\09-02\l-1543-09-02-Oct13.doc

Attachment: Table 1: Preliminary Tree Inventory, Risk Assessment and Tree Retention Summary
Figure 1: Detailed Tree Retention Plan

Table

Table 1
Preliminary Tree Inventory, Risk Assessment and Tree Retention Summary
Roche Point Creek, Noble Cove Site, North Vancouver, BC
Polygon Development 270 Ltd., PGL File: 1543-09.02

Tag #	Tree Code	Common Name	Scientific Name	DBH (cm)	Approximate Height (m)	Tree Protection Zone (TPZ) Multiplier[1]	Optimum TPZ Radius (m)[2]	General Comments & Short-Term Recommendations	Overall Health/ Condition	Risk Assessment[3]					Retain?
										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
1607	Mb	bigleaf maple	*Acer macrophyllum*	32 & 18	12	0.09	3	- double stemmed, union below dbh - located on steep slope - **DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	2	2	3	7	Moderate	No
1608	Mb	bigleaf maple	*Acer macrophyllum*	22	11	0.09	2	- swoop at base, self-corrected - notable deadwood in canopy - **DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	2	1	2	5	Moderate	No
1609	Mb	bigleaf maple	*Acer macrophyllum*	16	10	0.09	1	- **DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	1	1	2	4	Low	No
1610	Mb	bigleaf maple	*Acer macrophyllum*	15, 13, 13 & 13	10	0.09	1	- multi-stemmed, union at base - **DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	2	2	4	8	Moderate	No
1611	Mb	bigleaf maple	*Acer macrophyllum*	16, 22, 14 & 11	10	0.09	2	- cluster of 4 stems, plus additional <10cm dbh - **DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	2	2	4	8	Moderate	No
1612	Mb	bigleaf maple	*Acer macrophyllum*	41 & 31	8	0.09	4	- multi-stemmed, union at base - both stems topped at roughly 5m above grade - significant English ivy population growing up main stem - **DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Poor	2	2	3	7	Moderate	No
1613	Mb	bigleaf maple	*Acer macrophyllum*	34	10	0.09	3	- topped at roughly 5m above grade - significant English ivy population growing up main stem	Poor	2	2	4	8	Moderate	Yes
1614	Mb	bigleaf maple	*Acer macrophyllum*	22	12	0.09	2	- significant English ivy population growing up main stem	Moderate	1	2	4	7	Moderate	Yes
1615	Mb	bigleaf maple	*Acer macrophyllum*	32	7	0.09	3	- topped at roughly 5m above grade - significant English ivy population growing up main stem	Poor	2	2	4	8	Moderate	Yes
1616	Mb	bigleaf maple	*Acer macrophyllum*	57	20	0.09	5	- X2 stems, union at base, growing very close together with no separation at dbh - included bark observed - significant English ivy population growing up main stem	Moderate	2	2	4	8	Moderate	Yes
1617	Mb	bigleaf maple	*Acer macrophyllum*	32	18	0.09	3	- significant English ivy population growing up main stem	Moderate	2	2	4	8	Moderate	Yes
1618	Mb	bigleaf maple	*Acer macrophyllum*	34	18	0.09	3	- significant English ivy population growing up main stem	Moderate	2	2	4	8	Moderate	Yes
1619	Mb	bigleaf maple	*Acer macrophyllum*	50	20	0.09	5	- significant English ivy population growing up main stem	Moderate	2	2	4	8	Moderate	Yes
1620	Mb	bigleaf maple	*Acer macrophyllum*	77, 63 & 27	20	0.09	7	- x3 stems union at base - smaller stem has a broken top with new leader, union appears stable but likely point of decay and possible failure - significant English ivy population growing up all stems - tree also has Tag #4547 (DH) - **DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Poor	3	2	4	9	**High**	No

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Roche Point Creek, Noble Cove Site, North Vancouver, BC
Polygon Development 270 Ltd., PGL File: 1543-09.02

Tag #	Tree Code	Common Name	Scientific Name	DBH (cm)	Approximate Height (m)	Tree Protection Zone (TPZ) Multiplier[1]	Optimum TPZ Radius (m)[2]	General Comments & Short-Term Recommendations	Overall Health/ Condition	Risk Assessment[3]					Retain?
										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
1621	Mb	bigleaf maple	*Acer macrophyllum*	33	16	0.09	3	- slight lean to SSW over existing building - significant English ivy population growing up main stem **- REMOVE AS A PRECAUTION**	Moderate	3	2	4	9	**High**	No
1622	Cw	western redcedar	*Thuja plicata*	11.5	7	0.09	1		Good	1	2	3	6	Moderate	Yes
1623	Mb	bigleaf maple	*Acer macrophyllum*	13.5 & 33	15	0.06	2	- 33cm dbh is actually x2 stems with union below dbh but no separation between stems at dbh - 13.5cm dbh stem is standing dead **- REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Moderate	4	2	3	9	**High**	No
1624	Dr	red alder	*Alnus rubra*	13, 23.5, 20.5, 20,5 & 31	15	0.06	2	- multi-stemmed swooping out from creek bank - canopy extends over creek to other side - some broken tops and some standing dead stems	Moderate	3	2	0	0	Zero	Yes
1625	Dr	red alder	*Alnus rubra*	88	15	0.09	8	- swoop out from creek bank	Moderate	2	3	1	6	Moderate	Yes
1626	Dr	red alder	*Alnus rubra*	24	8	0.06	1	- growing out from creek bank	Good	1	2	1	4	Low	Yes
1627	Ep	paper birch	*Betula papyrifera*	16 & 13	10	0.06	1	- growing out from top of bank - appears in good health with no significant die-back in upper canopy	Good	1	2	1	4	Low	Yes
1628	Dr	red alder	*Alnus rubra*	23	15	0.06	1	- wound at base of tree with evidence of decay - some English ivy growing up main stem	Moderate	3	2	0	0	Zero	Yes
1629	Dr	red alder	*Alnus rubra*	23	10	0.06	1	- x2 stems, union at base - wounds with decay on both stems at base	Poor	3	2	0	0	Zero	Yes
1630	Dr	red alder	*Alnus rubra*	28	18	0.06	2	- dead leader at top - some English ivy growing up main stem - some canopy pruning observed in lower branches	Poor	2	2	3	7	Moderate	Yes
1631	Dr	red alder	*Alnus rubra*	23	15	0.06	1	- growing out from creek bank - some English ivy growing up main stem	Moderate	2	2	3	7	Moderate	Yes
1632	Dr	red alder	*Alnus rubra*	20	8	0.06	1	- growing out from creek bank rip rap - lean to ESE - wound with decay on upslope side of main stem	Poor	3	2	0	0	Zero	Yes
1633	Dr	red alder	*Alnus rubra*	13	8	0.06	1	- growing out from top of bank with lean to ESE	Moderate	3	2	1	6	Moderate	Yes
1634	Dr	red alder	*Alnus rubra*	20	8	0.06	1	- growing out from top of bank with lean to SSE - some visible stress in tree at base - wound with decay ~3m above grade on main stem	Poor	3	2	1	6	Moderate	Yes
1635	Dr	red alder	*Alnus rubra*	15	4	0.06	1	- significant lean out from top of bank to ESE	Moderate	2	2	1	5	Low	Yes
1636	Dr	red alder	*Alnus rubra*	18	8	0.06	1	- slight lean out from top of bank to ESE	Good	2	2	1	5	Low	Yes
1637	Mb	bigleaf maple	*Acer macrophyllum*	26, 19, 11 & 18	20	0.09	2	- multi-stemmed with significant English ivy population growing up stems	Moderate	2	2	4	8	Moderate	Yes
1638	Mb	bigleaf maple	*Acer macrophyllum*	25, 18, 5, 24, 5 & 22	20	0.09	2	- multi-stemmed with significant English ivy population growing up stems	Moderate	2	2	4	8	Moderate	Yes
1639	Mb	bigleaf maple	*Acer macrophyllum*	36, 25 & 25	20	0.09	3	- multi-stemmed with significant English ivy population growing up stems	Moderate	2	2	3	7	Moderate	Yes
1640	Dr	red alder	*Alnus rubra*	28	18	0.06	2	- lean in WNW direction towards Dollarton Highway **- REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Moderate	3	2	4	9	**High**	No
1641	Mb	bigleaf maple	*Acer macrophyllum*	54	25	0.09	5	- slight lean to W	Moderate	2	3	3	8	Moderate	Yes

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										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
1642	Mb	bigleaf maple	*Acer macrophyllum*	66	25	0.09	6	- some larger deadwood in canopy - branch in upper canopy (W side) has a significant wound with decay - **CONFIRM PROPERTY BOUNDARY; REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Poor	4	2	3	9	**High**	No
1643	Mb	bigleaf maple	*Acer macrophyllum*	44	25	0.09	4	- multi-stemmed with union ~4m above grade	Good	1	2	3	6	Moderate	Yes
1644	Dr	red alder	*Alnus rubra*	17.5	10	0.06	1		Good	1	2	2	5	Low	Yes
1647	Act	black cottonwood	*Populus balsamifer*	12	10	0.06	1		Good	1	2	1	4	Low	Yes
1648	Dr	red alder	*Alnus rubra*	15	8	0.06	1	- on bank of foreshore	Good	1	2	1	4	Low	Yes
1649	Act	black cottonwood	*Populus balsamifer*	24	12	0.06	1	- on bank of foreshore	Good	1	2	1	4	Low	Yes
1650	Dr	red alder	*Alnus rubra*	19.5	10	0.06	1		Good	1	2	1	4	Low	Yes
1651	Dr	red alder	*Alnus rubra*	22	12	0.06	1		Good	1	2	1	4	Low	Yes
1652	Dr	red alder	*Alnus rubra*	25	12	0.06	2	- **DIRECT CONFLICT WITH DEVELOPMENT REMOVE**	Good	1	2	1	4	Low	No
1653	Dr	red alder	*Alnus rubra*	12	15	0.06	1	- leaning on and over existing building - swoop out from slope with some self-correction apparent - **CONFIRM PROPERTY BOUNDARY; REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Moderate	3	2	4	9	**High**	No
1654	Dr	red alder	*Alnus rubra*	38.5	20	0.06	2	- significant swoop horizontal to ground and around existing platform structure - self-corrected beyond the platform structure - **CONFIRM PROPERTY BOUNDARY; REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Poor	4	2	3	9	**High**	No
1655	Mb	bigleaf maple	*Acer macrophyllum*	69	25	0.09	6	- multi-stemmed with union ~2m above grade - one stem is dead - one stem is topped/broken - **CONFIRM PROPERTY BOUNDARY; REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Poor	4	2	3	9	**High**	No
033 (HWM)	Dr	red alder	*Alnus rubra*	39	20	0.06	2	- growing out from slope with lean in WSW direction towards site - **DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	3	2	2	7	Moderate	No
4530 (DH)	Cw	western redcedar	*Thuja plicata*	87	25	0.12	10	- in good/stable condition, located at top of slope - x2 secondary leaders in canopy; unions appear stable from ground - double leader in upper canopy - **DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	1	1	2	4	Low	No
4531 (DH)	Act	black cottonwood	*Populus balsamifer*	66	25	0.09	6	- growing at top of bank with ESE lean over creek - some English ivy growing up main stem	Moderate	3	3	0	0	Zero	Yes
4532 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	28, 15 & 81	20	0.09	7	- x3 stems with union below dbh - significant English ivy population growing up largest stem	Moderate	2	3	3	8	Moderate	Yes

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										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
4533 (DH)	Dr	red alder	*Alnus rubra*	51	20	0.09	5	- lean to SSW over creek - significant English ivy population growing up main stem	Moderate	3	2	1	6	Moderate	Yes
4534 (DH)	Dr	red alder	*Alnus rubra*	59	20	0.09	5	- lean to SE over existing building - significant English ivy population growing up main stem **- REMOVE AS A PRECAUTION, OR WILDLIFE TO SAFE HEIGHT**	Moderate	3	3	3	9	High	No
4535 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	85	18	0.09	8	- x3 stems with union below dbh, but no separation of stems at dbh - included bark evident, but appears stable - significant English ivy population growing up main stems	Moderate	2	2	3	7	Moderate	Yes
4536 (DH)	Dr	red alder	*Alnus rubra*	45	18	0.09	4	- self-corrected swoop to SSW - significant English ivy population growing up main stem	Moderate	2	2	3	7	Moderate	Yes
4537 (DH)	Dr	red alder	*Alnus rubra*	38	20	0.06	2	- located on top of bank of creek with slight lean - open-grown and appears stable	Moderate	2	2	1	5	Low	Yes
4538 (DH)	Cw	western redcedar	*Thuja plicata*	47	20	0.09	4	- minor English ivy population growing up main stem - thin canopy, possibly due to climate or other stresses	Moderate	1	2	4	7	Moderate	Yes
4539 (DH)	Cw	western redcedar	*Thuja plicata*	43	20	0.09	4	- moderate English ivy population growing up main stem - broken top ~5m above grade with two new leaders, union appears stable **- RETAIN AND MONITOR**	Moderate	1	2	4	7	Moderate	Yes
4541 (DH)	Fd	Douglas-fir	*Pseudotsuga menziesii*	155	40	0.15	23	- stable, appears windfirm and open-grown - some deadwood and "widow-makers" in upper canopy - significant English ivy population growing up main stem, most of which was dead, but some alive and re-establishing on tree - some sap-staining down main stem, from possible defect in upper canopy (inconclusive) **- RETAIN AND MONITOR**	Moderate	2	2	4	8	Moderate	Yes
4542 (DH)	Cw	western redcedar	*Thuja plicata*	86	28	0.12	10	- stable, appears windfirm and open-grown - secondary leader with union ~4m above grade **- RETAIN AND MONITOR**	Good	1	2	4	7	Moderate	Yes
4543 (DH)	Cw	western redcedar	*Thuja plicata*	37 & 24	15	0.09	3	- x2 trees, separate at base - on steep slope, in good conditions, slight swoop at base from slope	Good	1	1	2	4	Low	No
4544 (DH)	Dr	red alder	*Alnus rubra*	40	14	0.09	4	**- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Good	1	2	4	7	Moderate	No
4545 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	69	18	0.09	6	- x2 stems with union just above dbh - significant English ivy population growing up main stem **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	1	2	4	7	Moderate	No

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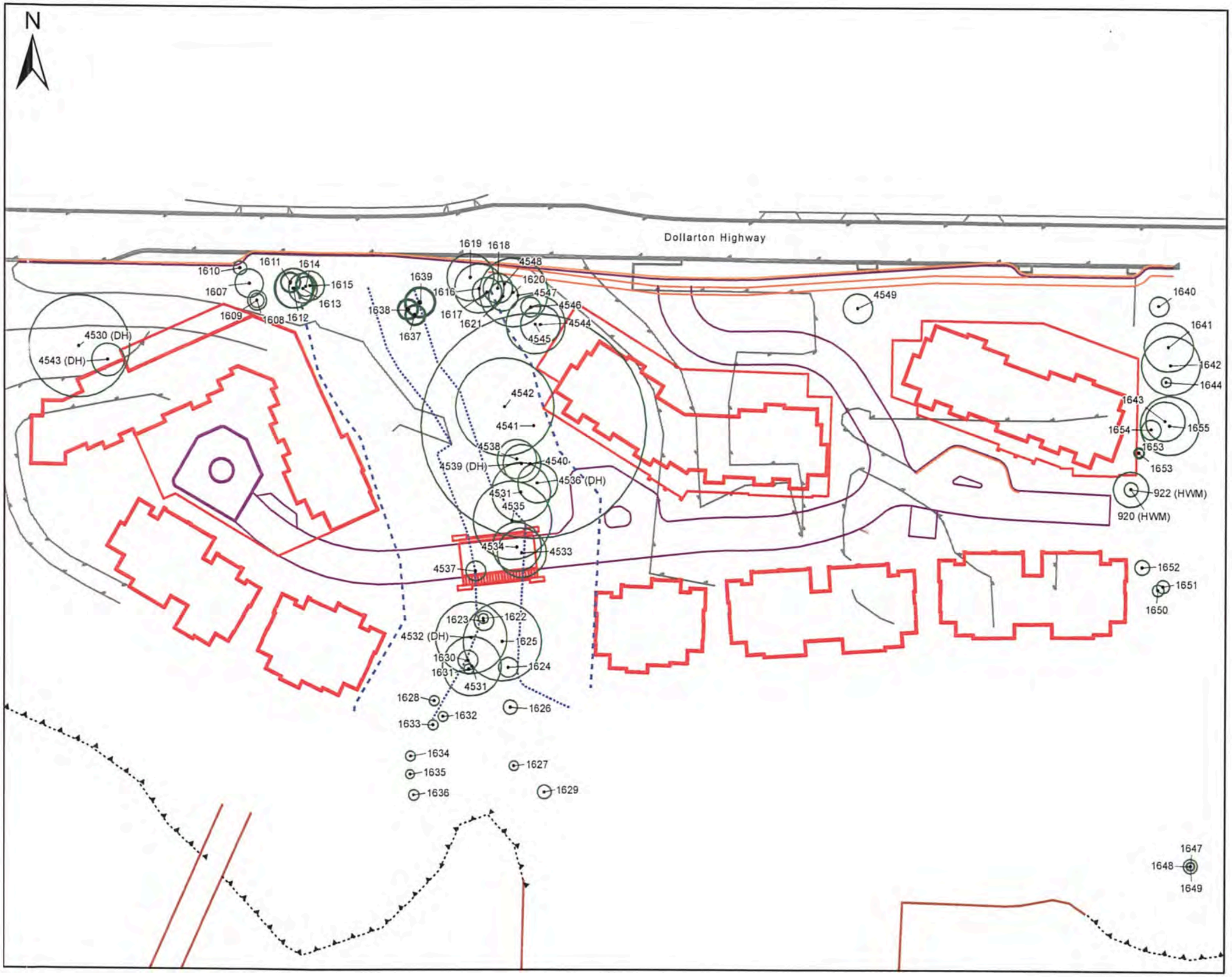
										Prob. of Failure (1-5)	Size of Part (1-4)	Target Rating (1-4)[4]	Overall Risk Rating (3-12)	Risk Level[5]	
4546 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	26	16	0.09	2	- significant English ivy population growing up main stem **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	1	2	4	7	Moderate	No
4549 (DH)	Hw	western hemlock	*Tsuge heterophylla*	21.5, 13, 18.5, 35 & 18	10	0.09	3	- topped and cut-back with significant pruning likely due to overhead utilities - pruning has resulted in multiple leaders and compacted canopy - growing along top of a retaining wall **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Poor	2	2	4	8	Moderate	No
4550 (DH)	Mb	bigleaf maple	*Acer macrophyllum*	63 & 39	18	0.09	6	- actually x3 stems growing very close together with included bark - 63cm dbh is actually x2 stems with no separation at dbh	Moderate	2	2	3	7	Moderate	Yes
920 (HWM)	Dr	red alder	*Alnus rubra*	23.5	15	0.06	1	- growing out from slope with lean in WSW direction towards site **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	3	2	2	7	Moderate	No
922 (HWM)	Dr	red alder	*Alnus rubra*	40	18	0.09	4	- growing out from slope with lean in WSW direction towards site **- DIRECT CONFLICT WITH DEVELOPMENT - REMOVE**	Moderate	3	2	2	7	Moderate	No

1) TPZ Multiplier determined based on guidelines provided in *Arboriculture - Integrated Management of Landscaper Trees, Shrubs, and Vines, 4th ed.* (Harris et al., 2004).
2) Where multiple stems were recorded, the recommended TPZ was calculated based on largest dbh.
3) Risk assessment completed based on guidelines outlined in *Tree Risk Assessment in Urban Areas and the Urban/Rural Interface* (Dunster, J., 2009).
4) If a target-rating is 0 (i.e., no targets present), then there are no risks associated with that tree (i.e., Zero Risk).
5) 0-2pts = Zero Risk; 3-5pts = Low Risk; 6-8pts = Moderate Risk; 9-11pts = High Risk; 12pts = Extreme Risk.

Figure



Tree Retention Plan

- • Tree Location
- ○ Optimum TPZ
- ········ Creek Top of Bank
- - - - Riparian Setback
- ── Proposed Building
- ── Proposed Road
- ── Existing Road
- ── Corridor Extension Line
- ── Existing Docks
- ·▲·▲· Foreshore

1:750

0 20 40

Metres

Coordinate System: NAD 1983 UTM Zone 10N

PGL Pottinger Gaherty Environmental Consultants Ltd.

Date: October 4, 2013	Map ID: 1543-09.02_003
Drawn by: RMS	File Number: 1543-09.02

Figure

PGL
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Vancouver, BC Canada V6E 4E6
www.pggroup.com

October 4, 2013
PGL File: 1543-09.01

Via E-mail: **cmelosky@polyhomes.com**

Polygon Development 270 Ltd.
900 –1333 West Broadway
Vancouver, BC
V6H 4C2

Attention: **Cynthia Melosky**
VP Development

RE: NOBLE COVE DEVELOPMENT– 3829–3919 DOLLARTON HIGHWAY, NORTH VANCOUVER, BC

As requested, Pottinger Gaherty Environmental Consultants Ltd. (PGL) is pleased to comment on environmental effects of retaining a beach for recreational purposes at the western edge of the Noble Cove site.

BACKGROUND

PGL has prepared a Habitat Restoration Plan for the Noble Cove site, as part of our assessment of the environmental issues raised by the District of North Vancouver and Port Metro Vancouver. The details of our assessment and restoration plan are included in our report dated April 23, 2013.

The environmental design philosophy is to restore and maximize environmental values on the site as much as possible. In addition to restoring anadromous fish access to Roche Point Creek, the restoration of a significant amount of estuarine and marine riparian and intertidal marsh habitat is planned. This restoration will significantly improve the habitat values of a large section of Burrard Inlet shoreline, and provide greater connectivity between Maplewood Flats and Cates Park. It also meets Port Metro Vancouver objectives of maximizing bankable habitat on the Burrard Inlet North Shore.

POTENTIAL HABITAT VALUE

The best potential for success for restored habitat is to create and maintain continuous zones of habitat behind the shoreline, which mimics a natural shoreline succession. The shoreline contouring and native plant selections are designed to be as close to natural as possible, to maximize habitat value, and enable a self-sustaining plant community. Some of the environmental benefits of this restoration include:

- Rearing/refuge habitat for salmonids;
- Additional sources of leaf litter and insect drop for fish; and
- Higher quality habitat for shore birds and small mammals.

The creation of intertidal marshes to provide rearing/refuge areas for salmonids and other fish species is the most important component of the habitat enhancement plans for Noble Cove, as such habitat is extremely limited (and becoming more scarce) in Burrard Inlet, and in the areas east and west of the site in particular.

BEACH AREA

As indicated in the Habitat Restoration Plan submitted in April, 2013, the small beach area at the western end of the site is scheduled for restoration. Areas 1 and 2 in this drawing indicate the planting of 100m^2 of intertidal marsh habitat and 130m^2 of riparian habitat. Without restoration of this area, that amount of habitat will have to be deleted from the plan, and connectivity across the site would be lost. Allowing public access to the waterfront in this area diminishes the quality of adjacent habitat, due to disturbance of human and dog presence.

Given the Noble Cove development's environmental design objectives, protecting this small beach area for recreational use significantly compromises the Habitat Restoration Plan. Our advice would be to continue to include this area in the habitat restoration plans, as originally designed.

We trust that this meets your needs. If you have any questions or require clarification, please contact Bruce Nidle or Susan Wilkins at 604-895-7609 or 604-895-7621.

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.

Per:

Susan Wilkins.

Susan P. Wilkins, M.Sc., P.Geo., LEED AP
Vice President, Operations

Bruce Nidle

Bruce H. Nidle, B.Sc., R.P.Bio.
Senior Environmental Scientist

SPW/BHN/mlo
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October 4, 2013
PGL File: 1543-09.01

District of North Vancouver
355 West Queens Road
North Vancouver, BC
V7N 4N5

RE: GREEN BUILDING STRATEGY FOR THE POLYGON NOBLE COVE PROJECT – UPDATE

Pottinger Gaherty Environmental Consultants Ltd. (PGL) was retained by Polygon Development 270 Ltd. (Polygon) to assist with their green building strategy for the Noble Cove project. The approach was to develop an energy strategy and demonstrate Built Green Gold equivalency to meet the District of North Vancouver's Green Building Policy.

The design team has completed a detailed review of the Built Green High Density (HD) checklist. We have prepared two separate checklists for the apartments and townhomes (attached) and we are pleased to report that we are able to meet and exceed the Built Green Gold standard for both housing forms.

We have also completed energy modelling using Trane Trace 700 software and the Model National Energy Code for Buildings (MNECB) reference building. For both housing forms, the energy savings outperform the reference building by 33%.

We trust that the above meets your requirements at this stage.

If you have any comments or questions, please contact Susan Wilkins at 604-895-7621.

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.

Per:
Susan Wilkins

Susan Wilkins, M.Sc., P.Geo., LEED AP
Vice President, Operations

SPW/mtl
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Attachments: Built Green HD Checklist – Noble Cove Apartments
Built Green HD Checklist – Noble Cove Townhomes

Built Green HD Checklist – Noble Cove Apartments

PGL

BuiltGreen

BUILT GREEN® High Density (HD) Project Checklist

Items selected must be applied to every unit, except where noted otherwise (i.e.: central systems).

Section 1: 35 Section 2: 14 Section 3: 19 Section 4: 20 Section 5: 15 Section 6: 9 Section 7: 13 TOTAL POINTS: 125

Polygon Homes - Noble Cove APARTMENTS

District of North Vancouver

I. OPERATIONAL SYSTEMS

This section awards points for construction methods and types of products that contribute toward lower energy consumption and/or renewable heating and electrical systems.

Minimum 32 (UNDER REVIEW)

1-1	All ductwork joints and penetrations sealed with low toxic mastic or aerosolized sealant system. Duct mastic is a preferred flexible sealant that can move with the expansion, contraction, and vibration of the duct system components. A high quality duct system greatly minimizes energy loss from ductwork. The additions to the system should be sized and designed to deliver the correct airflow to each room.	**3**	3
1-2	Install individual unit programmable thermostats capable of starting and stopping the system for at least 2 different daily schedules per week (2 pts. total for all units). A set back thermostat regulates the heating/cooling system to provide optimum comfort when the unit is occupied and to conserve energy when it is not. Builders are encouraged to install a central override system to ensure adequate temperatures for building durability (reference minimum temperatures recommended by CMHC).		2
1-3	Install high efficiency heating systems for all units and/or systems serving common areas (min. 90% AFUE gas furnace, min. 85% AFUE oil furnace, or min. 85% AFUE oil/gas boiler). High efficiency condensing furnaces and boilers reduce energy consumption and consequently fossil fuel reliance.	**3**	3
1-4	Calculate design heat loss and properly size HVAC equipment using CSA F280-M90 or ASHRAE/ACCA Standard 183, and/or implement a boiler management system to match the system operation to building loads and optimize controls for maximum energy savings. A properly sized heating and cooling system can reduce costs as well as conserve energy. When properly sized, HVAC equipment will run for longer periods which increases the efficiency and durability of the equipment due to less cycling on and off.	**2**	2
1-5a (new)	Install high efficiency cooling systems for all units and/or systems serving common areas (min. 14 SEER central A/C, or min. ENERGY STAR® window A/C). High efficiency A/C units reduce electricity consumption and associated pollution.		1
1-5	Centrally locate HVAC systems inside the building's heated envelope and reduce duct length. Roof top units are poorly insulated and waste heat is lost to the environment rather than added to the building. High efficiency heating systems with shorter distribution distances require less energy.		1
1-6	Install HVAC systems with variable speed motors (ECM). A variable speed fan motor is designed to vary its speed based on the building's heating and air conditioning requirements. Working in conjunction with the thermostat, it keeps the appropriate air temperature circulating through the building, reducing temperature variances in the home. It also provides greater air circulation and filtration, better temperature distribution, humidify control, higher efficiency and quiet performance.		3
1-7	Units contain multiple heating/cooling zones, thermostatically controlled zones (2 zones = 2pts., 3 zones = 3pts., 4 zones = 4pts.). Efficiency can be significantly improved by only heating or cooling when occupants are present and by only heating/cooling to the exact desired temperature. Different desired temperatures can be set in each room or space and an individual zone can be turned off when not occupied. This type of system results in a dramatic reduction of energy consumption and operating costs.	**2**	2 to 4
1-8	Install ground/water/solar heat pumps (10) or air-source heat pumps (7), either radiant or forced air, to supply majority of space heating and cooling loads. Heat pumps can significantly reduce primary energy use for building heating and cooling. The renewable component displaces the need for primary fuels, which, when burned, produce greenhouse gases and contribute to global warming. Please Note: Effectiveness of heat pumps is related to climate zone and energy costs. Please consult with specialist or engineer to confirm effectiveness.		10
1-9	Provide electricity (1 pt.) and/or natural gas (1 pt.) direct metering for each unit. Direct metering in a Multi Context may require significant additional expenses above and beyond prorated condominium energy fees and holds individuals responsible for energy use.	**1**	1 to 2
1-10	Install and balance an individually controlled active Heat Recovery Ventilator (HRV) and/or solar/geo fresh air pre-heating for each unit (4 pts.) and/or common area (2 pts.) and/or buildings exhaust air (3 pts.) HRVs exhaust return air out of the home while bringing in fresh air for ventilation. The process used to do this takes advantage of the heat in the exhaust air to preheat the incoming air, saving energy.		2 to 9
1-13	Install a district high efficiency domestic hot water heating system, with min. 85% AFUE boiler, or min. 0.67 EF gas storage water heater (3 pts.). Alternatively install an instantaneous "tankless" domestic hot water system in each unit (3 pts.). Hot water heater is direct vented with a closed combustion system, i.e. all air for combustion is taken directly from the outside. A direct system utilizes a co-axial vent pipe (pipe inside a pipe), drawing combustion air in through the outer pipe and exhausting the products of combustion through the inner pipe. A power vented heater exhausts air out of the building via a positive exhaust during main burner operation. Both systems eliminate the need for conventional chimneys or flue systems. A *tankless* water heater does not have a storage tank to keep heated all day, or a pilot light; it burns gas only when you need hot water. This eliminates standby heat loss and its higher efficiency will save on utility costs.	**3**	3

1-13a (new)	Install high efficiency pump drive motors for service water distribution with variable speed/flow capabilities. Pumps with variable speed drive motors operative more efficiently and help reduce electricity consumption.		1
1-14	Hot water storage tanks insulated by manufacturer to a minimum R-15. An insulation blanket will reduce the standby heat loss of the hot water in the tank.		2
1-15	Install solar/air/water/geo (solar fraction >50%) DHW Heating System to supply a minimum of 25% of the peak DHW heating load and 70% of the total DHW energy load. A substantial amount of energy is wasted heating water in a traditional gas system. Using renewable sources will reduce the consumption of non-renewable energy and also reduce green house gas emissions.		2
1-16	Provide roof area (min. 10% area of total) designed for future solar collector (Make solar ready; with solar thermal or PV conduit installed). A roof area with an appropriate slope allows for the effective addition of future solar air, water heating or photovoltaics.		1
1-17	Install urban wind/photovoltaic electrical generation system which supplies (10%-2 pts., 20%-4 pts., 50%-8 pts., 100%-10 pts.) of design electrical load for the private area(s) of the building. This does not include electric heat. Urban wind and photovoltaics use renewable energy to generate electricity for the home, greatly reducing reliance on non-renewable energy sources and also reducing green house gas emissions.		2 to 10
1-18	Install photovoltaic electrical generation system which supplies 50% (1 pt.) or 100% (2 pts.) of electrical needs for the common areas. This does not include electric heat. Photovoltaics use the sun's energy to generate electricity for the home, greatly reducing reliance on non-renewable energy sources and also reducing green house gas emissions.		1 or 2
1-19	50% (2 pts.) or 100% (4 pts.) of electricity used during construction of the project is generated by wind power or equivalent green power certificate. This practice encourages and promotes the use of renewable, sustainable energy resources as well as reducing green house gas emissions.		2 or 4
1-20	50% (2 pts.) or 100% (4 pts.) of electricity used by building during first year of occupancy is generated by wind power or equivalent green power certificate (prepaid by builder). This practice encourages and promotes the use of renewable, sustainable energy resources as well as reducing green house gas emissions.		2 or 4
1-21	Install a central drain water heat recovery, with a minimum of 1 DWHR unit installed per 4 apartments (2 pt.) or per 2 apartments (3 pts.). Drain water heat recovery units enable an exchange of heat from greywater to the incoming water. This pre-heating reduces the amount of energy required for the hot water tank.		1 to 3
1-22	Fireplaces in all units are electric, or gas with sealed combustion and electronic ignition. Sealed combustion fireplaces involve a double-walled special vent supplied by the manufacturer that normally vents through a sidewall in a horizontal position. The inner surface removes the flue gases and the outer container provides for passage of combustion air.		2
1-23	Install fireplace fan kit to circulate warm air into room on all fireplaces. A fan kit allows the heat generated by a fireplace to be transferred into the home more effectively.		2
1-24	All windows in the project are ENERGY STAR® labeled. ENERGY STAR labeled windows save energy by insulating better than standard windows, making the home more comfortable all year round, reducing outside noise and can result in less condensation forming on the window in cold weather.	2	2
1-25	All Electric ranges use below 480 kWh/yr based on EnerGuide rating system. EnerGuide label often reduces fuel consumption by approximately 20%.	1	1
1-26	Refrigerators(1 pt.), dishwashers (1 pt.), clothes washers (1 pt.) and/or combo washer dryer (2 pts.) are all ENERGY STAR® labeled products. An ENERGY STAR label for refrigerator indicates the product has met strict requirements to reduce energy consumption.	3	1 to 4
1-27	All clothes dryers have an energy performance auto sense dry setting which utilizes a humidity sensor for energy efficiency. Sensor saves energy by shutting dryer off when clothes are dry rather than leaving it on for a specified time.	1	1
1-27a (new)	Install ENERGY STAR® labeled bathroom exhaust fans for each unit An ENERGY STAR label for a bathroom exhaust fan indicates the product has met strict requirements to reduce energy consumption.	1	1
1-28	Other building appliances supplied at the time of sale (i.e.. TV, LCDs, security systems) are energy efficient/ENERGY STAR® rated. An ENERGY STAR label indicates the product has met strict requirements to reduce energy consumption.		1
1-29	Exposed Exterior Accessibility Ramps heated with renewable energy or waste heat. This practice encourages and promotes the use of renewable, sustainable energy resources as well as reducing green house gas emissions.		2
1-30	Install properly supported ceiling fan wired rough-in for each unit. Intended to allow for future temperature equalization .		1
1-31	Install interior motion sensor light switches in over 25% (1 pt.), 50% (2 pts.) or 75% (3 pts.) of hallways/corridors and stairwells. Motion sensor switches prevent lights from staying on in rooms that are unoccupied. This helps reduce electricity consumption.	3	1 to 3
1-32	Install lighting with an automation control system capable of unified automation control of lighting loads for all common areas. Lighting and automation control systems prevent lights from staying on in rooms without occupants, thereby reducing electricity consumption.	2	2

1-33	Install automatic lighting system (2 pts.) and/or ventilation system (2 pts.), which are triggered by movement or CO levels, for garages/ parkade. Automating will allow better control and energy efficiency.	2	2 to 4
1-34	Exterior Lighting follows IESNA illuminance requirements for recommended practice manual: Lighting for Exterior Environments. This addresses light pollution issues. The Illuminating Engineering Society of North America can be found online at: iesna.org and the "Lighting for Exterior Environments" guide (IESNA RP-33-99) can be purchased there.	2	2
1-35	Common Area lit with high efficiency (non-incandescent) lamps. Incandescent lights lose much of their energy as heat rather than light and therefore are not as energy efficient as many of the other options available.	1	1
1-36	Minimum 25% (1 pt.), 50% (2 pts.) or 100% (4 pts.) of light fixtures are L.E.D., fluorescent or have compact fluorescent light bulbs installed in each unit. Fluorescent, compact fluorescent and L.E.D bulbs use 50% less energy than standard bulbs and last up to ten times longer.	1	1, 2 or 4
1-37	Minimum 50% of recessed lights in the entire building use halogen bulbs. Halogen bulbs are slightly more energy efficient, last longer and provide a more effective task light than conventional bulbs.	1	1
1-38	All EXIT signs are photo luminescent or LED. Photo luminescent exit signs use no power as the light is supplied by a phosphorous chemical that absorbs light until needed and then emits it.		2
1-39	Air tight, insulation contact-rated recessed lights are used in all insulated ceilings, or insulated ceilings have no recessed lights. Prevent heated air from exhausting through ceiling. Air tight light fixtures lead to a more airtight, energy efficient home.	1	1
	TOTAL SECTION POINTS (min. 32 required):	35	

II. BUILDING MATERIALS

This section deals with building components that make up the structure of the home. Items involve alternatives to using large dimensional lumber, products with a recycled component, utilizing wood products that come from sustainable managed forests and reducing the overall amount of lumber used.

Minimum 10 (UNDER REVIEW)

2-1	Insulated Concrete Forming system (ICF's) used below grade (2 pts.) and/or above grade (2 pts.). Insulating Concrete Forms (ICFs) are hollow building elements made of plastic foam that are assembled, often like building blocks, into the shape of a building's exterior walls. The ICFs are filled with reinforced concrete to create structural walls. Unlike traditional forms, the ICFs are left in place to provide insulation and a surface for finishes.		2 to 4
2-2	Minimum of R-7.5 insulation installed under entire basement/foundation slab under conditioned space. Insulation installed under the basement slab will reduce the downward heat transfer into the ground below the slab, especially when hydronic in-slab heating is installed. Insulation under the slab can reduce temperature swings in the heated space and respond quicker to new changes in thermostat settings.		2
2-3	Attached garage, parking and/or loading dock overhead doors are insulated with R8 to R12 (1 pt.) or greater than R12 (2 pts.). An insulated overhead garage door will reduce heat loss.		1 or 2
2-4	Attached garage/parking walls and ceiling are insulated to NBC minimum (R12 for walls, R34 for ceilings). A fully insulated garage acts as a buffer zone, reducing heat loss.		1
2-5	Non-solvent based damp proofing (seasonal application). Water based damp proofing products use water as a thinner. Oil based damp proofing give off a number of volatile organic compounds (VOCs) as the solvent evaporates after application. These VOCs can be a strong irritant and can add to air pollution.	1	1
2-6	Paint Parkade semi gloss white to reduce number of required lighting fixtures. Using high reflectance white paint allows for fewer lights to be used in the parkade area.	1	1
2-7	Steel studs made from a recycled steel (min. 75%) are used to replace wood studs (min.15%). Recycling steel reduces landfill waste and saves on wood consumption.		1
2-8	Use Optimum Value Engineering (OVE) to reduce wood use in framing: - Exterior and interior wall stud spacing at 24" on-center (2 points) or 19.2" on-center (1 pt.). - Elimination of headers at non-bearing interior and exterior walls. (1 pt.) - Use of header hangers instead of jack studs. (1 pt.) - Elimination of cripples on hung windows. (1 pt.) - Elimination of double plates, use single plates with connectors by lining up roof framing with wall & floor framing (1 pt.) - Use of two stud corner framing with drywall clips or scrap lumber for drywall backing instead of studs. (1 pt.) For more details on Optimum Value Engineering (OVE) framing principles see www.buildingscience .com.	1	1 to 7
2-9	Walls and roof designed as 24" module to reduce waste. A 24" module takes into account the size of sheets of OSB or plywood, stud spacing, carpet size etc.		2
2-10	Use of insulated headers (either manufactured or site built open insulated single headers) with minimum insulation value of R10. Headers can either be insulated on site or can be a pre-manufactured product (often insulated with a foamed plastic).		1

2-11	Install manufactured insulated rim/band joist or build on site by setting back joists to allow rigid insulation filler of a minimum R10. Rim and band joists can either be insulated on site or can be pre-manufactured (often insulated with a foamed plastic).		2
2-12	Structural insulated panel system (SIPS) used for walls (3 pts.) and/or for roofs (2 pts.). Reduces thermal migration and controls air leakage – Keeps heating and cooling costs to a minimum compared to a conventionally framed wall.		2 to 5
2-13	All insulation used in the project is third-party certified to contain a minimum recycled content: 40% (1 pt.) or 50% (2 pts.). Recycled content means less landfill waste and raw material use. Also, according the North American Insulation Manufacturer's Association, insulation with recycled content takes less energy to produce than using all raw materials.	**1**	1 or 2
2-14	Insulation levels meet or exceed the MNECB (may include Roof-R28, Walls R14, Floor R14). Model New Energy Code minimums will help to keep heating and cooling costs to a minimum compared to a conventionally framed wall.	**1**	1
2-15	Replace exterior wood sheathing with installed insulating sheathing. Using rigid insulation instead of wood for exterior sheathing conserves forest resources, reduces thermal migration and controls air leakage; it also keeps heating and cooling costs to a minimum compared to a conventional wall.		2
2-16	Deck (1pt.), balcony surfaces (1pt.), and/or veranda structure (1 pt.) made from a third-party certified sustainable harvested wood source or third-party certified sustainable concrete. The issue of sustainable forest management (SFM) is considered to be of such importance by the Canadian forest industry that, in 1993, a group of 22 organizations representing virtually all of the industry came together to form the Canadian Sustainable Forestry Certification Coalition. The coalition regroups several different certification standards that each have their strengths and weaknesses. For more information, see www.sfms. com. Concrete produced from aggregates derived from a pit or quarry with a valid reclamation plan approved by Materials and Resources Canada or the governing provincial body.		1 to 3
2-17	Dimensional lumber from a third-party certified sustainable harvested source used for floor framing (1 pt.). wall framing (2 pts.), and/or roof framing (1 pt.). Saves old growth forests by using trees from a second generation forest.	**4**	1 to 4
2-18	Environmentally engineered flooring system (i.e.. Uses reclaimed/recycled/rapidly renewable wood waste, fly ash concrete (1pt-30%), recycled steel (1pt-90%)). Use of Engineered floor system saves old growth forest by using components from second generation forests and the use of recycled materials.	**1**	1
2-19	Environmentally engineered products for all load bearing beams (i.e.. Uses reclaimed/recycled/rapidly renewable wood waste, fly ash concrete (30%), recycled steel (90%)). Engineered products include wood products, concrete and recycled steel.		2
2-20	Environmentally engineered products for all exterior window and door headers (i.e.. Uses reclaimed/recycled/rapidly renewable wood waste, fly ash concrete (30%), recycled steel (90%)). Engineered products include wood products, concrete and recycled steel.		1
2-21	Engineered stud material for 10% of stud wall framing. Use of Engineered lumber products saves old growth forest by using components from second generation forests and recycled materials.		1
2-22	Engineered and/or finger-jointed plate material. Use of recycled materials saves old growth forest.		1
2-23	Finger-jointed studs for 90% of non-structural stud wall framing. Use of recycled materials saves old growth forest.	**2**	2
2-25	Recycled content exterior wall sheathing (min. 50% pre or post consumer). Recycled content reduces landfill waste and the use of new materials.		2
2-27	100% Recycled content rainscreen attachment system. Use of recycled content polypropylene, steel or aluminum rainscreen strapping may replace the traditional use of treated wood strapping on rainscreen systems.		2
2-28	Advanced sealing package, non-HCFC expanding foam around window, door openings and all exterior wall penetrations (2 pts.). All sill plates sealed with foam gaskets or a continuous bead of acoustical sealant (1 pt.). Controls air leakage and keeps heating and cooling costs to a minimum.	**2**	1 to 3
2-29	Builder has installed a green roof over 50% (3 pts.), 75% (5 pts.) or 100% of total roof area (7 pts.). Green roofs are defined as a system of plants, growing medium and roof/waterproof membrane that acts as a whole to maximize the available environmental benefits of improving air temperature (reduced heat island effect), air pollution, storm water management and green space. Extensive or 2-6" Thickness typically requires 30-40 lbs./ft^2 structural support, while Intensive roofs (8"-4') require significant structural support.		3, 5 or 7
2-30	Builder has incorporated exterior horizontal and/or vertical shading devices for glazing (2 pts.), or exterior operational shading devices (4 pts.). Shading windows from solar heat gain is a key design strategy for passive cooling and to reduce cooling loads on active HVAC systems in multi buildings. Light shelves and/or louvers can be optimized to allow for winter solar gain, while reducing overheating during the summer.		2 or 4
2-31	All decks or balconies are thermally broken from the envelope by R10 (1 pt.), or fully separated (3 pts.).		1 or 3
	TOTAL SECTION POINTS (min. 10 required):	**14**	

III. EXTERIOR and INTERIOR FINISHES

This section focuses on the finish materials used both inside and outside of the project. The items listed include using longer lasting products, products with recycled content and products that are harvested from third party certified managed forests.

Minimum 10 (UNDER REVIEW)

3-1	Exterior doors with a minimum of 15% recycled, recovered, or third party sustainably harvested content. Recycled or recovered content ensures we keep our landfill use to a minimum.		1
3-2	All exterior doors manufactured from fiberglass. Fiberglass doors insulate better than steel skinned or wood doors, have a longer lifespan, do not warp, twist or crack, and therefore reduce landfill use.		1
3-3	Exterior window frames contain a minimum of 10% recycled, recovered, or third party sustainably harvested content. Reusing materials such as plastics reduces landfill usage, which may not be biodegradable.		1
3-4	Exterior window frames are made from third-party certified sustainable harvested wood. Uses trees from a forest managed system that prevents clear cutting trees, and replants trees to replace from which they've been harvested.		2
3-5	Concrete used in home has a minimum supplementary cementing material of 25% (1 pt.) and/or 40% (2 pts.) and is within the scope of proper engineering practices. For every one tonne of Portland cement generated, eighth tenths of a ton of carbon dioxide is produced. Supplementary cementitious products include fly ash, blast furnace slag as well as metakaolin.	**1**	1 to 2
3-6	Natural cementitious stone/stucco/brick or fiber cement siding – complete or combination thereof for 100% of exterior cladding. Battens are included in cladding. Strong, long lasting, fireproof material.	**4**	4
3-7	Exterior trim and finish is made of recycled content (50% min.) material, durable and fire rated; trim (1 pt.) and/or wall finish (4 pts.). Fiber cement fascia and soffit, made with recycled content from sawmill waste and Portland cement, is a strong, long lasting and fireproof material.		1 to 5
3-8	Exterior trim (3 pts.) and /or siding materials (4 pts.) have recycled and/or recovered-content (min. 50%). Recycled and/or recovered-content trim materials reduce the amount of new material used in production by gluing up miss scraps into large pieces, which conserves natural resources and reduces landfill usage.		3 to 4
3-9	Exterior trim materials are manufactured from OSB . Trim materials manufactured from OSB uses a laminating process to make larger pieces from smaller pieces or strands of wood. The process saves old growth forests by using trees from forest managed systems that prevents clear cutting trees, and replants trees in areas from which they have been harvested.		1
3-10	All exterior trim is clad with pre-finished metal (1 pt. over top wood backings, 2 pts. without wood backings). Trim clad with pre-finished metal is a durable long lasting product that requires no maintenance, reduces waste in landfills due to long life of product.		1 to 2
3-11	Deck or balcony surfaces made from recycled materials: 50% (1 pt.), 75% (2 pts.), 100% (3 pts.), and/or from low maintenance materials (2 pts.) (Deck surfaces should not need maintenance of any kind, including painting, for a minimum of 5 years). Substituting recycled material outdoors avoids the use of pressure treated and high mildew resistant wood that may otherwise be harvested from disappearing old growth or rain forests. Material which lasts longer and reduces landfill usage tends to require little to no maintenance, saving replacement costs and reducing energy spent.	**2**	1,2,3 or 5
3-12	Install 25-year (2 pts.), 30-year (3 pts.), 35-year (4 pts.), 40-year (5 pts.), or 50-year (6 pts.) roofing material -- with manufacturer's warranty. A longer warrantied roof system saves money in replacement costs, and reduces the use of landfills due to the longevity of the product.	**3**	2, 3, 4, 5 or 6
3-13	Minimum 25% recycled-content roofing material. Recycled content roof material reduces the use of new resources, and waste in landfills.		3
3-13a (new)	Use roofing material with a high solar reflectance index (SRI) of ≥78 (for roof slopes ≤ 2:12), or ≥29 (for roof slopes > 2:12). Roofs with a high solar reflectance help cool the building during the summer by reducing the heat island effect.		1
3-14	Interior doors made with recycled or recovered content (min.15%-1 pt.), or from third-party certified sustainably harvested sources (2 pts.). Recycled or recovered content ensures we keep our landfill use to a minimum.		1 to 2
3-16	Domestic wood from reused/recovered or re-milled sources – 500 square foot minimum for flooring or all cabinets or all millwork. Reused, recovered or re-milled sources eliminate the need for new resources, saves energy, transportation costs, and forestry from depletion.		6
3-17	All carpet padding made from natural or recycled textile, or tire waste. Natural or recycled-content carpet padding is a good use of reusable resources. Rebond still qualifies.		2
3-18	Install carpet that has a minimum of 50% recycled content. Recycled-content carpet is a good use of renewable resources, lessens off gases, and improves air quality.		2
3-19	100% recycled or recovered content underlayment or use of concrete finishes to enable the flooring to remain concrete. Concrete finishes such as stamped or stained concrete etc.		1
3-20	Install a minimum of 300 square feet per unit of laminate flooring. Laminate flooring is made up of sustainable raw materials.	**2**	2

3-21	Bamboo, cork or hardwood flooring used in the project (min. 300 square feet per unit installed). Products must be third-party certified to be from managed forests or from certified sustainable sources. Cork flooring comes from stripping the bark off cork oak, which regenerates itself. The cork tiles are moisture, rot and mold resistant, providing a floor that can last over 30 years. Bamboo flooring is a good use of natural resources because it is fast growing, durable and flexible.		3
3-22	All ceramic tile installed in the project has a minimum of 25% recycled-content. Reduces landfill usage.	2	2
3-23	MDF casing and baseboard used throughout the project. MDF casing is created from sawdust and glues, utilizing all wood waste to create usable product.	1	1
3-24	Finger-jointed casings, baseboards and jambs used throughout the project. Finger-jointed casing and baseboards maximize wood usage, buy using small pieces of wood glued together to create longer pieces. The process saves old growth forests by using trees from forest managed systems that prevents clear cutting trees, and replants trees in areas from which they have been harvested.	1	1
3-25	Solid hardwood trim from third party certified sustainable harvested sources approved for millwork (2 pts.) and/or cabinets (2 pts.). This process saves old growth forests by using trees from forest managed systems that prevents clear cutting trees, and replants trees in areas from which they have been harvested.		2 to 4
3-26	Paints or finishes with minimum of 20% recycled content. Paints or finishes made form recycled content are environmentally friendly because recycling paint reduces the hazardous waste in landfills.	1	1
3-27	Natural granite, concrete, recycled glass or stone countertops in 100% of the kitchens (2 pts.) and all other countertop areas (1 pt.). Natural product is more durable; easy to clean and maintain and is resistant to heat and scoring.		1 to 3
3-28	100% agricultural waste or 100% recycled wood particle board used for shelving. Products such as wheat board are made from agricultural waste.		2
3-29	PVD finish on all door hardware (1 pt.) PVD finish on all faucets (1 pt.). Physical Vapor Disposition (PVD) provides a more durable product; no toxic wastes are produced making it.	2	1 to 2
	TOTAL SECTION POINTS (min. 10 required):	**19**	

IV. INDOOR AIR QUALITY

This section focuses on the quality of the air within the finished project. Products listed here include materials that are low in VOC's, products made from all natural materials as well as various air cleaning and ventilation systems.
Minimum 15 (UNDER REVIEW)

4-1	Install pleated media filter (1 pt.) or an electrostatic air cleaner (2 pts.) or an electronic air cleaner (3 pts.) or a HEPA filtration system (6 pts.) or an ultraviolet air purifier (2 pts.) in conjunction with the HVAC system. *Pleated air filters* are made with material that has been pleated or folded to provide more surface area. These pleated air filters are often the most efficient of all the media air filter types and are a whole house air filter. By increasing the surface area for collecting dust, airflow through the pleated air filter is less restricted. The *electrostatic air cleaner* is a permanent washable air filter that traps and removes airborne particles from the air before being circulated through the furnace and into the home. An *Electronic Air Cleaner* offers a superior level of filtration by using advanced, 3-stage filtration technology to trap and filter airborne particles like dust, cat dander and smoke. It works by placing an electric charge on airborne particles, and then collecting the charged pollutants like a magnet. The air cleaner cells can be washed in your dishwasher or sink. *HEPA* stands for High-Efficiency Particle Arresting. HEPA filtration offers the highest particulate removal available - 99.97% of particles that pass through the system including dust, cat dander, certain bacteria, pollens and more. The system is connected to the cold air return of the forced air heating/cooling system which provides a whole house filtration system.		1,2, 3 or 6
4-2	Install power drum humidifier (1pt.) or a drip type humidifier (2 pts.) in conjunction with the HVAC system. Proper humidity provides a more comfortable living environment at a lower temperature, so you can turn down your thermostat for energy savings. Controlling humidity also means moisturizing dry air to prevent damage to hardwood floors and woodwork. Power drum humidifiers direct the heated air through a water-laden evaporator sleeve which absorbs moisture and then returns to the heating system for distribution throughout the home.		2
4-4	Install in-line ventilation fan with programmable timer (separate switch from lighting) in each unit. A programmable timer ensures necessary, regular, automatic mechanical ventilation of the housing units.		1
4-5	Install passive Heat Recovery Ventilator (HRV-2 pts.) or an active Heat Recovery Ventilator/ Energy Recovery Ventilator (HRV or ERV- 4pts.) in each unit . A Heat Recovery Ventilator (HRV) is an air exchanger that exhausts humid, stale, polluted air out of the housing unit and draws in fresh, clean outdoor air. Invisible pollutants produced by common household substances, plus dust and excess humidity that get trapped in today's houses, can increase your risk of chronic respiratory illness and your home's risk of serious structural damage. A passive HRV unit does not have its own internal fan and is 100% furnace assisted. It works by tying the exhaust side of the unit to the supply air plenum which forces air to exhaust from the housing unit and at the same time fresh air enters from outside through the unit and into the cold air return duct work. Much like the HRV the ERV recovers heat. It also recuperates the energy trapped in moisture; this greatly improves the overall recovery efficiency. In dry climates and humidified homes the ERV limits the amount of moisture expelled from the home. In humid climates and air conditioned homes, when it is more humid outside than inside, the ERV limits the amount of moisture coming into the housing unit.		2 to 4
4-6	Install thermostat that indicates the need for the air filter to be changed or cleaned. This feature displays filter maintenance reminders on the thermostat. Regular furnace maintenance is required to keep your mechanical equipment running efficiently and problem free as well as ensuring a healthy indoor air environment.		1
4-6 a (new)	Install bathroom exhaust fan controls in each unit using either an occupancy sensor, automatic humidistat controller, automatic timer, or continuously operating exhaust fan. Bathroom exhaust fan controls increase occupant comfort by further controlling indoor moisture and odour levels.	1	1

4-6 b (new)	Install timer switches or occupancy sensors on all local exhaust fans outside of individual units (i.e. laundry, recreation, storage areas, etc.). Operating of local exhaust fans only when necessary using controls helps reduce heat loss of interior air to outside, and also reduces electrical consumption by reducing duration of fan operation.		1
4-6 c (new)	For indoor pool areas, install a designated dehumidification system designed by a consulting engineer or qualified contractor to match the water and air temperatures maintained in the area. Dehumidification systems serving pool areas eliminate the need to exhaust large quantities of indoor air, therefore reducing heat loss.		1
4-6 d (new)	For all permanent entryways leading from outdoors, install an entryway system of at least 10 feet in length to captures dirt and particulates (i.e. grates/grills/slotted systems, or roll-out mats that are maintained weekly by a service organization). Entryway systems that capture dirt and particulates from outdoors help reduce occupants exposure to indoor airborne contaminants		2
4-7	All combustion space and water heating equipment located within building are sealed with no possibility of backdraft. Sealed-combustion appliances draw all their combustion air from the outdoors, which eliminates any chance of back drafting. This feature is especially helpful in well sealed buildings. These types of appliances do not negatively affect indoor air quality.		3
4-8	Install hardwired carbon monoxide detector within each unit, if combustion spillage susceptible appliances are used in the building. Carbon monoxide detectors warn against high levels of toxic carbon monoxide.	1	1
4-9	Seal all permanent ductwork upon installation, removing seals once all phases of construction are complete (1 pt.), and/or power vacuum all HVAC ducting prior to occupancy (1 pt.). This process helps eliminate pollutants that drop into the HVAC ducting during the construction process from being circulated into the housing unit.		2
4-9 a (new)	Flush out each unit with fresh air for at least 48 hours after all construction phases and prior to occupancy by opening all exterior windows and interior doors and running ventilation system. Flushing out units with fresh air after construction helps reduce occupants' exposure to indoor airborne contaminants from dust, VOCs and other particulates that have accumulated during construction		2
4-11	All insulation in the project is third-party certified as low or zero formaldehyde. Formaldehyde may cause eye, nose, and throat irritation, headaches, loss of coordination, nausea, damage to liver, kidney, and central nervous system .		2
4-12	Third-party certified low formaldehyde sub floor sheathing. Formaldehyde is colorless gaseous organic compound, water soluble, with a characteristic pungent and stifling smell. Building materials low in or free of formaldehyde glues are used in the floor underlayment, cabinetry and elsewhere to protect the indoor air quality.		3
4-13	Third-party certified low formaldehyde underlayment is used in the project. (ANSI A208.1 – 2009 concentration ≤0.21 ppm). Low formaldehyde (phenol) and formaldehyde-free binders (PMDI) are available and becoming more common. FSC certified OSB is becoming more common, reducing environmental impacts on air, water, social quality.	1	1
4-14	Low formaldehyde particle board/MDF used for cabinets (ANSI A208.2 – 2009 concentration ≤ 0.21 ppm). Urea formaldehyde-free fibreboard can be used in the same way as conventional fibreboard, but with the added caution of greater potential for water damage.		1
4-15	Low formaldehyde particle board/MDF used for shelving (ANSI A208.2 – 2009 concentration ≤ 0.21 ppm).		1
4-16	Zero formaldehyde particle board/MDF used for cabinets (2 pts.) and/or for shelving (2 pts.). Cabinets made from formaldehyde free particleboard or MDF eliminate the Volatile Organic Compounds (VOC) that off gas into the home, resulting in healthier indoor air quality.		2 to 4
4-17	All interior wire shelving is factory powder coated. Vinyl coating on conventional shelving units off gas VOC toxins.	2	2
4-18	Water-based urethane finishes used on all site-finished wood floors. Water-Based Epoxy: Generally referred to as "epoxy-modified finish," water-based epoxy finish differs from its solvent-based counterpart in that the epoxy resin is itself the catalyst for an acrylic or urethane resin.		2
4-19	All wood or laminate flooring in the project is factory finished. Installing a pre-finished floor eliminates the time, the dust and the odors associated with the on-site sanding and finishing of an unfinished product.	2	2
4-20	Water-based Lacquer or paints are used on all site built and installed millwork, including doors, casing and baseboards. Water based interior finish products reduces VOC off-gassing which improves indoor air quality.	3	3
4-21	Interior paints are used that have low VOC content (2 pts.--Standards are < 150 grams/liter of VOCs) and/or interior paint is used that has no VOC's in base paint--prior to tint (3 pts.). Volatile Organic Compounds (VOC) are a class of chemical compounds that can cause short or long-term health problems. A high level of VOCs in paints/finishes off gas and can have detrimental effects to a building's indoor air quality and occupant health. Any paint with VOC's in the range of 5 grams/litre or less can be called "Zero VOC", according to an EPA standard. Some manufacturers may claim "Zero-VOC's", but these paints may still use colorants, biocides and fungicides with some VOC's. Adding a color tint usually brings the VOC level up to 10 grams/liter, which is still quite low.	5	2 to 5

4-22	Carpet and Rug Institute (CRI) IAQ label on all carpet used in units (2 pts.) and/or on all underlay used in units (1 pt.). To identify carpet products that are truly low-VOC, CRI has established a labeling program. The green and white logo displayed on carpet samples, of the CRI Indoor Air Quality Carpet Testing Program, in showrooms informs the consumer that the product type has been tested by an independent laboratory and has met the criteria for very low emissions. The adhesives used to install carpets and the latex rubber by some manufacturers to adhere face fibers to backing materials generate volatile organic compounds (VOCs). Carpets also cover large surfaces within an interior environment and can provide "sinks" for the absorption of VOCs from other sources.	3	1 to 3
4-23	Natural wool carpet in all living areas. Natural wool carpets are durable and use less secondary backing materials and chemicals. Off gassing is typically caused by the secondary backings and chemical additives in synthetic carpets, for controlling mildew, fungus, fire and rot.		2
4-24	All vinyl sheet flooring is installed with low VOC adhesives (1 pt.--Low VOC = standard is < 60 grams per litre), and/or is replaced by hard surface flooring (2pts.), and/or is replaced by natural linoleum (1pt.). Low VOC adhesive or backing minimizes the amount of VOC off-gassing, therefore improving IAQ.	1	1 to 4
4-26	All ceramic tiles are installed with low VOC adhesives and plasticizer-free grout. (Low VOC = standard is less than 65 grams per litre). Most adhesives are still based on SB latex, which releases large quantities of volatile organic compounds (VOCs). The volatile solvents are used to emulsify (or liquefy) the resin that acts as the bonding agent. However, water-based adhesives emit far less VOCs than their conventional solvent based counterparts. There are three types of low-VOC formulas: water-based (latex and acrylics); reactive (silicone and polyurethane); and exempt solvent-based (VOC-compliant solvents). While all three technologies yield low- or zero-VOC caulks, sealants, and adhesives, their performance is slightly different.	1	1
4-28	All carpet in units are replaced by hard surface flooring. Hard surface flooring is generally more durable and improves the IAQ within a building. Carpets collect dust, dust mites and other allergens which when disturbed become airborne particulates, directly affecting the health of the occupants.		4
	TOTAL SECTION POINTS (min. 15 required):	20	

V. WASTE MANAGEMENT

This section deals with the handling of waste materials on the construction site and encourages recycling.
Minimum 7 (UNDER REVIEW)

5-1	Comprehensive recycling program for building site including education, site signage and bins. A comprehensive recycling program that is strictly followed significantly reduces the amount of waste ending up in landfills. Currently it is estimated that up to 50% of landfill waste is construction related.	2	2
5-2	Collection of waste materials from site by a waste management company that is a current member of a provincial recycling council or equivalent association and verifies that a minimum of 10% of the materials collected from the construction site have been recycled. Not only does this reduce overall waste of product, it ensures that as much product as possible is being utilized for the production of future resources.		4
5-3	Suppliers and Trades recycle their own waste. (1 pt. per trade, max. 4 pts.). Trades being responsible for recycling and removal of waste not only reduces landfill waste, but also promotes a cleaner and safer working environment.	4	1 to 4
5-4	Minimum 25% (2 pts.) or 50% (4 pts.) by weight of waste materials collected from construction site is diverted from waste stream. Trades being responsible for recycling and removal of waste not only reduces landfill waste, but also promotes a cleaner and safer working environment.	2	2 or 4
5-5	Use of recycled materials derived from local construction sites (1 pt. for each different product used, max of 3 pts.). Products recycled from the construction site, such as mulched wood cut offs or mulched gypsum are often useable as either clay/ soil water retention additives or for organic burning.		1 to 3
5-6	Trees and natural features on site protected during construction. The protection of existing trees and other natural features such as streams, ponds and other vegetation reduces environmental impact, and ecosystem impact. Many of these features can be protected simply by following good waste management procedures.	1	1
5-7	Shared transportation benefits: provide one parking stall for a car-sharing vehicle (1 pt.), and/or a car sharing vehicle as one component of condominium association (3 pts.) and/or bicycle storage on site (1 pt.). Providing a vehicle to share allows occupants to live without their own vehicle and using the shared vehicle when needed. Provision of covered storage facilities for securing bicycles on site encourages the use of alternative transportation.	1	1 to 5
5-8	Metal or engineered durable form systems used for concrete foundation walls. The use of metal forming systems reduces the requirement of lumber, a limited resource.	1	1
5-9	Reusable bracing is used for framing. The use of reusable bracing for framing reduces the requirement of lumber, a limited resource.	1	1
5-10	Install built-in recycling center with two or more bins in each unit (2 pts.) and/or provide composter to each unit (1 additional pt.). By installing built in recycling centers, which can be as simple as labeled containers (paper, cardboard, cans, plastics, etc.). Occupants are more likely to utilize the pre-existing facilities and thus contribute to the reduction in landfill waste. Providing a composter promotes a reduction in wastes heading to the landfill by giving occupants an option for organic waste such as food leftovers.	2	2 to 3

5-11	Provide a central recycling center for the housing project (1 pt.--min. of paper, glass and tin recycling) and/or install trash compactor for unit or building (1 pt.). Providing a recycling center will promote recycling among the occupants. Installing a trash compactor, while not actually reducing the mass of waste, does help by reducing it's volume, which over time can make a significant difference to landfill levels.	1	1 to 2
	TOTAL SECTION POINTS (min. 7 required):	15	

VI. WATER CONSERVATION

This section encourages a reduction in the amount of water used in the home or in individual units within multi story buildings.

Minimum 7 (UNDER REVIEW)

6-1	CSA approved single flush toilet averaging 1.6 GPF or less installed in all bathrooms. Lower flow toilets can save a substantial amount of water over time.		2
6-2	Install a dual flush or 1.2 GPF toilet in one or more bathrooms in each unit (2 pts. for one bathroom, 3 pts. for all) These toilets offer a choice between two water levels for every flush: 1.6 GPF (6 LPF) or 0.8 GPF (3 LPF).	2	2 or 3
6-3	Install waterless urinals in men's public facilities. The Average public urinal uses approximately 400 litres of water/day or 3.8- 10 litres per flush. Waterless urinals are more sanitary, reduce maintenance, installation costs and are only marginally more expensive to purchase.		1
6-4	Insulate the first three feet of the water lines on the hot water tank with flexible pipe insulation where units contain independent DHW system (1 pt.) and/or insulate all hot water lines to all locations (2 pts.). Minimizing the heat loss in the water line will decrease the initial water wasted by delivering hot water faster. Minimizing the heat loss in the water line will decrease the initial water wasted by delivering hot water faster.		1
6-5	Install hot water recirculation line. Having the hot water re-circulated from the hot water source to the fixture points will decrease the initial water wasted by delivery the hot water faster.	3	3
6-6	Install low flow faucet aerators on all bathroom and kitchen sinks (1 pt.) and/or install hands free lavatory or kitchen faucets in each unit (4 pts.). Low flow faucets may be included if flow rate is a maximum of 3.8 L/ minute on bathroom sinks and/or 6.8 L/minute on kitchen sinks. Battery powered electronic sensor minimizes the spread of germs and saves water.	1	1 to 5
6-7	Supply front loading clothes washer in each unit. Front loading clothes washers conserve water by design, as they are only required to fill up the washing compartment 1/3 full to effectively wash clothing. Additionally they use up to 75% less environmentally damaging laundry detergent. AND they also conserve electrical or gas energy by significantly reducing drying time for clothes with a more thorough spin cycle.		3
6-8	Install water saving dishwasher that uses less than 26.0 L/water per load in each unit. Water saving dishwasher uses technology to reduce both the amount of water required as well as electrical energy requirements. The EnerGuide appliance directory put out by Natural Resources Canada has a comprehensive listing of all manufacturers and models of dishwashers and other appliances with water usage and energy efficiency ratings.	1	1
6-9	Install permeable paving materials for driveways and walkways (min. 70% of hardscape area). Permeable paving materials allow rainwater to flow back into the ground instead of into storm sewers.		1
6-9 a (new)	Design all impermeable hardscape surfaces to direct rainwater to an on-site infiltration feature (i.e. vegetated swale, rain-garden, cistern, etc.) Designing for on-site infiltration allows rainwater to flow back into the ground instead of into storm sewers.		1
6-10	Install a water meter in every unit. Installing a water meter in each unit makes the occupants more aware or and responsible for water use.		3
6-11	Install Efficient Irrigation Technology that has head-to-head coverage (1 pt.), a central shut-off valve (1 pt.), a sub meter (1 pt.), uses drip irrigation for at least 50% of planting bed area (1 pts.), has a pressure regulating device to reduce (1 pt.), high efficiency nozzles with a distribution uniformity of ≥ 0.7 (1pt.), and/or motion sensor/rain delay controller (1 pt.). Max. 3 points can be claimed. Water efficient irrigation systems that include sensors, regulators, micro drip feed systems etc. help reduce the demand on the municipal water system.		1 to 3
6-12	Provide a list of drought tolerant plants and a copy of the local municipality water usage guide to building owner with closing package. Most municipalities provide a guide that gives the water requirements of various plants and grasses. When properly designed, landscaping choices can significantly contribute to water conservation.		1
6-13	Reduce lawn/turf to 50% of landscaped area. Lawns require a large amount of water to maintain. By reducing the amount of lawn, water use can also be reduced.	1	1
6-14	Builder captures rainwater for use in atrium, patio garden feature, landscaping and/or indoor water use. Using rainwater helps with stormwater management, and also reduces demand on the municipal water system	1	1
6-15	Greywater is collected, treated and reused throughout the project for landscaping and/or indoor water use. Reusing greywater helps reduce demand on the municipal water system		5
	TOTAL SECTION POINTS (min. 7 required):	9	

VII. BUSINESS PRATICE

This section deals more with manufacturers and builders office and business practices

Minimum 9 (UNDER REVIEW)

7-1	Products used for the project are manufactured within 800 km. (1 pt. for each product to a max. of 5 products). Products made closer to the location of use will have less embodied energy. Basically this means that the shorter the transportation distance the less energy used in moving the product. Less energy used means fewer emissions.	5	1 to 5
7-2	Builder provides BUILT GREEN building owner manual and/or educational walkthrough and/or Green systems manual for building managers. Building owner education is an important component to any high performance building. If the technology is not used correctly, it will diminish the efficiency.		2
7-3	Builders office and show homes purchase a minimum of 50% (1 pt.) up to 100% (2 pts.) solar, wind or renewable energy. Wind Energy is a cleaner way to provide energy. Lower emissions benefit the environment.		1 to 2
7-4	Manufacturers and/or suppliers purchase 50% or more solar, wind or renewable electricity. Wind Energy is a cleaner way to provide energy. Lower emissions benefit the environment.		1
7-5	Builder supplies a minimum of 8" of topsoil as finish grading throughout site. Compared to subsoil materials, topsoils usually have higher aggregate stability, lower bulk density, and more favourable pore size distributions which leads to higher hydraulic conductivity, water-holding capacity, and aeration porosity.	2	2
7-6	Development site provides community amenity space for not for profit community services. Floor area made available to the City for not-for-profit community use. (I.e., Assemblies, offices, educational facilities etc.).		2
7-7	Development site provides for Publicly Accessible Private Space . I.e., Atriums, open courtyards etc. which are part of the residential project but have links to/for public access.		1
7-8	Development includes a diversity of housing types including 20% live/work units (2pts.), 25% mixed use (2 pts.) facilities and/or 20% with separate basement suite units (2pts.) This type of development encourages neighborhoods where people can live, work, shop etc. without having to drive.		2 to 6
7-9	Builder has written environmental policy which defines their commitment (which must include an office recycling program and energy efficient lighting). A statement of commitment helps to emphasize priority and ultimately define a corporate culture.		1
7-10	Manufacturer and/or supplier has a written environmental policy which defines their commitment (this must include an office recycling program and energy efficient lighting). (1 pt. per supplier/manufacturer, max. of 2 pts.). Doing business with others committed to the environment helps to promote the ideals of being earth friendly.	2	1 to 2
7-11	Builder has written an environmental policy which prioritizes milestones for future net zero housing developments. The next step toward easing our reliance on non-renewable energy is net zero housing. Net zero houses produce as much energy as they consume using renewable sources such as solar, thermal, wind, geoexchange etc.	1	1
7-12	Make provision Truck Management Plan, to avoid high congestion areas during construction. A truck management plan would minimize the impact of trucks in the construction neighborhood. Features include scheduled arrivals/departures, reuse of materials to reduce truck traffic, communication with community and specific hours of work designated.	1	1
7-13	Delivery Area wheel washed/ treated during construction. Wheel wash area will cut down on dust pollution in the neighborhoods where construction is taking place.	1	1
7-14	Builder's company vehicles are hybrid or bio-diesel vehicles (1 pt. per vehicle to max. of 3 pts.). A commitment to the environment shouldn't stop at construction. Using a hybrid vehicle produces lower harmful emissions. Diesel construction vehicles converted to bio-diesel reduce fuel consumption by up to 75%.	1	1
7-15	Builder uses radiantly supplied cold weather construction practice. Propane heaters under tarps are often inefficient; this results in a great deal of wasted energy while reducing the quality of workmanship. Alternatives may include manufacturing components indoors.		1
7-16	Environmental certification for builder's place of business (building, office etc.). Many commercial buildings have been rated with various energy efficiency standards. Does your company work within an ENERGY STAR or LEED certified office building?		3
7-17	Builder agrees to construct and label a min. of 50% of all projects to the BUILT GREEN standard per calendar year. (3 pts. for 50% or 5 pts. for 100%). A commitment to the environment from the builder can expand energy efficiency exposure to a large number of home owners and other home builders. Every BUILT GREEN project that is built is a reduction in material use, a reduction of green house gas emissions, less waste and better efficiency.		3 or 5
7-18	Contracted trades and/or suppliers have successfully taken BUILT GREEN Builder Training. (1 pt. per company, max 3 pts.). Using trades or suppliers who have successfully taken Built Green Builder Training means that there is common understanding about what needs to be done and how it will be accomplished, streamlining the process.		1 to 3
	TOTAL SECTION POINTS (min. 9 required):	13	
	TOTAL CHECKLIST POINTS	125	

Built Green HD Checklist – Noble Cove Townhomes

PGL

BUILT GREEN® High Density (HD)
Project Checklist

Items selected must be applied to every unit, except where noted otherwise (i.e.: central systems).

Section 1: 33 Section 2: 14 Section 3: 19 Section 4: 21 Section 5: 15 Section 6: 7 Section 7: 13 TOTAL POINTS: 122

Polygon Homes - Noble Cove TOWNHOMES

District of North Vancouver

I. OPERATIONAL SYSTEMS

This section awards points for construction methods and types of products that contribute toward lower energy consumption and/or renewable heating and electrical systems.

Minimum 32 (UNDER REVIEW)

1-1	All ductwork joints and penetrations sealed with low toxic mastic or aerosolized sealant system. Duct mastic is a preferred flexible sealant that can move with the expansion, contraction, and vibration of the duct system components. A high quality duct system greatly minimizes energy loss from ductwork. The additions to the system should be sized and designed to deliver the correct airflow to each room.	**3**	3
1-2	Install individual unit programmable thermostats capable of starting and stopping the system for at least 2 different daily schedules per week (2 pts. total for all units). A set back thermostat regulates the heating/cooling system to provide optimum comfort when the unit is occupied and to conserve energy when it is not. Builders are encouraged to install a central override system to ensure adequate temperatures for building durability (reference minimum temperatures recommended by CMHC).	**2**	2
1-3	Install high efficiency heating systems for all units and/or systems serving common areas (min. 90% AFUE gas furnace, min. 85% AFUE oil furnace, or min. 85% AFUE oil/gas boiler). High efficiency condensing furnaces and boilers reduce energy consumption and consequently fossil fuel reliance.	**3**	3
1-4	Calculate design heat loss and properly size HVAC equipment using CSA F280-M90 or ASHRAE/ACCA Standard 183, and/or implement a boiler management system to match the system operation to building loads and optimize controls for maximum energy savings. A properly sized heating and cooling system can reduce costs as well as conserve energy. When properly sized, HVAC equipment will run for longer periods which increases the efficiency and durability of the equipment due to less cycling on and off.	**2**	2
1-5a (new)	Install high efficiency cooling systems for all units and/or systems serving common areas (min. 14 SEER central A/C, or min. ENERGY STAR® window A/C). High efficiency A/C units reduce electricity consumption and associated pollution.		1
1-5	Centrally locate HVAC systems inside the building's heated envelope and reduce duct length. Roof top units are poorly insulated and waste heat is lost to the environment rather than added to the building. High efficiency heating systems with shorter distribution distances require less energy.		1
1-6	Install HVAC systems with variable speed motors (ECM). A variable speed fan motor is designed to vary its speed based on the building's heating and air conditioning requirements. Working in conjunction with the thermostat, it keeps the appropriate air temperature circulating through the building, reducing temperature variances in the home. It also provides greater air circulation and filtration, better temperature distribution, humidity control, higher efficiency and quiet performance.		3
1-7	Units contain multiple heating/cooling zones, thermostatically controlled zones (2 zones = 2pts., 3 zones = 3pts., 4 zones = 4pts.). Efficiency can be significantly improved by only heating or cooling when occupants are present and by only heating/cooling to the exact desired temperature. Different desired temperatures can be set in each room or space and an individual zone can be turned off when not occupied. This type of system results in a dramatic reduction of energy consumption and operating costs.		2 to 4
1-8	Install ground/water/solar heat pumps (10) or air-source heat pumps (7), either radiant or forced air, to supply majority of space heating and cooling loads. Heat pumps can significantly reduce primary energy use for building heating and cooling. The renewable component displaces the need for primary fuels, which, when burned, produce greenhouse gases and contribute to global warming. Please Note: Effectiveness of heat pumps is related to climate zone and energy costs. Please consult with specialist or engineer to confirm effectiveness.		10
1-9	Provide electricity (1 pt.) and/or natural gas (1 pt.) direct metering for each unit. Direct metering in a Multi Context may require significant additional expenses above and beyond prorated condominium energy fees and holds individuals responsible for energy use.	**2**	1 to 2
1-10	Install and balance an individually controlled active Heat Recovery Ventilator (HRV) and/or solar/geo fresh air pre-heating for each unit (4 pts.) and/or common area (2 pts.) and/or buildings exhaust air (3 pts.) HRVs exhaust return air out of the home while bringing in fresh air for ventilation. The process used to do this takes advantage of the heat in the exhaust air to preheat the incoming air, saving energy.		2 to 9
1-13	Install a district high efficiency domestic hot water heating system, with min. 85% AFUE boiler, or min. 0.67 EF gas storage water heater (3 pts.). Alternatively install an instantaneous "tankless" domestic hot water system in each unit (3 pts.). Hot water heater is direct vented with a closed combustion system, i.e. all air for combustion is taken directly from the outside. A direct system utilizes a co-axial vent pipe (pipe inside a pipe), drawing combustion air in through the outer pipe and exhausting the products of combustion through the inner pipe. A power vented heater exhausts air out of the building via a positive exhaust during main burner operation. Both systems eliminate the need for conventional chimneys or flue systems. A *tankless* water heater does not have a storage tank to keep heated all day, or a pilot light; it burns gas only when you need hot water. This eliminates standby heat loss and its higher efficiency will save on utility costs.		3

1-13a (new)	Install high efficiency pump drive motors for service water distribution with variable speed/flow capabilities. Pumps with variable speed drive motors operative more efficiently and help reduce electricity consumption.		1
1-14	Hot water storage tanks insulated by manufacturer to a minimum R-15. An insulation blanket will reduce the standby heat loss of the hot water in the tank.		2
1-15	Install solar/air/water/geo (solar fraction >50%) DHW Heating System to supply a minimum of 25% of the peak DHW heating load and 70% of the total DHW energy load. A substantial amount of energy is wasted heating water in a traditional gas system. Using renewable sources will reduce the consumption of non-renewable energy and also reduce green house gas emissions.		2
1-16	Provide roof area (min. 10% area of total) designed for future solar collector (Make solar ready; with solar thermal or PV conduit installed). A roof area with an appropriate slope allows for the effective addition of future solar air, water heating or photovoltaics.		1
1-17	Install urban wind/photovoltaic electrical generation system which supplies (10%-2 pts., 20%-4 pts., 50%-8 pts., 100%-10 pts.) of design electrical load for the private area(s) of the building. This does not include electric heat. Urban wind and photovoltaics use renewable energy to generate electricity for the home, greatly reducing reliance on non-renewable energy sources and also reducing green house gas emissions.		2 to 10
1-18	Install photovoltaic electrical generation system which supplies 50% (1 pt.) or 100% (2 pts.) of electrical needs for the common areas. This does not include electric heat. Photovoltaics use the sun's energy to generate electricity for the home, greatly reducing reliance on non-renewable energy sources and also reducing green house gas emissions.		1 or 2
1-19	50% (2 pts.) or 100% (4 pts.) of electricity used during construction of the project is generated by wind power or equivalent green power certificate. This practice encourages and promotes the use of renewable, sustainable energy resources as well as reducing green house gas emissions.		2 or 4
1-20	50% (2 pts.) or 100% (4 pts.) of electricity used by building during first year of occupancy is generated by wind power or equivalent green power certificate (prepaid by builder). This practice encourages and promotes the use of renewable, sustainable energy resources as well as reducing green house gas emissions.		2 or 4
1-21	Install a central drain water heat recovery, with a minimum of 1 DWHR unit installed per 4 apartments (2 pt.) or per 2 apartments (3 pts.). Drain water heat recovery units enable an exchange of heat from greywater to the incoming water. This pre-heating reduces the amount of energy required for the hot water tank.		1 to 3
1-22	Fireplaces in all units are electric, or gas with sealed combustion and electronic ignition. Sealed combustion fireplaces involve a double-walled special vent supplied by the manufacturer that normally vents through a sidewall in a horizontal position. The inner surface removes the flue gases and the outer container provides for passage of combustion air.	**2**	2
1-23	Install fireplace fan kit to circulate warm air into room on all fireplaces. A fan kit allows the heat generated by a fireplace to be transferred into the home more effectively.	**2**	2
1-24	All windows in the project are ENERGY STAR® labeled. ENERGY STAR labeled windows save energy by insulating better than standard windows, making the home more comfortable all year round, reducing outside noise and can result in less condensation forming on the window in cold weather.	**2**	2
1-25	All Electric ranges use below 480 kWh/yr based on EnerGuide rating system. EnerGuide label often reduces fuel consumption by approximately 20%.	**1**	1
1-26	Refrigerators(1 pt.), dishwashers (1 pt.), clothes washers (1 pt.) and/or combo washer dryer (2 pts.) are all ENERGY STAR® labeled products. An ENERGY STAR label for refrigerator indicates the product has met strict requirements to reduce energy consumption.	**3**	1 to 4
1-27	All clothes dryers have an energy performance auto sense dry setting which utilizes a humidity sensor for energy efficiency. Sensor saves energy by shutting dryer off when clothes are dry rather than leaving it on for a specified time.	**1**	1
1-27a (new)	Install ENERGY STAR® labeled bathroom exhaust fans for each unit An ENERGY STAR label for a bathroom exhaust fan indicates the product has met strict requirements to reduce energy consumption.	**1**	1
1-28	Other building appliances supplied at the time of sale (i.e.. TV, LCDs, security systems) are energy efficient/ENERGY STAR® rated. An ENERGY STAR label indicates the product has met strict requirements to reduce energy consumption.		1
1-29	Exposed Exterior Accessibility Ramps heated with renewable energy or waste heat. This practice encourages and promotes the use of renewable, sustainable energy resources as well as reducing green house gas emissions.		2
1-30	Install properly supported ceiling fan wired rough-in for each unit. Intended to allow for future temperature equalization .	**1**	1
1-31	Install interior motion sensor light switches in over 25% (1 pt.), 50% (2 pts.) or 75% (3 pts.) of hallways/corridors and stairwells. Motion sensor switches prevent lights from staying on in rooms that are unoccupied. This helps reduce electricity consumption.		1 to 3
1-32	Install lighting with an automation control system capable of unified automation control of lighting loads for all common areas. Lighting and automation control systems prevent lights from staying on in rooms without occupants, thereby reducing electricity consumption.		2

1-33	Install automatic lighting system (2 pts.) and/or ventilation system (2 pts.), which are triggered by movement or CO levels, for garages/ parkade. Automating will allow better control and energy efficiency.	**2**	2 to 4
1-34	Exterior Lighting follows IESNA illuminance requirements for recommended practice manual: Lighting for Exterior Environments. This addresses light pollution issues. The Illuminating Engineering Society of North America can be found online at: iesna.org and the "Lighting for Exterior Environments" guide (IESNA RP-33-99) can be purchased there.	**2**	2
1-35	Common Area lit with high efficiency (non-incandescent) lamps. Incandescent lights lose much of their energy as heat rather than light and therefore are not as energy efficient as many of the other options available.	**1**	1
1-36	Minimum 25% (1 pt.), 50% (2 pts.) or 100% (4 pts.) of light fixtures are L.E.D., fluorescent or have compact fluorescent light bulbs installed in each unit. Fluorescent, compact fluorescent and L.E.D bulbs use 50% less energy than standard bulbs and last up to ten times longer.	**1**	1, 2 or 4
1-37	Minimum 50% of recessed lights in the entire building use halogen bulbs. Halogen bulbs are slightly more energy efficient, last longer and provide a more effective task light than conventional bulbs.	**1**	1
1-38	All EXIT signs are photo luminescent or LED. Photo luminescent exit signs use no power as the light is supplied by a phosphorous chemical that absorbs light until needed and then emits it.		2
1-39	Air tight, insulation contact-rated recessed lights are used in all insulated ceilings, or insulated ceilings have no recessed lights. Prevent heated air from exhausting through ceiling. Air tight light fixtures lead to a more airtight, energy efficient home.	**1**	1
	TOTAL SECTION POINTS (min. 32 required):	**33**	

II. BUILDING MATERIALS

This section deals with building components that make up the structure of the home. Items involve alternatives to using large dimensional lumber, products with a recycled component, utilizing wood products that come from sustainable managed forests and reducing the overall amount of lumber used.

Minimum 10 (UNDER REVIEW)

2-1	Insulated Concrete Forming system (ICF's) used below grade (2 pts.) and/or above grade (2 pts.). Insulating Concrete Forms (ICFs) are hollow building elements made of plastic foam that are assembled, often like building blocks, into the shape of a building's exterior walls. The ICFs are filled with reinforced concrete to create structural walls. Unlike traditional forms, the ICFs are left in place to provide insulation and a surface for finishes.		2 to 4
2-2	Minimum of R-7.5 insulation installed under entire basement/foundation slab under conditioned space. Insulation installed under the basement slab will reduce the downward heat transfer into the ground below the slab, especially when hydronic in-slab heating is installed. Insulation under the slab can reduce temperature swings in the heated space and respond quicker to new changes in thermostat settings.		2
2-3	Attached garage, parking and/or loading dock overhead doors are insulated with R8 to R12 (1 pt.) or greater than R12 (2 pts.). An insulated overhead garage door will reduce heat loss.		1 or 2
2-4	Attached garage/parking walls and ceiling are insulated to NBC minimum (R12 for walls, R34 for ceilings). A fully insulated garage acts as a buffer zone, reducing heat loss.		1
2-5	Non-solvent based damp proofing (seasonal application). Water based damp proofing products use water as a thinner. Oil based damp proofing give off a number of volatile organic compounds (VOCs) as the solvent evaporates after application. These VOCs can be a strong irritant and can add to air pollution.	**1**	1
2-6	Paint Parkade semi gloss white to reduce number of required lighting fixtures. Using high reflectance white paint allows for fewer lights to be used in the parkade area.		1
2-7	Steel studs made from a recycled steel (min. 75%) are used to replace wood studs (min.15%). Recycling steel reduces landfill waste and saves on wood consumption.		1
2-8	Use Optimum Value Engineering (OVE) to reduce wood use in framing: - Exterior and interior wall stud spacing at 24" on-center (2 points) or 19.2" on-center (1 pt.). - Elimination of headers at non-bearing interior and exterior walls. (1 pt.) - Use of header hangers instead of jack studs. (1 pt.) - Elimination of cripples on hung windows. (1 pt.) - Elimination of double plates, use single plates with connectors by lining up roof framing with wall & floor framing (1 pt.) - Use of two stud corner framing with drywall clips or scrap lumber for drywall backing instead of studs. (1 pt.) For more details on Optimum Value Engineering (OVE) framing principles see www.buildingscience .com.	**1**	1 to 7
2-9	Walls and roof designed as 24" module to reduce waste. A 24" module takes into account the size of sheets of OSB or plywood, stud spacing, carpet size etc.		2
2-10	Use of insulated headers (either manufactured or site built open insulated single headers) with minimum insulation value of R10. Headers can either be insulated on site or can be a pre-manufactured product (often insulated with a foamed plastic).	**1**	1

2-11	Install manufactured insulated rim/band joist or build on site by setting back joists to allow rigid insulation filler of a minimum R10. Rim and band joists can either be insulated on site or can be pre-manufactured (often insulated with a foamed plastic).		2
2-12	Structural insulated panel system (SIPS) used for walls (3 pts.) and/or for roofs (2 pts.). Reduces thermal migration and controls air leakage – Keeps heating and cooling costs to a minimum compared to a conventionally framed wall.		2 to 5
2-13	All insulation used in the project is third-party certified to contain a minimum recycled content: 40% (1 pt.) or 50% (2 pts.). Recycled content means less landfill waste and raw material use. Also, according the North American Insulation Manufacturer's Association, insulation with recycled content takes less energy to produce than using all raw materials.	**1**	1 or 2
2-14	Insulation levels meet or exceed the MNECB (may include Roof-R28, Walls R14, Floor R14). Model New Energy Code minimums will help to keep heating and cooling costs to a minimum compared to a conventionally framed wall.	**1**	1
2-15	Replace exterior wood sheathing with installed insulating sheathing. Using rigid insulation instead of wood for exterior sheathing conserves forest resources, reduces thermal migration and controls air leakage; it also keeps heating and cooling costs to a minimum compared to a conventional wall.		2
2-16	Deck (1pt.), balcony surfaces (1pt.), and/or veranda structure (1 pt.) made from a third-party certified sustainable harvested wood source or third-party certified sustainable concrete. The issue of sustainable forest management (SFM) is considered to be of such importance by the Canadian forest industry that, in 1993, a group of 22 organizations representing virtually all of the industry came together to form the Canadian Sustainable Forestry Certification Coalition. The coalition regroups several different certification standards that each have their strengths and weaknesses. For more information, see www.sfms. com. Concrete produced from aggregates derived from a pit or quarry with a valid reclamation plan approved by Materials and Resources Canada or the governing provincial body.		1 to 3
2-17	Dimensional lumber from a third-party certified sustainable harvested source used for floor framing (1 pt.), wall framing (2 pts.), and/or roof framing (1 pt.). Saves old growth forests by using trees from a second generation forest.	**4**	1 to 4
2-18	Environmentally engineered flooring system (i.e.. Uses reclaimed/recycled/rapidly renewable wood waste, fly ash concrete (1pt-30%), recycled steel (1pt-90%)). Use of Engineered floor system saves old growth forest by using components from second generation forests and the use of recycled materials.	**1**	1
2-19	Environmentally engineered products for all load bearing beams (i.e.. Uses reclaimed/recycled/rapidly renewable wood waste, fly ash concrete (30%), recycled steel (90%)). Engineered products include wood products, concrete and recycled steel.		2
2-20	Environmentally engineered products for all exterior window and door headers (i.e.. Uses reclaimed/recycled/rapidly renewable wood waste, fly ash concrete (30%), recycled steel (90%)). Engineered products include wood products, concrete and recycled steel.		1
2-21	Engineered stud material for 10% of stud wall framing. Use of Engineered lumber products saves old growth forest by using components from second generation forests and recycled materials.		1
2-22	Engineered and/or finger-jointed plate material. Use of recycled materials saves old growth forest.		1
2-23	Finger-jointed studs for 90% of non-structural stud wall framing. Use of recycled materials saves old growth forest.	**2**	2
2-25	Recycled content exterior wall sheathing (min. 50% pre or post consumer). Recycled content reduces landfill waste and the use of new materials.		2
2-27	100% Recycled content rainscreen attachment system. Use of recycled content polypropylene, steel or aluminum rainscreen strapping may replace the traditional use of treated wood strapping on rainscreen systems.		2
2-28	Advanced sealing package, non-HCFC expanding foam around window, door openings and all exterior wall penetrations (2 pts.). All sill plates sealed with foam gaskets or a continuous bead of acoustical sealant (1 pt.). Controls air leakage and keeps heating and cooling costs to a minimum..	**2**	1 to 3
2-29	Builder has installed a green roof over 50% (3 pts.), 75% (5 pts.) or 100% of total roof area (7 pts.). Green roofs are defined as a system of plants, growing medium and roof/waterproof membrane that acts as a whole to maximize the available environmental benefits of improving air temperature (reduced heat island effect), air pollution, storm water management and green space. Extensive or 2-6" Thickness typically requires 30-40 lbs./ft^2 structural support, while Intensive roofs (8"-4') require significant structural support.		3, 5 or 7
2-30	Builder has incorporated exterior horizontal and/or vertical shading devices for glazing (2 pts.), or exterior operational shading devices (4 pts.). Shading windows from solar heat gain is a key design strategy for passive cooling and to reduce cooling loads on active HVAC systems in multi buildings. Light shelves and/or louvers can be optimized to allow for winter solar gain, while reducing overheating during the summer.		2 or 4
2-31	All decks or balconies are thermally broken from the envelope by R10 (1 pt.), or fully separated (3 pts.).		1 or 3
	TOTAL SECTION POINTS (min. 10 required):	**14**	

III. EXTERIOR and INTERIOR FINISHES

This section focuses on the finish materials used both inside and outside of the project. The items listed include using longer lasting products, products with recycled content and products that are harvested from third party certified managed forests.

Minimum 10 (UNDER REVIEW)

3-1	Exterior doors with a minimum of 15% recycled, recovered, or third party sustainably harvested content. Recycled or recovered content ensures we keep our landfill use to a minimum.		1
3-2	All exterior doors manufactured from fiberglass. Fiberglass doors insulate better than steel skinned or wood doors, have a longer lifespan, do not warp, twist or crack, and therefore reduce landfill use.		1
3-3	Exterior window frames contain a minimum of 10% recycled, recovered, or third party sustainably harvested content. Reusing materials such as plastics reduces landfill usage, which may not be biodegradable.		1
3-4	Exterior window frames are made from third-party certified sustainable harvested wood. Uses trees from a forest managed system that prevents clear cutting trees, and replants trees to replace from which they've been harvested.		2
3-5	Concrete used in home has a minimum supplementary cementing material of 25% (1 pt.) and/or 40% (2 pts.) and is within the scope of proper engineering practices. For every one tonne of Portland cement generated, eighth tenths of a ton of carbon dioxide is produced. Supplementary cementitious products include fly ash, blast furnace slag as well as metakaolin.	**1**	1 to 2
3-6	Natural cementitious stone/stucco/brick or fiber cement siding – complete or combination thereof for 100% of exterior cladding. Battens are included in cladding. Strong, long lasting, fireproof material.	**4**	4
3-7	Exterior trim and finish is made of recycled content (50% min.) material, durable and fire rated; trim (1 pt.) and/or wall finish (4 pts.). Fiber cement fascia and soffit, made with recycled content from sawmill waste and Portland cement, is a strong, long lasting and fireproof material.		1 to 5
3-8	Exterior trim (3 pts.) and /or siding materials (4 pts.) have recycled and/or recovered-content (min. 50%). Recycled and/or recovered-content trim materials reduce the amount of new material used in production by gluing up miss scraps into large pieces, which conserves natural resources and reduces landfill usage.		3 to 4
3-9	Exterior trim materials are manufactured from OSB . Trim materials manufactured from OSB uses a laminating process to make larger pieces from smaller pieces or strands of wood. The process saves old growth forests by using trees from forest managed systems that prevents clear cutting trees, and replants trees in areas from which they have been harvested.		1
3-10	All exterior trim is clad with pre-finished metal (1 pt. over top wood backings, 2 pts. without wood backings). Trim clad with pre-finished metal is a durable long lasting product that requires no maintenance, reduces waste in landfills due to long life of product.		1 to 2
3-11	Deck or balcony surfaces made from recycled materials: 50% (1 pt.), 75% (2 pts.), 100% (3 pts.), and/or from low maintenance materials (2 pts.) (Deck surfaces should not need maintenance of any kind, including painting, for a minimum of 5 years). Substituting recycled material outdoors avoids the use of pressure treated and high mildew resistant wood that may otherwise be harvested from disappearing old growth or rain forests. Material which lasts longer and reduces landfill usage tends to require little to no maintenance, saving replacement costs and reducing energy spent.	**2**	1,2,3 or 5
3-12	Install 25-year (2 pts.), 30-year (3 pts.), 35-year (4 pts.), 40-year (5 pts.), or 50-year (6 pts.) roofing material -- with manufacturer's warranty. A longer warrantied roof system saves money in replacement costs, and reduces the use of landfills due to the longevity of the product.	**3**	2, 3, 4, 5 or 6
3-13	Minimum 25% recycled-content roofing material. Recycled content roof material reduces the use of new resources, and waste in landfills.		3
3-13a (new)	Use roofing material with a high solar reflectance index (SRI) of ≥ 78 (for roof slopes $\leq$ 2:12), or ≥ 29 (for roof slopes > 2:12). Roofs with a high solar reflectance help cool the building during the summer by reducing the heat island effect.		1
3-14	Interior doors made with recycled or recovered content (min.15%-1 pt.), or from third-party certified sustainably harvested sources (2 pts.). Recycled or recovered content ensures we keep our landfill use to a minimum.		1 to 2
3-16	Domestic wood from reused/recovered or re-milled sources – 500 square foot minimum for flooring or all cabinets or all millwork. Reused, recovered or re-milled sources eliminate the need for new resources, saves energy, transportation costs, and forestry from depletion.		6
3-17	All carpet padding made from natural or recycled textile, or tire waste. Natural or recycled-content carpet padding is a good use of reusable resources. Rebond still qualifies.		2
3-18	Install carpet that has a minimum of 50% recycled content. Recycled-content carpet is a good use of renewable resources, lessens off gases, and improves air quality.		2
3-19	100% recycled or recovered content underlayment or use of concrete finishes to enable the flooring to remain concrete. Concrete finishes such as stamped or stained concrete etc.		1
3-20	Install a minimum of 300 square feet per unit of laminate flooring. Laminate flooring is made up of sustainable raw materials.	**2**	2

3-21	Bamboo, cork or hardwood flooring used in the project (min. 300 square feet per unit installed). Products must be third-party certified to be from managed forests or from certified sustainable sources. Cork flooring comes from stripping the bark off cork oak, which regenerates itself. The cork tiles are moisture, rot and mold resistant, providing a floor that can last over 30 years. Bamboo flooring is a good use of natural resources because it is fast growing, durable and flexible.		3
3-22	All ceramic tile installed in the project has a minimum of 25% recycled-content. Reduces landfill usage.	**2**	2
3-23	MDF casing and baseboard used throughout the project. MDF casing is created from sawdust and glues, utilizing all wood waste to create usable product.	**1**	1
3-24	Finger-jointed casings, baseboards and jambs used throughout the project. Finger-jointed casing and baseboards maximize wood usage, buy using small pieces of wood glued together to create longer pieces. The process saves old growth forests by using trees from forest managed systems that prevents clear cutting trees, and replants trees in areas from which they have been harvested.	**1**	1
3-25	Solid hardwood trim from third party certified sustainable harvested sources approved for millwork (2 pts.) and/or cabinets (2 pts.). This process saves old growth forests by using trees from forest managed systems that prevents clear cutting trees, and replants trees in areas from which they have been harvested.		2 to 4
3-26	Paints or finishes with minimum of 20% recycled content. Paints or finishes made form recycled content are environmentally friendly because recycling paint reduces the hazardous waste in landfills.	**1**	1
3-27	Natural granite, concrete, recycled glass or stone countertops in 100% of the kitchens (2 pts.) and all other countertop areas (1 pt.). Natural product is more durable; easy to clean and maintain and is resistant to heat and scoring.		1 to 3
3-28	100% agricultural waste or 100% recycled wood particle board used for shelving. Products such as wheat board are made from agricultural waste.		2
3-29	PVD finish on all door hardware (1 pt.) PVD finish on all faucets (1 pt.). Physical Vapor Disposition (PVD) provides a more durable product; no toxic wastes are produced making it.	**2**	1 to 2
	TOTAL SECTION POINTS (min. 10 required):	**19**	

IV. INDOOR AIR QUALITY

This section focuses on the quality of the air within the finished project. Products listed here include materials that are low in VOC's, products made from all natural materials as well as various air cleaning and ventilation systems.
Minimum 15 (UNDER REVIEW)

4-1	Install pleated media filter (1 pt.) or an electrostatic air cleaner (2 pts.) or an electronic air cleaner (3 pts.) or a HEPA filtration system (6 pts.) or an ultraviolet air purifier (2 pts.) in conjunction with the HVAC system. *Pleated air filters* are made with material that has been pleated or folded to provide more surface area. These pleated air filters are often the most efficient of all the media air filter types and are a whole house air filter. By increasing the surface area for collecting dust, airflow through the pleated air filter is less restricted. The *electrostatic air cleaner* is a permanent washable air filter that traps and removes airborne particles from the air before being circulated through the furnace and into the home. An *Electronic Air Cleaner* offers a superior level of filtration by using advanced, 3-stage filtration technology to trap and filter airborne particles like dust, cat dander and smoke. It works by placing an electric charge on airborne particles, and then collecting the charged pollutants like a magnet. The air cleaner cells can be washed in your dishwasher or sink. *HEPA* stands for High-Efficiency Particle Arresting. HEPA filtration offers the highest particulate removal available - 99.97% of particles that pass through the system including dust, cat dander, certain bacteria, pollens and more. The system is connected to the cold air return of the forced air heating/cooling system which provides a whole house filtration system.		1,2, 3 or 6
4-2	Install power drum humidifier (1pt.) or a drip type humidifier (2 pts.) in conjunction with the HVAC system. Proper humidity provides a more comfortable living environment at a lower temperature, so you can turn down your thermostat for energy savings. Controlling humidity also means moisturizing dry air to prevent damage to hardwood floors and woodwork. Power drum humidifiers direct the heated air through a water-laden evaporator sleeve which absorbs moisture and then returns to the heating system for distribution throughout the home.		2
4-4	Install in-line ventilation fan with programmable timer (separate switch from lighting) in each unit. A programmable timer ensures necessary, regular, automatic mechanical ventilation of the housing units.		1
4-5	Install passive Heat Recovery Ventilator (HRV-2 pts.) or an active Heat Recovery Ventilator/ Energy Recovery Ventilator (HRV or ERV- 4pts.) in each unit . A Heat Recovery Ventilator (HRV) is an air exchanger that exhausts humid, stale, polluted air out of the housing unit and draws in fresh, clean outdoor air. Invisible pollutants produced by common household substances, plus dust and excess humidity that get trapped in today's houses, can increase your risk of chronic respiratory illness and your home's risk of serious structural damage. A passive HRV unit does not have its own internal fan and is 100% furnace assisted. It works by tying the exhaust side of the unit to the supply air plenum which forces air to exhaust from the housing unit and at the same time fresh air enters from outside through the unit and into the cold air return duct work. Much like the HRV the ERV recovers heat. it also recuperates the energy trapped in moisture; this greatly improves the overall recovery efficiency. In dry climates and humidified homes the ERV limits the amount of moisture expelled from the home. In humid climates and air conditioned homes, when it is more humid outside than inside, the ERV limits the amount of moisture coming into the housing unit.		2 to 4
4-6	Install thermostat that indicates the need for the air filter to be changed or cleaned. This feature displays filter maintenance reminders on the thermostat. Regular furnace maintenance is required to keep your mechanical equipment running efficiently and problem free as well as ensuring a healthy indoor air environment.		1
4-6 a (new)	Install bathroom exhaust fan controls in each unit using either an occupancy sensor, automatic humidistat controller, automatic timer, or continuously operating exhaust fan. Bathroom exhaust fan controls increase occupant comfort by further controlling indoor moisture and odour levels.	**1**	1

4-6 b (new)	Install timer switches or occupancy sensors on all local exhaust fans outside of individual units (i.e. laundry, recreation, storage areas, etc.). Operating of local exhaust fans only when necessary using controls helps reduce heat loss of interior air to outside, and also reduces electrical consumption by reducing duration of fan operation.		1
4-6 c (new)	For indoor pool areas, install a designated dehumidification system designed by a consulting engineer or qualified contractor to match the water and air temperatures maintained in the area. Dehumidification systems serving pool areas eliminate the need to exhaust large quantities of indoor air, therefore reducing heat loss.		1
4-6 d (new)	For all permanent entryways leading from outdoors, install an entryway system of at least 10 feet in length to captures dirt and particulates (i.e. grates/grills/slotted systems, or roll-out mats that are maintained weekly by a service organization). Entryway systems that capture dirt and particulates from outdoors help reduce occupants exposure to indoor airborne contaminants		2
4-7	All combustion space and water heating equipment located within building are sealed with no possibility of backdraft. Sealed-combustion appliances draw all their combustion air from the outdoors, which eliminates any chance of back drafting. This feature is especially helpful in well sealed buildings. These types of appliances do not negatively affect indoor air quality.		3
4-8	Install hardwired carbon monoxide detector within each unit, if combustion spillage susceptible appliances are used in the building. Carbon monoxide detectors warn against high levels of toxic carbon monoxide.	**1**	1
4-9	Seal all permanent ductwork upon installation, removing seals once all phases of construction are complete (1 pt.), and/or power vacuum all HVAC ducting prior to occupancy (1 pt.). This process helps eliminate pollutants that drop into the HVAC ducting during the construction process from being circulated into the housing unit.	**1**	2
4-9 a (new)	Flush out each unit with fresh air for at least 48 hours after all construction phases and prior to occupancy by opening all exterior windows and interior doors and running ventilation system. Flushing out units with fresh air after construction helps reduce occupants' exposure to indoor airborne contaminants from dust, VOCs and other particulates that have accumulated during construction		2
4-11	All insulation in the project is third-party certified as low or zero formaldehyde. Formaldehyde may cause eye, nose, and throat irritation, headaches, loss of coordination, nausea, damage to liver, kidney, and central nervous system .		2
4-12	Third-party certified low formaldehyde sub floor sheathing. Formaldehyde is colorless gaseous organic compound, water soluble, with a characteristic pungent and stifling smell. Building materials low in or free of formaldehyde glues are used in the floor underlayment, cabinetry and elsewhere to protect the indoor air quality.		3
4-13	Third-party certified low formaldehyde underlayment is used in the project. (ANSI A208.1 – 2009 concentration ≤0.21 ppm). Low formaldehyde (phenol) and formaldehyde-free binders (PMDI) are available and becoming more common. FSC certified OSB is becoming more common, reducing environmental impacts on air, water, social quality.	**1**	1
4-14	Low formaldehyde particle board/MDF used for cabinets (ANSI A208.2 – 2009 concentration ≤ 0.21 ppm). Urea formaldehyde-free fibreboard can be used in the same way as conventional fibreboard, but with the added caution of greater potential for water damage.		1
4-15	Low formaldehyde particle board/MDF used for shelving (ANSI A208.2 – 2009 concentration ≤ 0.21 ppm).		1
4-16	Zero formaldehyde particle board/MDF used for cabinets (2 pts.) and/or for shelving (2 pts.). Cabinets made from formaldehyde free particleboard or MDF eliminate the Volatile Organic Compounds (VOC) that off gas into the home, resulting in healthier indoor air quality.		2 to 4
4-17	All interior wire shelving is factory powder coated. Vinyl coating on conventional shelving units off gas VOC toxins.	**2**	2
4-18	Water-based urethane finishes used on all site-finished wood floors. Water-Based Epoxy: Generally referred to as "epoxy-modified finish," water-based epoxy finish differs from its solvent-based counterpart in that the epoxy resin is itself the catalyst for an acrylic or urethane resin.		2
4-19	All wood or laminate flooring in the project is factory finished. Installing a pre-finished floor eliminates the time, the dust and the odors associated with the on-site sanding and finishing of an unfinished product.	**2**	2
4-20	Water-based Lacquer or paints are used on all site built and installed millwork, including doors, casing and baseboards. Water based interior finish products reduces VOC off-gassing which improves indoor air quality.	**3**	3
4-21	Interior paints are used that have low VOC content (2 pts.--Standards are < 150 grams/liter of VOCs) and/or interior paint is used that has no VOC's in base paint--prior to tint (3 pts.). Volatile Organic Compounds (VOC) are a class of chemical compounds that can cause short or long-term health problems. A high level of VOCs in paints/finishes off gas and can have detrimental effects to a building's indoor air quality and occupant health. Any paint with VOC's in the range of 5 grams/litre or less can be called "Zero VOC", according to an EPA standard. Some manufacturers may claim "Zero-VOC's", but these paints may still use colorants, biocides and fungicides with some VOC's. Adding a color tint usually brings the VOC level up to 10 grams/liter, which is still quite low.	**5**	2 to 5

4-22	Carpet and Rug Institute (CRI) IAQ label on all carpet used in units (2 pts.) and/or on all underlay used in units (1 pt.). To identify carpet products that are truly low-VOC, CRI has established a labeling program. The green and white logo displayed on carpet samples, of the CRI Indoor Air Quality Carpet Testing Program, in showrooms informs the consumer that the product type has been tested by an independent laboratory and has met the criteria for very low emissions. The adhesives used to install carpets and the latex rubber by some manufacturers to adhere face fibers to backing materials generate volatile organic compounds (VOCs). Carpets also cover large surfaces within an interior environment and can provide "sinks" for the absorption of VOCs from other sources.	**3**	1 to 3
4-23	Natural wool carpet in all living areas. Natural wool carpets are durable and use less secondary backing materials and chemicals. Off gassing is typically caused by the secondary backings and chemical additives in synthetic carpets, for controlling mildew, fungus, fire and rot.		2
4-24	All vinyl sheet flooring is installed with low VOC adhesives (1 pt.--Low VOC = standard is < 60 grams per litre), and/or is replaced by hard surface flooring (2pts.), and/or is replaced by natural linoleum (1pt.). Low VOC adhesive or backing minimizes the amount of VOC off-gassing, therefore improving IAQ.	**1**	1 to 4
4-26	All ceramic tiles are installed with low VOC adhesives and plasticizer-free grout. (Low VOC = standard is less than 65 grams per litre). Most adhesives are still based on SB latex, which releases large quantities of volatile organic compounds (VOCs). The volatile solvents are used to emulsify (or liquefy) the resin that acts as the bonding agent. However, water-based adhesives emit far less VOCs than their conventional solvent based counterparts. There are three types of low-VOC formulas: water-based (latex and acrylics); reactive (silicone and polyurethane); and exempt solvent-based (VOC-compliant solvents). While all three technologies yield low- or zero-VOC caulks, sealants, and adhesives, their performance is slightly different.	**1**	1
4-28	All carpet in units are replaced by hard surface flooring. Hard surface flooring is generally more durable and improves the IAQ within a building. Carpets collect dust, dust mites and other allergens which when disturbed become airborne particulates, directly affecting the health of the occupants.		4
	TOTAL SECTION POINTS (min. 15 required):	**21**	

V. WASTE MANAGEMENT

This section deals with the handling of waste materials on the construction site and encourages recycling.
Minimum 7 (UNDER REVIEW)

5-1	Comprehensive recycling program for building site including education, site signage and bins. A comprehensive recycling program that is strictly followed significantly reduces the amount of waste ending up in landfills. Currently it is estimated that up to 50% of landfill waste is construction related.	**2**	2
5-2	Collection of waste materials from site by a waste management company that is a current member of a provincial recycling council or equivalent association and verifies that a minimum of 10% of the materials collected from the construction site have been recycled. Not only does this reduce overall waste of product, it ensures that as much product as possible is being utilized for the production of future resources.		4
5-3	Suppliers and Trades recycle their own waste. (1 pt. per trade, max. 4 pts.). Trades being responsible for recycling and removal of waste not only reduces landfill waste, but also promotes a cleaner and safer working environment.	**4**	1 to 4
5-4	Minimum 25% (2 pts.) or 50% (4 pts.) by weight of waste materials collected from construction site is diverted from waste stream. Trades being responsible for recycling and removal of waste not only reduces landfill waste, but also promotes a cleaner and safer working environment.	**2**	2 or 4
5-5	Use of recycled materials derived from local construction sites (1 pt. for each different product used, max of 3 pts.). Products recycled from the construction site, such as mulched wood cut offs or mulched gypsum are often useable as either clay/ soil water retention additives or for organic burning.		1 to 3
5-6	Trees and natural features on site protected during construction. The protection of existing trees and other natural features such as streams, ponds and other vegetation reduces environmental impact, and ecosystem impact. Many of these features can be protected simply by following good waste management procedures.	**1**	1
5-7	Shared transportation benefits: provide one parking stall for a car-sharing vehicle (1 pt.), and/or a car sharing vehicle as one component of condominium association (3 pts.) and/or bicycle storage on site (1 pt.). Providing a vehicle to share allows occupants to live without their own vehicle and using the shared vehicle when needed. Provision of covered storage facilities for securing bicycles on site encourages the use of alternative transportation.	**1**	1 to 5
5-8	Metal or engineered durable form systems used for concrete foundation walls. The use of metal forming systems reduces the requirement of lumber, a limited resource.	**1**	1
5-9	Reusable bracing is used for framing. The use of reusable bracing for framing reduces the requirement of lumber, a limited resource.	**1**	1
5-10	Install built-in recycling center with two or more bins in each unit (2 pts.) and/or provide composter to each unit (1 additional pt.). By installing built in recycling centers, which can be as simple as labeled containers (paper, cardboard, cans, plastics, etc.), Occupants are more likely to utilize the pre-existing facilities and thus contribute to the reduction in landfill waste. Providing a composter promotes a reduction in wastes heading to the landfill by giving occupants an option for organic waste such as food leftovers.	**2**	2 to 3

5-11	Provide a central recycling center for the housing project (1 pt.--min. of paper, glass and tin recycling) and/or install trash compactor for unit or building (1 pt.). Providing a recycling center will promote recycling among the occupants. Installing a trash compactor, while not actually reducing the mass of waste, does help by reducing it's volume, which over time can make a significant difference to landfill levels.	1	1 to 2

TOTAL SECTION POINTS (min. 7 required): 15

VI. WATER CONSERVATION

This section encourages a reduction in the amount of water used in the home or in individual units within multi story buildings.
Minimum 7 (UNDER REVIEW)

6-1	CSA approved single flush toilet averaging 1.6 GPF or less installed in all bathrooms. Lower flow toilets can save a substantial amount of water over time.		2
6-2	Install a dual flush or 1.2 GPF toilet in one or more bathrooms in each unit (2 pts. for one bathroom, 3 pts. for all) These toilets offer a choice between two water levels for every flush: 1.6 GPF (6 LPF) or 0.8 GPF (3 LPF).	2	2 or 3
6-3	Install waterless urinals in men's public facilities. The Average public urinal uses approximately 400 litres of water/day or 3.8- 10 litres per flush. Waterless urinals are more sanitary, reduce maintenance, installation costs and are only marginally more expensive to purchase.		1
6-4	Insulate the first three feet of the water lines on the hot water tank with flexible pipe insulation where units contain independent DHW system (1 pt.) and/or insulate all hot water lines to all locations (2 pts.). Minimizing the heat loss in the water line will decrease the initial water wasted by delivering hot water faster. Minimizing the heat loss in the water line will decrease the initial water wasted by delivering hot water faster.		1
6-5	Install hot water recirculation line. Having the hot water re-circulated from the hot water source to the fixture points will decrease the initial water wasted by delivery the hot water faster.		3
6-6	Install low flow faucet aerators on all bathroom and kitchen sinks (1 pt.) and/or install hands free lavatory or kitchen faucets in each unit (4 pts.). Low flow faucets may be included if flow rate is a maximum of 3.8 L/ minute on bathroom sinks and/or 6.8 L/minute on kitchen sinks. Battery powered electronic sensor minimizes the spread of germs and saves water.	1	1 to 5
6-7	Supply front loading clothes washer in each unit. Front loading clothes washers conserve water by design, as they are only required to fill up the washing compartment 1/3 full to effectively wash clothing. Additionally they use up to 75% less environmentally damaging laundry detergent. AND they also conserve electrical or gas energy by significantly reducing drying time for clothes with a more thorough spin cycle.		3
6-8	Install water saving dishwasher that uses less than 26.0 L/water per load in each unit. Water saving dishwasher uses technology to reduce both the amount of water required as well as electrical energy requirements. The EnerGuide appliance directory put out by Natural Resources Canada has a comprehensive listing of all manufacturers and models of dishwashers and other appliances with water usage and energy efficiency ratings.	1	1
6-9	Install permeable paving materials for driveways and walkways (min. 70% of hardscape area). Permeable paving materials allow rainwater to flow back into the ground instead of into storm sewers.		1
6-9 a (new)	Design all impermeable hardscape surfaces to direct rainwater to an on-site infiltration feature (i.e. vegetated swale, rain-garden, cistern, etc.) Designing for on-site infiltration allows rainwater to flow back into the ground instead of into storm sewers.		1
6-10	Install a water meter in every unit. Installing a water meter in each unit makes the occupants more aware or and responsible for water use.		3
6-11	Install Efficient Irrigation Technology that has head-to-head coverage (1 pt.), a central shut-off valve (1 pt.), a sub meter (1 pt.), uses drip irrigation for at least 50% of planting bed area (1 pts.), has a pressure regulating device to reduce (1 pt.), high efficiency nozzles with a distribution uniformity of ≥ 0.7 (1pt.), and/or motion sensor/rain delay controller (1 pt.). Max. 3 points can be claimed. Water efficient irrigation systems that include sensors, regulators, micro drip feed systems etc. help reduce the demand on the municipal water system.		1 to 3
6-12	Provide a list of drought tolerant plants and a copy of the local municipality water usage guide to building owner with closing package. Most municipalities provide a guide that gives the water requirements of various plants and grasses. When properly designed, landscaping choices can significantly contribute to water conservation.	1	1
6-13	Reduce lawn/turf to 50% of landscaped area. Lawns require a large amount of water to maintain. By reducing the amount of lawn, water use can also be reduced.	1	1
6-14	Builder captures rainwater for use in atrium, patio garden feature, landscaping and/or indoor water use. Using rainwater helps with stormwater management, and also reduces demand on the municipal water system	1	1
6-15	Greywater is collected, treated and reused throughout the project for landscaping and/or indoor water use. Reusing greywater helps reduce demand on the municipal water system		5

TOTAL SECTION POINTS (min. 7 required): 7

VII. BUSINESS PRATICE

This section deals more with manufacturers and builders office and business practices
Minimum 9 (UNDER REVIEW)

7-1	Products used for the project are manufactured within 800 km. (1 pt. for each product to a max. of 5 products). Products made closer to the location of use will have less embodied energy. Basically this means that the shorter the transportation distance the less energy used in moving the product. Less energy used means fewer emissions.	**5**	1 to 5
7-2	Builder provides BUILT GREEN building owner manual and/or educational walkthrough and/or Green systems manual for building managers. Building owner education is an important component to any high performance building. If the technology is not used correctly, it will diminish the efficiency.		2
7-3	Builders office and show homes purchase a minimum of 50% (1 pt.) up to 100% (2 pts.) solar, wind or renewable energy. Wind Energy is a cleaner way to provide energy. Lower emissions benefit the environment.		1 to 2
7-4	Manufacturers and/or suppliers purchase 50% or more solar, wind or renewable electricity. Wind Energy is a cleaner way to provide energy. Lower emissions benefit the environment.		1
7-5	Builder supplies a minimum of 8" of topsoil as finish grading throughout site. Compared to subsoil materials, topsoils usually have higher aggregate stability, lower bulk density, and more favourable pore size distributions which leads to higher hydraulic conductivity, water-holding capacity, and aeration porosity.	**2**	2
7-6	Development site provides community amenity space for not for profit community services. Floor area made available to the City for not-for-profit community use. (I.e., Assemblies, offices, educational facilities etc.).		2
7-7	Development site provides for Publicly Accessible Private Space . I.e., Atriums, open courtyards etc. which are part of the residential project but have links to/for public access.		1
7-8	Development includes a diversity of housing types including 20% live/work units (2pts.), 25% mixed use (2 pts.) facilities and/or 20% with separate basement suite units (2pts.) This type of development encourages neighborhoods where people can live, work, shop etc. without having to drive.		2 to 6
7-9	Builder has written environmental policy which defines their commitment (which must include an office recycling program and energy efficient lighting). A statement of commitment helps to emphasize priority and ultimately define a corporate culture.		1
7-10	Manufacturer and/or supplier has a written environmental policy which defines their commitment (this must include an office recycling program and energy efficient lighting). (1 pt. per supplier/manufacturer, max. of 2 pts.). Doing business with others committed to the environment helps to promote the ideals of being earth friendly.	**2**	1 to 2
7-11	Builder has written an environmental policy which prioritizes milestones for future net zero housing developments. The next step toward easing our reliance on non-renewable energy is net zero housing. Net zero houses produce as much energy as they consume using renewable sources such as solar, thermal, wind, geoexchange etc.	**1**	1
7-12	Make provision Truck Management Plan, to avoid high congestion areas during construction. A truck management plan would minimize the impact of trucks in the construction neighborhood. Features include scheduled arrivals/departures, reuse of materials to reduce truck traffic, communication with community and specific hours of work designated.	**1**	1
7-13	Delivery Area wheel washed/ treated during construction. Wheel wash area will cut down on dust pollution in the neighborhoods where construction is taking place.	**1**	1
7-14	Builder's company vehicles are hybrid or bio-diesel vehicles (1 pt. per vehicle to max. of 3 pts.). A commitment to the environment shouldn't stop at construction. Using a hybrid vehicle produces lower harmful emissions. Diesel construction vehicles converted to bio-diesel reduce fuel consumption by up to 75%.	**1**	1
7-15	Builder uses radiantly supplied cold weather construction practice. Propane heaters under tarps are often inefficient; this results in a great deal of wasted energy while reducing the quality of workmanship. Alternatives may include manufacturing components indoors.		1
7-16	Environmental certification for builder's place of business (building, office etc.). Many commercial buildings have been rated with various energy efficiency standards. Does your company work within an ENERGY STAR or LEED certified office building?		3
7-17	Builder agrees to construct and label a min. of 50% of all projects to the BUILT GREEN standard per calendar year. (3 pts. for 50% or 5 pts. for 100%). A commitment to the environment from the builder can expand energy efficiency exposure to a large number of home owners and other home builders. Every BUILT GREEN project that is built is a reduction in material use, a reduction of green house gas emissions, less waste and better efficiency.		3 or 5
7-18	Contracted trades and/or suppliers have successfully taken BUILT GREEN Builder Training. (1 pt. per company, max 3 pts.). Using trades or suppliers who have successfully taken Built Green Builder Training means that there is common understanding about what needs to be done and how it will be accomplished, streamlining the process.		1 to 3
	TOTAL SECTION POINTS (min. 9 required):	**13**	
	TOTAL CHECKLIST POINTS	**122**	

Polygon Development 270 Ltd

TRANSPORTATION OVERVIEW

ADDENDUM

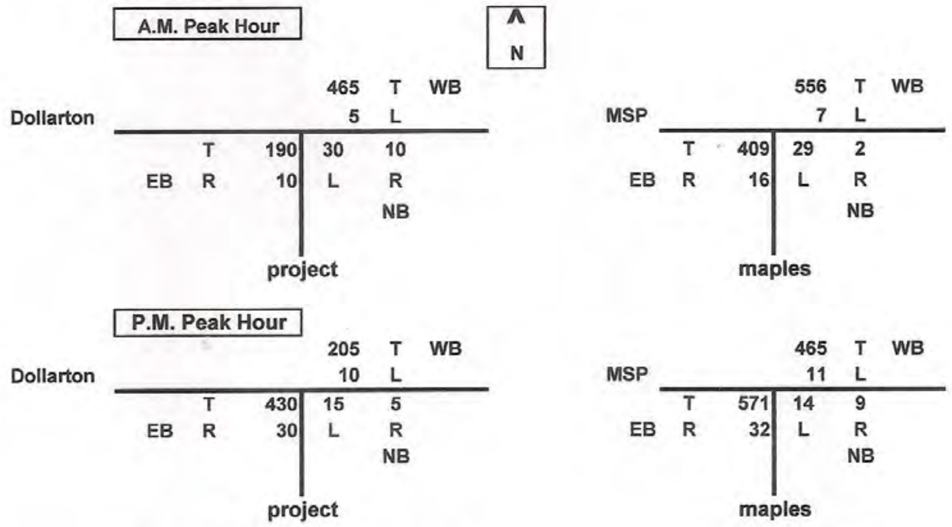
Prepared by

BWW CONSULTING
North Vancouver BC
July 3, 2013

Polygon’s Dollarton Residential Redevelopment
Transportation Overview: Addendum

At the public information meeting held June 11, 2013 concerns were expressed by some attendees about traffic getting out of the project onto Dollarton Highway. Subsequently traffic data was collected at a similar location – the Maples development on the south side of the Mt. Seymour Parkway (MSP) just east of the Mt. Seymour Golf and Country Club. The Maples is an 86 unit town house development with a single access driveway onto Mt. Seymour Parkway. The Dollarton project is 15 town houses and 80 apartments.

The comparative traffic data is shown below in Sketch 1. Comments about the data are provided also.



T = through
R = right turn
L = left turn

EB = eastbound
WB = westbound
NB = northbound

Vehicle Volumes
Sketch 1

Trip Rate (vehicles per residential unit)

		project	maples
a.m.	IN	0.16	0.27
a.m.	OUT	0.42	0.36
	2 Way	0.58	0.63
p.m.	IN	0.42	0.50
p.m.	OUT	0.21	0.27
	2 Way	0.63	0.77

Comments:

At Dollarton / project the EB and WB through are counted volumes while the turning volumes in and out of the project are calculated volumes. At MSP / maples all the volumes shown are counted volumes.

No unusual delays or back-ups at the Maples driveway were observed during the count periods.

The through volumes on the Mt. Seymour Parkway are 47% and 63% higher than on Dollarton in the a.m. and p.m. peak hours respectively.

Based on data in the Institute of Transportation Engineers Trip Generation Manual (recognized industry data source) trip rates are generally lower for low rise apartments compared to town houses.

In the calculation of project traffic activity no reduction was included that would reflect a portion of the residents being retirees or not in the "9 to 5" work force.

The forecast exiting volumes onto Dollarton are similar to the exiting volumes at the Maples (most critical movement).

A standard procedure for analyzing the intersection operating conditions is to use the SYNCHRO computer model that is based on the Highway Capacity Manual analysis procedures. The basic SYNCHRO inputs are the volumes by movement, the laning and the control (in this case stop sign on the driveway). The SYNCHRO outputs include (by movement and for the overall intersection) volume/capacity ratios, delays in seconds per vehicle and a letter grade measure of the Level of Service (LoS). Letter grades range from" A" to "F". A LoS of "A" represents excellent operating conditions with no delay or congestion (e.g. at 5 a.m. on the Second Narrows Bridge). A LoS of "F" represents poor operating conditions with congestion and significant delays (e.g. at 5 p.m. southbound onto the Lions Gate Bridge). A generally desirable target in urban areas is LoS "D".

The SYNCHRO analyses for the project driveway/Dollarton intersection (with the east-west volumes on Sketch 1 increased by 25%) showed Levels of Service of "C" for the driveway (left out, right out) for both the a.m. and p.m. representing good operating conditions. The overall intersection operation is LoS "A" in both the a.m. and p.m. peak.

The roadway configuration proposed for the site driveway location is as follows:

- Westbound through lane
- Westbound to southbound left turn lane
- Eastbound combined through and right turn lane
- Northbound combined left turn and right turn lane.

The addition of the left turn lane will enhance the traffic operations and will provide a safety benefit by storing left turning vehicles in their own lane so that westbound through traffic is not affected.

The conclusion drawn from this comparison is the same as stated in the Transportation Overview i.e.: "The operating conditions at the site driveway/Dollarton intersection will be satisfactory at opening day and for many years depending on the growth in traffic along Dollarton".

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July 3, 2013

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northwest hydraulic consultants

300164

May 27, 2013

Polygon Homes Ltd.
Suite 900 – 1333 West Broadway
Vancouver, BC V6H 4C2

Attention: **Ms. Cynthia Melosky**
VP Development

Dear Ms. Melosky:

Subject: **Noble Cove Residential Development**
Coastal/Foreshore Hazard Assessment

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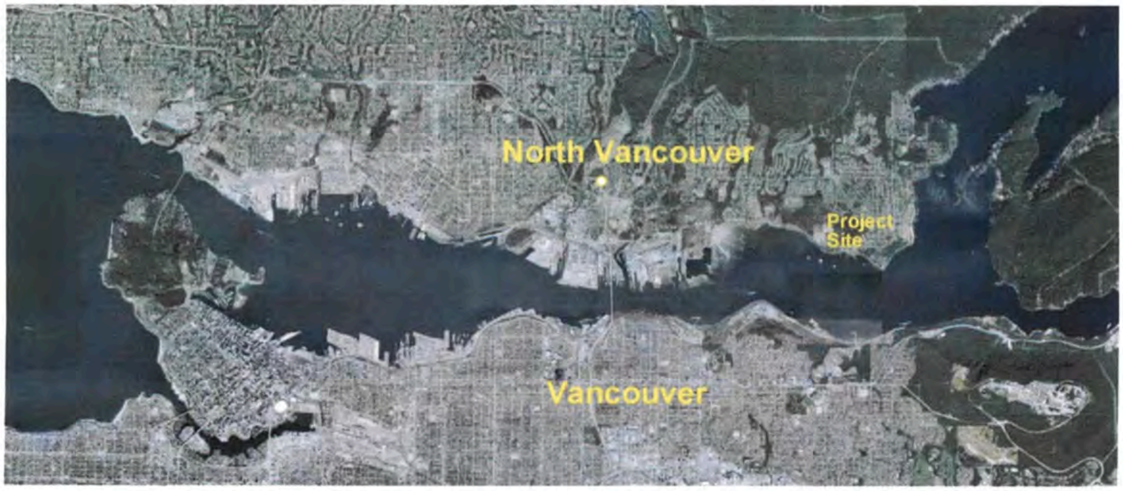
1 INTRODUCTION

Polygon Homes Ltd. (Polygon) is in the process of developing the Noble Cove project at 3829 to 3919 Dollarton Highway in the District of North Vancouver. The project is on the north shore of Burrard Inlet adjacent to the west boundary of Cates Park (**Figure 1**) and is planned as 5 two story townhomes - 15 units total - and 3 four storey apartment buildings - an additional 80 units. Northwest Hydraulic Consultants Ltd. (NHC) has been retained to investigate potential coastal impacts to the site (such as flooding and erosion) as well as potential geomorphic effects of the project on adjacent lands and foreshore.

Figure 1: Noble Cove Residential Development Project Site



This report provides the Flood Construction Level (FCL) for present and future sea level conditions, erosion protection, and discussion of potential geomorphic impacts. It is recommended that this report is presented and discussed with the District of North Vancouver to obtain early acceptance of FCLs. NHC can support these discussions.

2 GEOMORPHIC ASSESSMENT

2.1 SETTING

The proposed Noble Cove development site is approximately 100 m wide as it slopes down at roughly 7% on the north shore of Burrard Inlet immediately west of Cates Park. **Photo 1** through **Photo 4** show the current condition of the property. Presently the site is occupied by an aging shipyard occupied by numerous metal sided buildings ranging in size from 7x7 m to 20x75 m, concrete and gravel paved parking/work areas, dry-docks, and two timber pile supported wharfs/piers each extending 70 to 100 m out from shore. Most of the current infrastructure would be removed from the property and foreshore. The shoreline is relatively steep with coarse gravel, cobble, and occasional boulders, consistent with much of Indian Arm and Burrard Inlet. Exception to this is a localized gravel and sand beach roughly 15 m wide and 50 m long at the west end of the project site (**Photo 5**). Across the site banks are generally armoured. A range of materials and methods have been used; including small boulders, loosely placed angular rock riprap (D_{50} +- 400 mm), treated timbers, waste concrete slabs, concrete lock blocks, and cast concrete foundations (**Photo 6**). Locations of exposed or poorly armoured bank, such as portions of the adjacent shoreline along Cates Park, show signs of toe erosion and localised bank failure (**Photo 7**).

Immediately east of the site, the shoreline heads slightly inland at the mouth of small creek. The beach at the outlet of the creek is relatively uniformly graded small to medium sized cobble, with the beach surface 50 to 100 m eastwards coarsening to cobble and small boulders; however, finer materials persist between coarser elements. The banks east of the site are 0.5 to 2 m high and well vegetated with mature trees. Where banks are not armoured, there is local erosion and undercutting; however, the established vegetation has limited the progression of this erosion. West of the site are a number of private residences situated above steep 2 to 3 m high banks armoured with tightly placed angular rock riprap. The fronting shore is well sorted coarse sand to boulders with the majority of surface material between medium to large cobble.

A small creek runs through Cates Park near the east boundary of the project discharging to Burrard Inlet through a concrete orifice and weir fish ladder (**Photo 8**). A second slightly larger creek bisects the property with the east side of the property noticeably higher in elevation than the west. This creek flows under Dollarton Highway through a 1.8 m diameter corrugated metal pipe (CMP) culvert - perched about one-half metre above the grade of the downstream channel bed, creating a small plunge pool. The downstream channel is entrenched within steep banks composed of boulders, waste concrete slabs, and well vegetated earth. A local resident stated they had never observed the creek flooding outside its banks. This statement and current condition of the channel

suggests the banks are relatively stable and not frequently inundated. However, the earth embankment forming the right bank (facing downstream) is steep, narrow, and potentially maintains the channel above the adjacent ground (**Photo 9**).

Further downstream of the Dollarton CMP, the creek flows under a number of timber supported concrete deck single span crossings and the foundation of the Dollarton Shipyard building. The creek then discharges to Burrard Inlet through a widening channel armoured with treated timber cribbing along its left bank and rock, waste concrete, and treated timber piles along its right bank. Upstream of Dollarton Highway, the creek is entrenched within a large forested gulley and exhibits weakly defined step-pool morphology with small pockets of cobbles and gravels on the bed. Channel gradient downstream of Dollarton Highway reduces from near 10% to closer to 5% with channel width of 3 to 5 metres widening as the channel enters the intertidal zone.

2.2 POTENTIAL FLUVIAL GEOMORPHIC IMPACTS TO PROJECT AND POTENTIAL EFFECTS OF THE PROJECT

Upland slopes of the creek that bisects the property are subject to potential failure during extreme rainfall events or during seismic events which could result in temporary channel blockage (DNV, 2013). Slide material would enter the creek no closer than 80 m upstream from the culvert entrance. Based on the channel gradient the creek appears to lack the conveyance to transport substantial material downstream. Therefore, the risk of a landslide or landslide debris blocking the culvert upstream or the creek becoming blocked with deposited material within the project site is unlikely.

Although the creek appears to transport some sand and gravel sized material modification of the site and shoreline is not expected to affect sediment processes with respect to the creek.

2.3 POTENTIAL COASTAL GEOMORPHIC IMPACTS TO THE PROJECT AND POTENTIAL EFFECTS OF THE PROJECT

The site is exposed to fluctuating water levels, wind generated waves, boat generated waves, and currents. The remaining sections of this document presents initial concepts to withstand these impacts.

The proposed development would include the removal of all existing industrial facilities including some pilings, building footprints, and ramping structures that potentially affect shoreline stability. Although the removal of this infrastructure will return the foreshore to a natural state, it could also increase the potential for waves to pass unaffected through to the shoreline and cause erosion. The abundance and coarseness of cobble presently surfacing the beach should limit any coarsening of beach materials or steepening of the beach profile. Proposed protection of the banks through armouring and/or reducing the slope of the bank profile will limit erosion within the project site.

Removal of existing infrastructure may also restore littoral currents and the potential transport of beach sediments. On inspection of the shoreline morphology and coarseness of local intertidal material, there are no indications of substantial littoral sediment transport and the impact of the project is expected to be minimal.

Potential project effects are expected to be more substantial east of the site following removal of a prominent pier (**Photo 4**). The large number of piles used to support this structure reduces the transmission of waves, providing shelter to adjacent shorelines from oblique wave attacks. Removal of the structure is likely to increase wave approach and erosion potential at the shoreline immediately east of the pier from west and southwest waves, which is the direction with largest fetch at this location. The increased wave erosion is likely to extend to the west end of Cates Park. Rock has been placed along the toe of the bank at Cates Park in several locations to prevent erosion.

There is active erosion observed at several locations where this protection does not exist, or is not continuous (**Photo 7**). This shoreline should be monitored following substantial westerly storms (i.e. 1-2 times each year or two, that is following west winds excess of 60 km/h) for the first two to five years post removal of the pier to ensure additional armouring is not required and to ensure the shoreline does not steepen or undermine adjacent foreshore; i.e. banks along Cates Park or the east creek outlet structure.

3 FLOOD CONSTRUCTION LEVEL ANALYSIS

The water level at Noble Cove is primarily governed by sea level as opposed to river flood level and incorporates the combined effects of tide, storm surge, wind setup, wave run-up, and sea level rise (SLR).

In January 2011, the BC Ministry of Environment (MOE) published Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use (MOE, 2011a). The guidelines present an approach for developing a flood construction level (FCL) calculated as the summation of:

FCL = Higher High Water Level Large Tide (HHWLT)
+ the 200-year storm surge
+ sea level rise (SLR)
+ local subsidence
+ wave effects from a 200-yr storm
+ 0.6 m freeboard

Referred to as Designated Flood Level (DFL)

Referred to as the Flood Construction Reference Plane (FCRP)

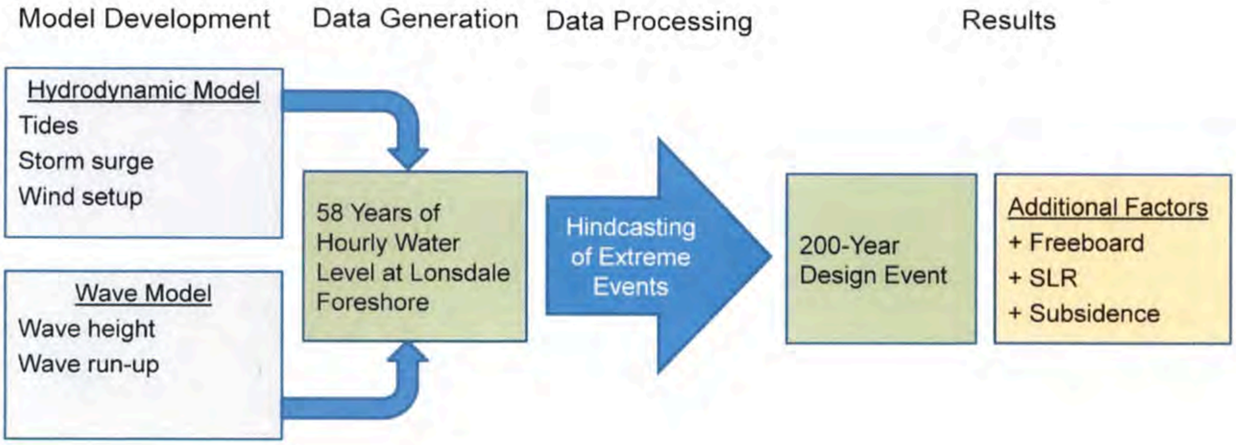
Similar methodology is adopted by the 2011 *Coastal Floodplain Mapping Guidelines and Specifications* published by the BC Ministry of Forests, Lands, and Natural Resource Operations (FLNRO) published (FLNRO, 2011) and the 2012 *Creek Hydrology, Floodplain Mapping, and Bridge Hydraulic Assessment* study (KWL, 2012) prepared for the City of North Vancouver. The 2012 floodplain mapping study provides local FCLs for the City and District of North Vancouver; reported FCL of 5.3 m, 6.2 m, and 7.1 m Geodetic Datum (GD) for year 2012, 2100, and 2200 respectively at a site referred to as Tidal Flats, located 2 km west of the Noble Cove project.

Although much of the underlying design events used by the method presented by these documents are 200-year events, the probability of simultaneous occurrence of the events is vaguely if at all defined. The *Guidelines for Sea Dikes* (MOE 2011a) suggests a probability of 200-year storm surge co-occurring with HHWLT of near 0.025% (4000-year return period). Annual exceedance probability (AEP) of this magnitude are stated by the accompanying policy document (MOE, 2011b) to be justified where the consequence of dike failure has moderate to high consequence, such as the Fraser River Delta where there is potential for several weeks of disruption, major financial losses for multiple owners, multiple people injured, and multiple loss of life.

The proposed shoreline development consists of townhouses and apartments; it is not a continuous sea dike and does not present the same consequence if design water level is exceeded. The design life of the development is likely on the order of 100-years. Based on provincial flood assessment guidelines produced by the *Association of Professional Engineers and Geoscientists of BC* (APEGBC, 2012) the risk of exposure of vulnerable populations appears to be moderate to high and warrant design to a return flood period of 200-years. The 200-year design event was selected as the design criteria.

Instead of using the summation methodology a statistical approach based on joint probability has been applied to establish the FCL. A hydrodynamic model and a wave model of Burrard Inlet were developed to generate 58 years of hourly water level data. The data was hindcast and extreme event frequency analysis conducted to establish a FCL for 2012. Sea level rise and local subsidence was then added for future design conditions. **Figure 2** presents a schematic of this process.

Figure 2: Approach for developing coastal design conditions


Model Development
Data Generation
Data Processing
Results

Hydrodynamic Model
Tides
Storm surge
Wind setup

Wave Model
Wave height
Wave run-up

58 Years of Hourly Water Level at Lonsdale Foreshore

Hindcasting of Extreme Events

200-Year Design Event

Additional Factors
+ Freeboard
+ SLR
+ Subsidence

3.1 BURRARD INLET HYDRODYNAMIC MODEL

A hydrodynamic model of Burrard Inlet was developed using TELEMAC-2D model to hindcast the water level at the project site. TELEMAC-2D model was developed by the National Hydraulics and Environment Laboratory (Laboratoire National d'Hydraulique et Environnement - LNHE) of the Research and Development Directorate of the French Electricity Board (EDF-R&D), in collaboration with other research institutes. Telemac-2D uses an unstructured flexible mesh composed of triangular elements where the vertices of each triangle represent the computational points for the model. **Figure 3** illustrates the computational mesh and bathymetry used in the study.

To encompass into the effect of tide, storm surge, and wind setup the Burrard Inlet model was defined with water levels along the open boundary to the west specified with the observed hourly water level at Point Atkinson. In addition hourly wind data from Vancouver International Airport and Point Atkinson were applied to the model to incorporate wind forcing which causes surface currents, water level differences in the inlet, and wind set-up. The environmental data used for the study are summarized in **Table 1**.

Figure 3: Burrard Inlet Hydrodynamic Model

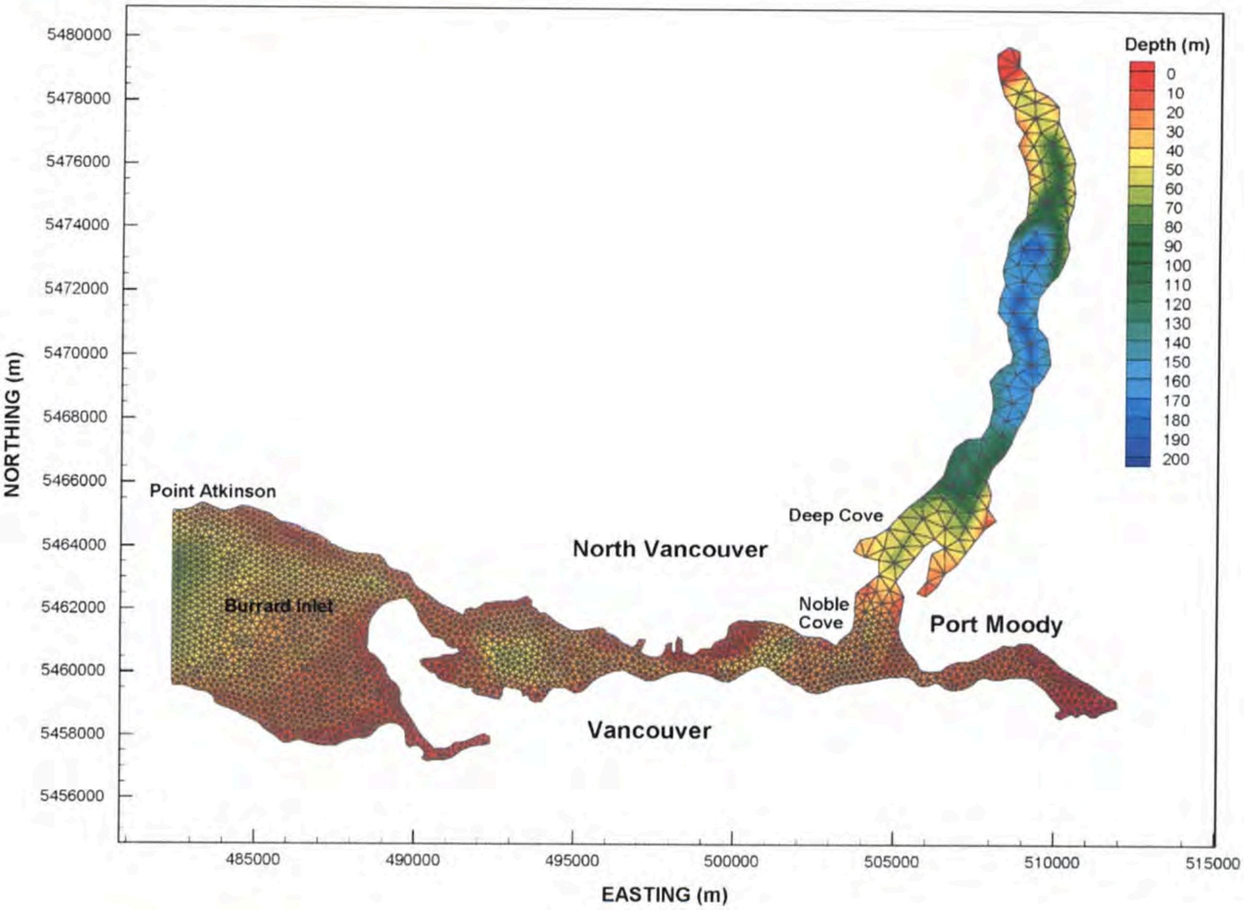


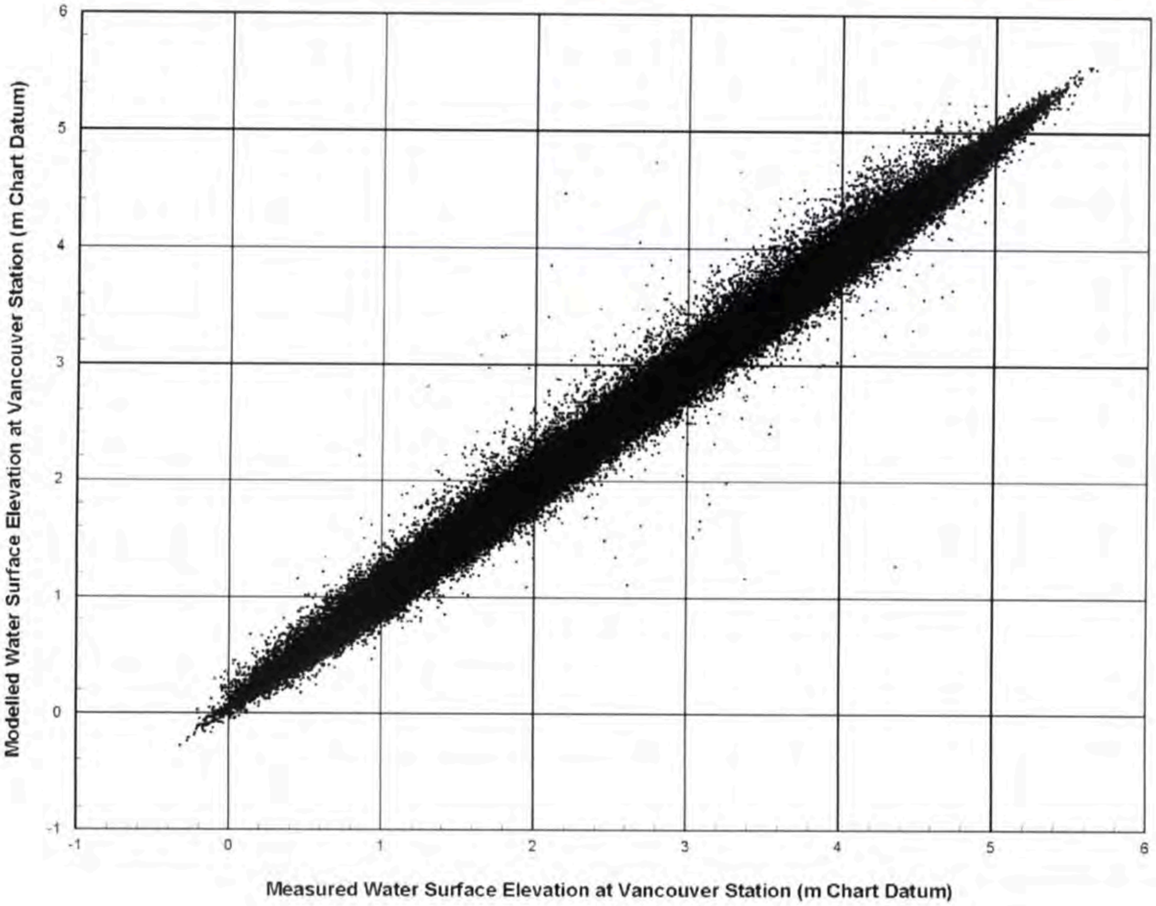
Table 1: Environmental data

Data Type	Station	Data Case	Station ID	Station Location	Period
Water Level*	Point Atkinson	Canadian Hydrographic Service	7795	49° 20′ 13.2″ N 123° 15′ 11″ W	1953 – 1958, 1961 – 2012
Wind	Vancouver International Airport	Meteorological Service of Canada	1108447	49° 11′ 42″ N 123° 10′ 55″ W	1953 – 1958, 1961 – 1996
Wind	Point Atkinson	Meteorological Service of Canada	1106200	49° 20′ 13.2″ N 123° 15′ 53″ W	1997 – 2012

*No data is available for the period between 1959 and 1961.

The model was simulated from 1953 to 2012 (excluding 1959, 1960 and 1961). The modelled water levels near the Canadian Hydrographic Service Vancouver Station (Station ID 7735) located inside Burrard Inlet were extracted and compared with the observed data (**Figure 4**). The mean difference between the modelled and observed water levels is 3 cm and the standard deviation is about 8 cm. Hourly hindcast water level at the project site was archived for the FCL analysis (**Section 3.4**).

Figure 4: Modelled water surface elevation vs measured water surface elevation at CHS Vancouver Station

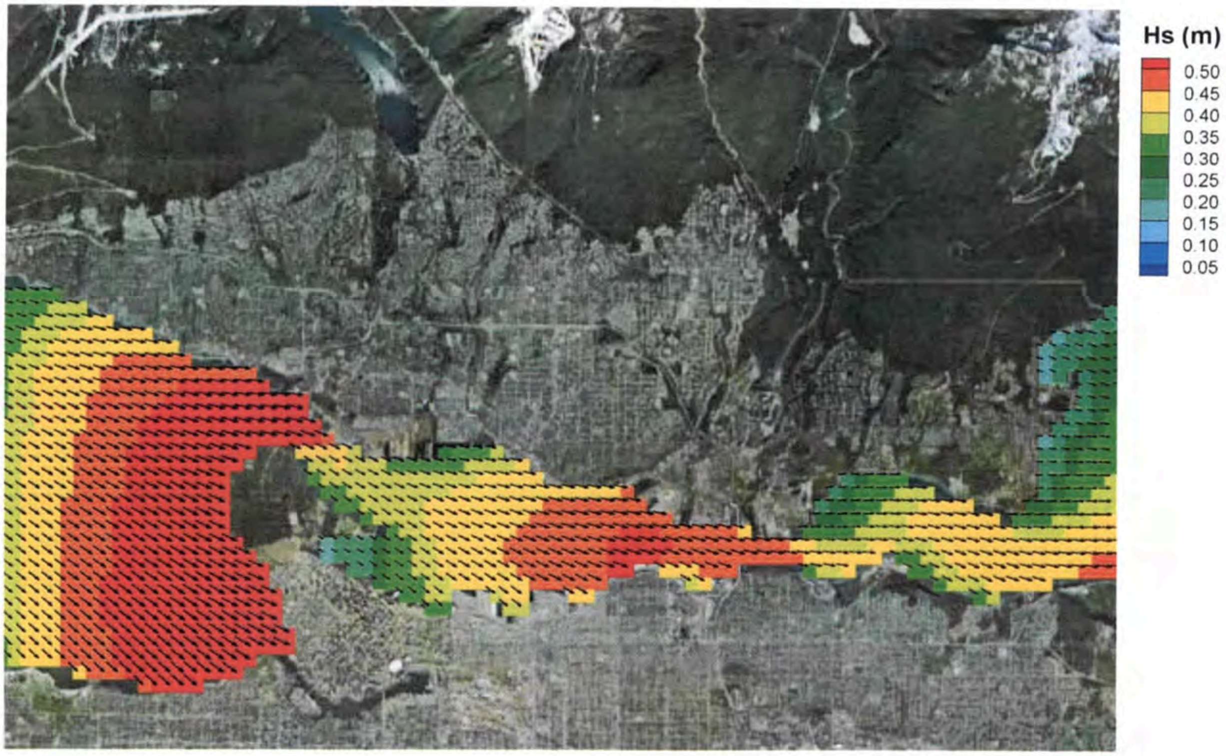


3.2 BURRARD INLET WAVE MODEL

A wave climate model of Burrard Inlet was developed using the University of Miami Wave Model (UMWM) to hindcast the water climate at the project site. UMWM is a spectral ocean wave model applicable on a wide range of spatial and temporal scales; small lakes to global applications.

A two-dimensional, time-dependent wind field required as input by UMWM was generated from the Vancouver Airport and Point Atkinson wind record. The effects of fetch (distance from shore) and duration (length of time the wind has been blowing) on the wind-generated wave field are incorporated in the model. As an example of model output, **Figure 5** shows the modelled significant wave height result for the recent December 19, 2012 storm event. The shading of the map represents wave height as shown by the colour bar. Vectors represent the direction of wave propagation.

Figure 5: Burrard Inlet Wave Model example results



The model was simulated from 1953 to 2012 (excluding 1959, 1960 and 1961). Hourly hindcast wave data at the project site was archived and used for the wave run-up analysis, as described in the next section.

3.3 WAVE RUN-UP ANALYSIS

The BC *Provincial Sea Dike Guidelines* (MOE, 2011) accept the use of a number of criteria for calculation of the wave run-up component for design elevation. For this study, the 2% exceedance level was adopted, that is the run-up from a wave with a height that is only expected to be exceeded by 2% of the waves occurring during a design event.

The wave run-up is estimated using the method described in *Technical Report: Wave run-up and wave overtopping at dikes* (TAW 2002). Required data includes wave heights and periods, angle of propagation, and structural design information such as the profile of the shoreline and bank, depth of the fronting slope, and roughness and porosity of the shoreline bank materials. Wave characteristics were obtained from the wave model. Design profiles of beach and landscape, and structure location have not yet been provided in detail. Based on preliminary design concepts the TAW method was applied to the hourly hindcast wave data from the wave model to determine hourly wave run-up at the site. Based on sensitivity of the water level to the range of potential profile conditions simulated, an additional freeboard of 0.3 m has been included in the design.

3.4 FREQUENCY ANALYSIS

Goda (1988) extreme event analysis was conducted on the generated water level time-series from the hindcast water level and wave run-up. The analysis used a partial duration or peak-over-threshold (POT) data series consisting of the maximum consecutive water levels for each event exceeding a given threshold. **Table 2** provides baseline tidal water levels (from Canadian Hydrographic Service Chart 3493) and results from the frequency analysis for extreme water levels.

Table 2: Reported and predicted water elevation

Sea State	Tide Elevation (m GD)
Higher High Water, Large Tide (HHWLT)	1.9
Higher High Water, Mean Tide (HHWMT)	1.3
Mean Water Level (MWL)	0.0
Lower Low Water, Mean Tide (LLWMT)	-2.0
Lower Low Water, Large Tide (LLWLT)	-3.2

Event	Water Level (m GD)
2-Yr	2.8
5-Yr	3.0
10-Yr	3.1
20-Yr	3.2
50-Yr	3.3
100-Yr	3.4
200-Yr	3.5

3.5 SEA LEVEL RISE

Sea level rise to be experienced at the site is the sum of the global rise in sea level during the design life plus the local ground subsidence during the same period; negative if local ground is experiencing uplift. The Draft Policy Discussion Paper (MOE, 2011b) suggests using a global SLR value of 10 mm/yr for BC dike design and a local ground uplift rate of 1.2 mm/yr (uplift for Vancouver). The net SLR for Noble Cove is 8.8 mm/yr.

3.6 FLOOD CONSTRUCTION LEVEL

Design FCL was derived by the summation of the 200-year water level (based on frequency analysis of design events from historic tide, surge, wind set-up, and wave run-up), SLR, and freeboard. The freeboard includes 0.6 m applied to account for temporal and spatial variances, as well as precision of the approximation and 0.3 m to account for uncertainty in the shoreline and bank profile (**Section 3.3**). **Table 3** summarizes the results providing the recommended FCL for current and future condition.

Table 3: Flood Construction Levels

FCL Components	2012	2100	2200
200-year Water Level (m GD) (including tide, surge, wind set-up and ½ wave run-up)	3.5	3.5	3.5
Sea Level Rise (m)	0.0	0.9	1.8
Freeboard (m)	0.9	**0.9**	0.9
Flood Construction Level (m GD)	4.4	**5.3**	6.2
Reduction (m) from addition method	0.9	0.9	0.9

The following figure (**Figure 6**) presents an approximation of the projection of the year 2100 FCL for the project site based on present site geography, that is the 5.3 m GD contour.

Figure 6: Approximation of coastal FCL of 5.3 m for current site geometry

3.7 CREEK FLOODING

One unamed creek crosses through the property, and another smaller creek is located to the east of the property. Based from delineation of the watersheds on a 1:20,000 scale TRIM[1] map 92G036 the larger of the creeks catchment above the project site is on the order of 56 ha. Hydrological analysis for the creek was carried out using regional information contained in the British Columbia Streamflow Inventory (BCSI - Coulson et al., 1998). The BCSI provides a 1:2,000,000 scale provincial map of 100-year peak instantaneous flood isolines based on a drainage area of 100 km^2. According to the map, the regional 100-year peak flood (per 100 km^2) in the vicinity is approximately, 200 m^3/s. Flow was transposed to the local watershed through area transposition to the power of 0.785 to provide an approximate instantaneous design flood of 3.4 m^3/s.

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[1] Terrain Resource Information Map, an initiative of B.C. Ministry of Crown Lands

A simplified one-dimensional numerical model was developed for the creek based on existing channel dimensions, slopes, and roughness. Based on this assessment the design sectional average velocity is 2.4 m/s and the design depth of flow is 0.4 m. Construction adjacent to either of the creeks should incorporate an FCL of 1 m from the bed of the adjacent creek. Any reconstruction of the creek that crosses the property should including armouring of the toe of the channel banks using semi-angular rock with 50% of the stones by mass having a median diameter of 350 mm. Such stones should also be used to provide periodic grade control; with rows of stones spaced no greater than 2 m for slopes greater than 5% and 3.5 m for slopes less than or equal to 5%.

Figure 7: Location of low ground adjacent to creek

Low ground, FCL potentially governed by adjacent creek

The existing ground is lower than the adjacent creek along the right bank of the creek that crosses the centre of the property (**Figure 7** and **Photo 9**). This should be filled or the creek embankment improved or further assessed to prevent overbank flow from the creek (more likely originating from seepage than embankment failure). As shown in **Figure 6** the coastal FCL appears to extend through this low lying portion of the property as well. The steep gradient of the creek and relatively small flow negates any need to investigate simultaneous occurrence of high coastal water levels and high creek flows, such condition associated with a similar probability would not govern the FCL.

4 WAVE LOADING ANALYSIS

Noble Cove is exposed to wind-driven waves and boat wakes. To assess the wave loading on the shoreline stabilization system, the wind-driven wave climate and boat wake climate were evaluated separately.

4.1 WIND-DRIVEN WAVES

Since there is no comprehensive measurement of waves in Noble Cove, the incident wave climate hindcast from the UMWM model (**Section 3.2**) was used to establish the design wind-driven wave. Noble Cove is susceptible to waves generated by winds from the west, southwest, south and southeast. Goda analysis was applied to the 58-year time series of waves generated by the UMWM model to extract the wave height associated with storms of varying return period. Scatter plots prepared for the entire wave simulation showed no distinct relationship between wave height and period. Thus, the wave period associated with the various return period wave heights could not be determined directly from extreme value analysis. However, the wave height and period were determined to track closely during storm events and permitted a relationship to be established between wave height and period based on the rising limbs of the largest storms in the simulation. The relationship was very consistent for all events considered, given $T \approx 4.3 H^{1/2}$, where T is the period in seconds and H is the wave height in metres. The results are presented in **Table 4**.

Table 4: Wind-Driven deepwater wave for various return periods using UMWM model

	West		Southwest		South		Southeast	
Return Period	Wave Height (m)	Wave Period (sec)	Wave Height (m)	Wave Period (sec)	Wave Height (m)	Wave Period (sec)	Wave Height (m)	Wave Period (sec)
1	0.51	3.02	0.18	1.82	0.18	1.83	0.26	2.16
5	0.67	3.45	0.25	2.15	0.24	2.12	0.33	2.43
10	0.73	3.60	0.28	2.28	0.27	2.25	0.37	2.55
20	0.78	3.74	0.31	2.40	0.30	2.37	0.40	2.67
50	0.86	3.91	0.35	2.56	0.34	2.52	0.44	2.81
100	0.91	4.03	0.38	2.67	0.37	2.63	0.48	2.91
200	0.96	4.15	0.41	2.78	0.40	2.73	0.51	3.00

The deepwater waves from the UMWM model were transformed to the nearshore zone with the model SWAN (Booij et al. 1996). SWAN incorporates physical processes such as wave propagation, wave generation by wind, white-capping, shoaling, wave breaking, bottom friction, sub-sea obstacles, wave setup and wave-wave interactions in its computations.

The SWAN model was implemented on a bathymetric grid resolved on a 20 m by 20 m orthogonal grid spacing. The model grid was generated from hydrographic charts. The grid extends 3,000 m in the east-west direction and 1,800 m in the north-south direction. The offshore wave height and period determined from the extreme event analysis of the UMWM model results were used as input to the model on the boundaries.

The SWAN model domain and vector fields showing the transformation of the 200 year extreme deepwater waves from the west, southwest, south and southeast when the water level is at Higher High Water Mean Tide (HHWMT), 1.3 m GD, are shown in **Figure 8**, **Figure 9**, **Figure 10**, and **Figure 11** respectively. Wave height distributions are shown by coloured shading, wave direction and relative heights are shown by vectors and dark contour lines represent depth in chart datum.

Figure 8: 200-year westernly wave

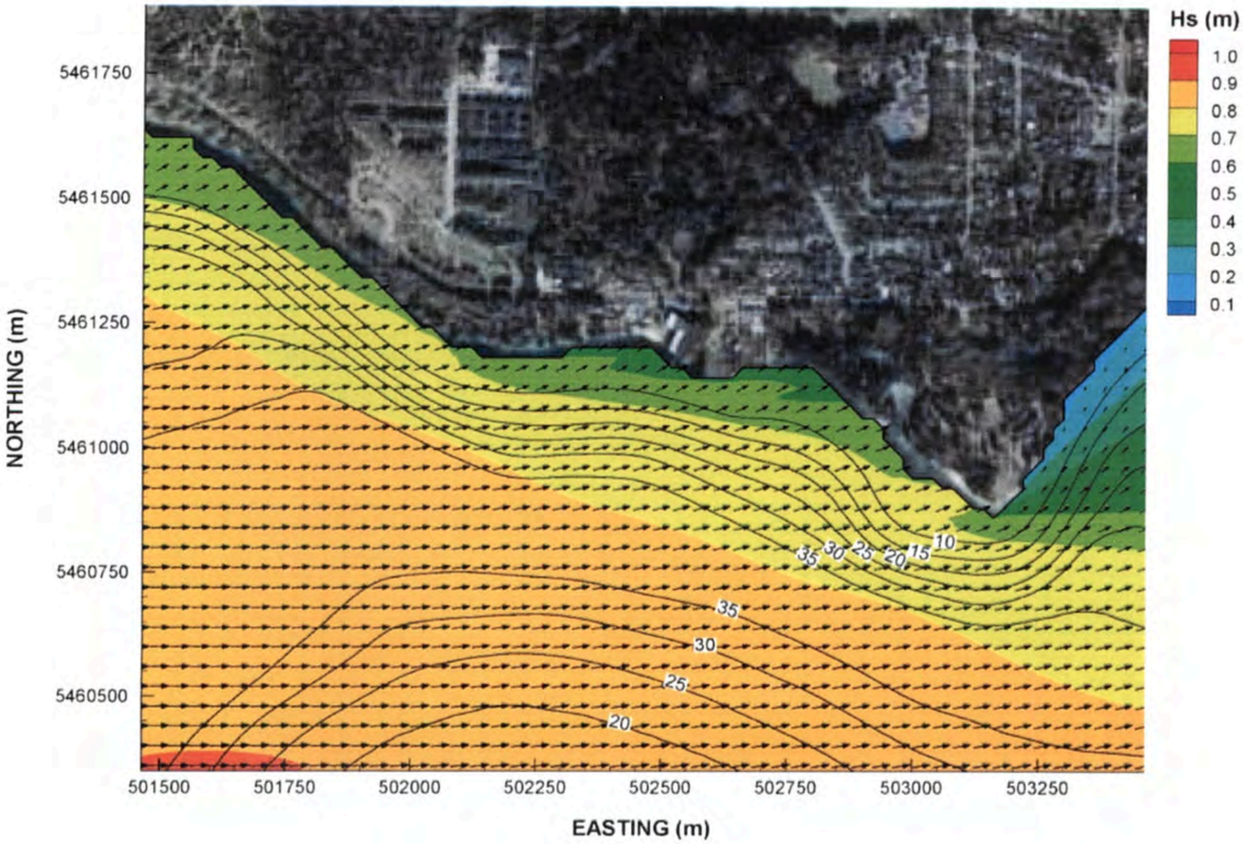


Figure 9: 200-year southwesterly wave

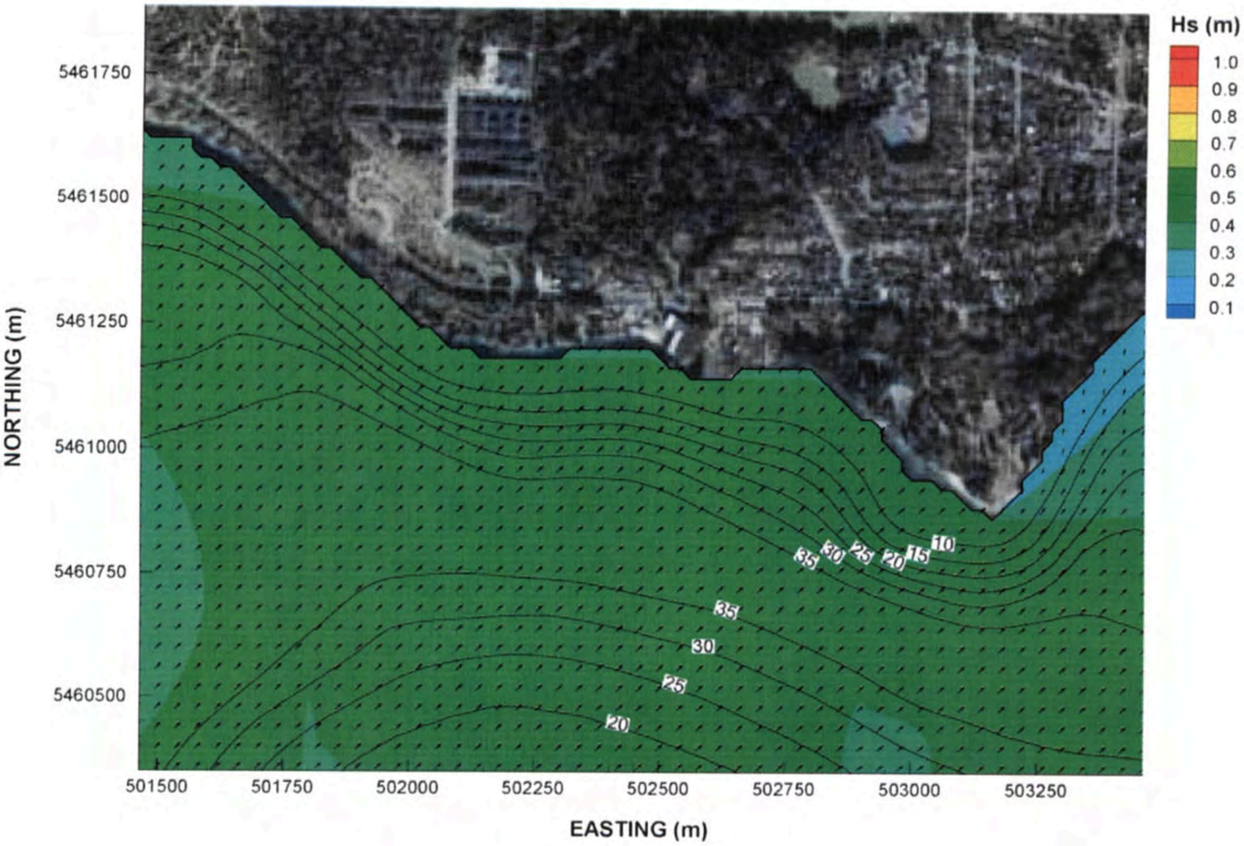


Figure 10: 200-year southerly wave

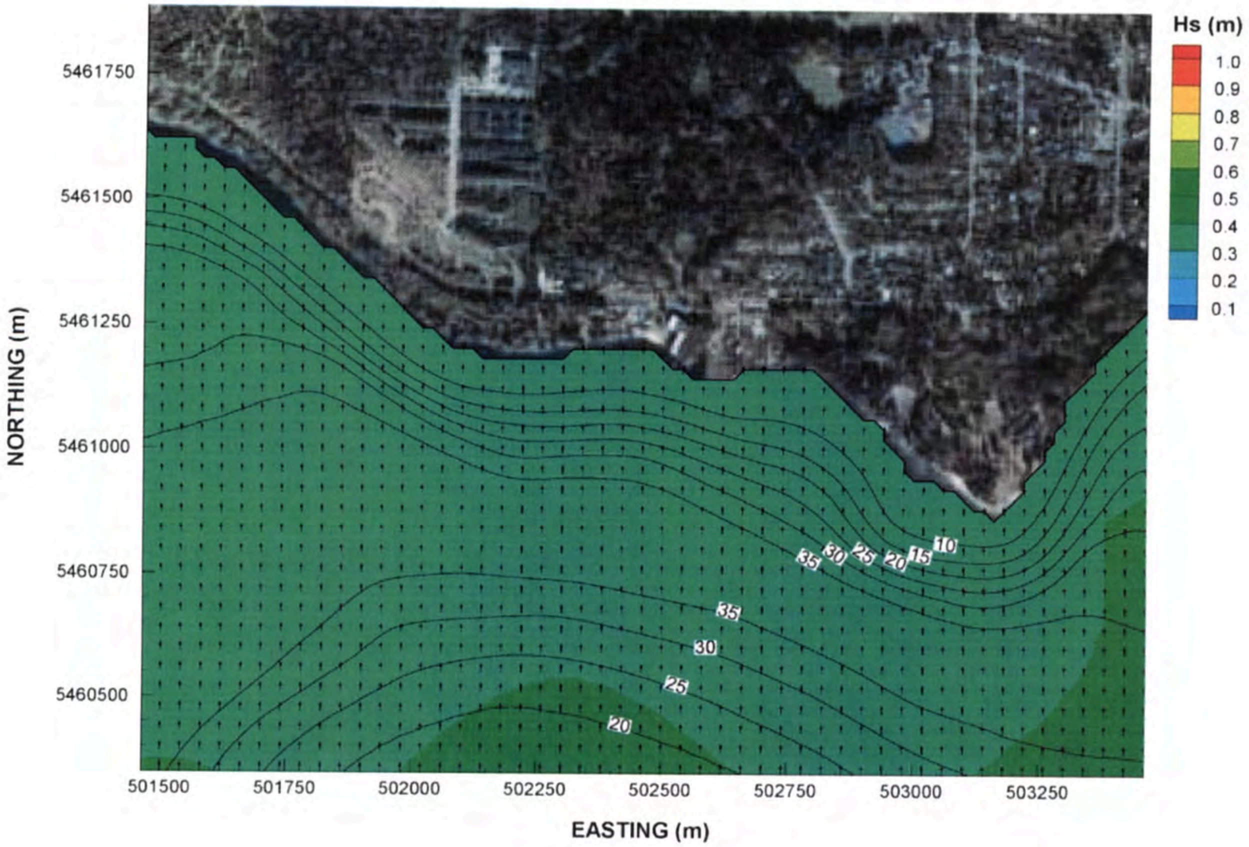
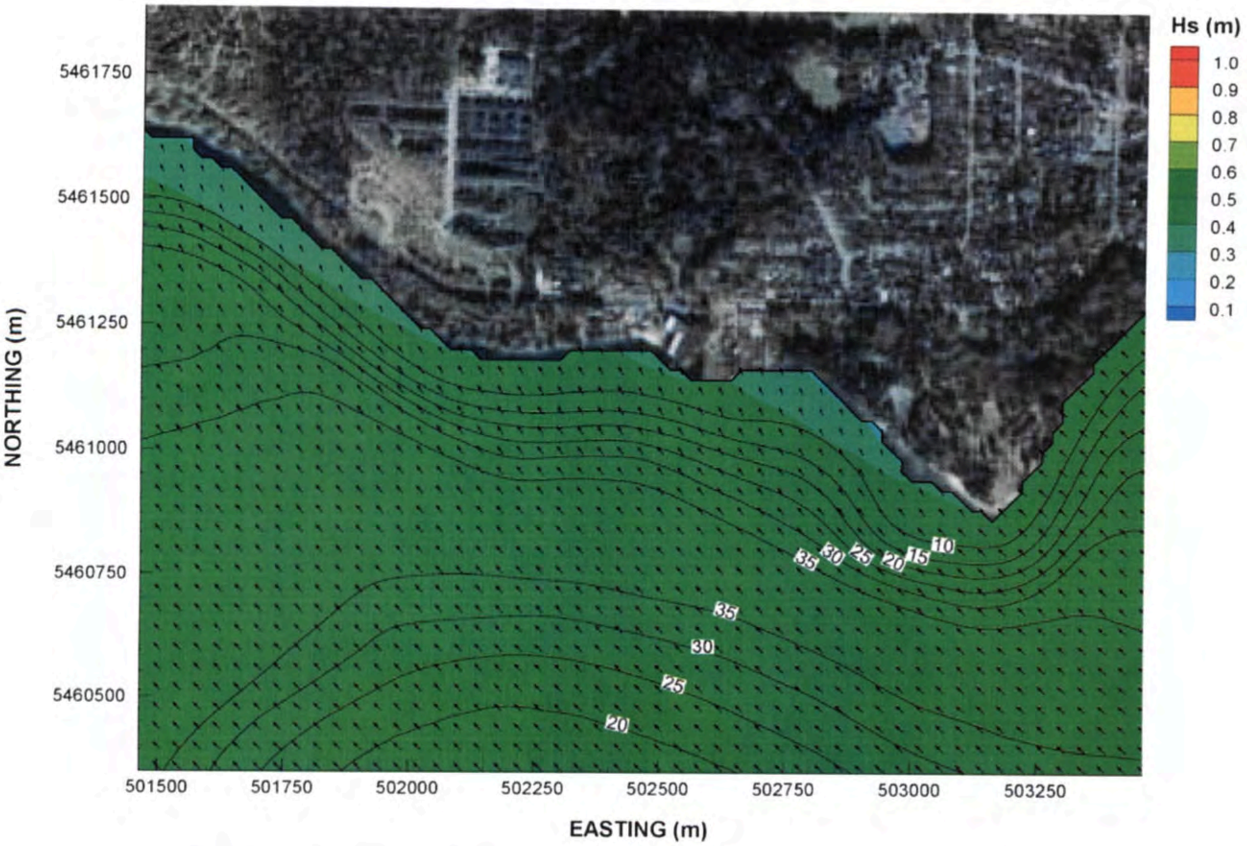


Figure 11: 200-year southeasterly wave



The aforementioned wave conditions are summarized in **Table 5**.

Table 5: 200-year nearshore wave at Noble Cove, water level at HHWMT

	Wave	
Direction	Wave Height (m)	Wave Period (sec)
West	0.60	3.19
Southwest	0.40	2.36
South	0.39	2.32
Southeast	0.41	2.49

4.2 VESSEL GENERATED WAVES

When a boat moves across the surface of water, it displaces water and meets resistance, some of which manifests itself as wave energy. The displaced water first moves up whereupon gravity acts upon it, resulting in the familiar form of an undulating wave with predictable shape and properties (URS, 2003). The characteristics of a boat wake when it reaches the shoreline depend on many factors such as ship type and size, speed, water depth, and distance of the shoreline from the vessel's sailing line. Boat wake height is estimated from the following equation proposed by Verhey and Bogaerts (1989).

The computed maximum wave heights, H_{max}, for various vessels operating in the area of Noble Cove are provided in **Table 6**.

Table 6: Maximum wave heights created by boat wakes

Parameter	Vessel Type				
	Tug[1]	Barge (towed by tug)	Fishing Boat	Recreational Speed Boat	Largest Tanker Ship[2]
Length, L_e (m)	37.8	163	17.5	5.2	379.7
Beam (m)	11.3	41.2	4.6	2.2	56.4
Draft (m)	4.5	4.0	2.0	0.4	15.5
Depth of Water, h (m)[3]	17	17	17	17	23
Distance from shore, s (m)[4]	350	350	210	210	580
Service Speed, v_s (knots)	10	10	15	20	10
Max. Wave Height, H_{max} (m)[5]	0.15	0.08	0.45	0.45	0.11

[1] Tug boat dimensions provided by Seaspan
[2] Based on largest container ship, Maersk Emma
[3] Water depth reported as the lowest normal water depth according to Canadian Hydrographic Service Chart 3493, 2013.
[4] Distance between ship's side and bank (distance from shore) were determined from Historical Google Earth imagery of travel routes for vessel types.
[5] α_1 as recommended by Verhey and Boagaerts 1989.

5 LOW WATER LEVEL

Low water levels are also an important design consideration to prevent exposure and damage of the toe of erosion protection structures. Low water level is a combination of low tide and negative surge. Negative surge can occur during periods of high atmospheric pressure and can also be driven by disturbances propagating into the Strait of Georgia from the open Pacific.

A statistical analysis of modelled water levels, which inherently includes the combined effect of low tides and negative surge, gave a 200-year low water level of -3.5 m GD. As with the high water analysis, the recommended design value for the low water level of 200-year return period is the value derived from observations, -3.5 m GD.

6 TSUNAMI

Tsunami's are long-waves caused by displacement of a large volume of water, potentially resulting from earthquake, volcanic eruption, or landslide. The Centre for Natural Hazard Research at Simon Fraser University (Clague & Orwin, 2005) stated that they were unable to find regional geological evidence of past tsunamis spanning more than 4000 years. They further states the risk of North Vancouver being struck by a damaging tsunami (wave height in excess of 2.5 to 3.0 m) is very low; with an annual probability of occurrence of 0.1% or less; that is 1 event every 1000 years. Since this study suggests a maximum expected tsunami elevation on the order of 0.5 to 1.0 m below the 200-year design water level, tsunami events were not further applied to the design.

7 BANK ARMOURING

Based on the 200-year nearshore design wave of 0.6 m, the recent king tide conditions, and the potential greater near shore condition of 1.0 m in 2100, rock armouring is proposed as defined in **Table 7** to armour the bank of the shoreline. It has been assumed that the bank will be sloped at 2H:1V. This table provides an initial estimate and NHC requests the opportunity to revise or review design drawings once site profiles are developed.

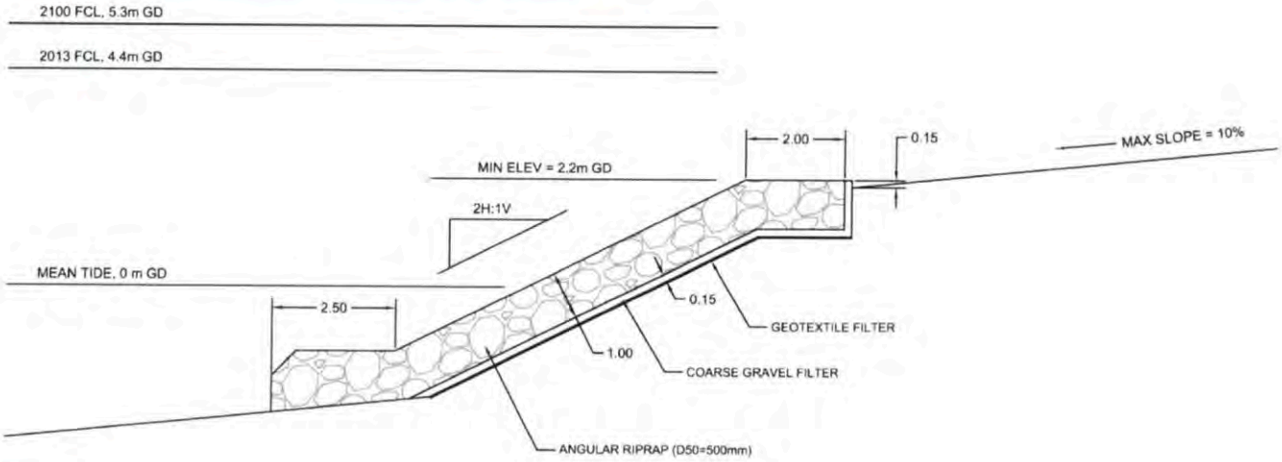
Table 7: Erosion Protection

Criteria	Value
Median Diameter & Gradation (mm)	500 D_{15}=200-380, D_{20}>380, D_{50}>500, D_{80}>550, D_{85}>600, D_{100}=850-1000
Thickness (mm)	1,000
Min Elevation (m GD)	2.2
Toe Apron width (m)	2.5
Underlying Filter Rock	medium to very coarse gravel or pit-run (15 to 90 mm, +/-15)
Underlying Filter Rock Thickness (mm)	150
Underlying Filter Fabric	Nilex 4545 non-woven or equivalent ($q > 6$ L/s/m^2 AND opening size < 0.35 mm)

Minimum armouring elevation has been set at 0.3 m above current HHWMT. It should be expected that armouring may need to be extended to a minimum elevation of 3.1 m GD by the year 2100 to account for SLR. Design of the site should either include this additional height of armouring now or be adaptable to future sea levels.

Figure 12 provides a sketch of typical shoreline bank armouring. Habitat benches are often incorporated in armoured banks to provide local aquatic habitat compensation. The design should be refined and further detailed as survey data is available for the intertidal zone, habitat benching requirements are defined (elevation, width, soil thickness), and proposed shoreline profile is known.

Figure 12: Typical section of coastal bank armouring



8 SUMMARY AND CONCLUSIONS

Geomorphic impacts to or from the project are not expected to be substantial. However, the removal of the pier at the east of the property and hence the shelter this structure may have historically provided may lead to increased waves and erosion along the shoreline and bank of Cates Park immediately east of the project site. Monitoring following substantial westerly events during the first two to five years should be considered to ensure bank erosion or shoreline changes are not adversely impacting the park.

The study established the Flood Construction Levels (FCLs) and 200-year low water level for the Noble Cove development using a joint probability method based on 58-years of hindcast data. The FCL for the year 2100 is El. 5.3 m GD. This value is 0.9 m lower than the value derived using simple addition method described in the provincial guideline for dike design. The 200-year low water level is established to be at El. -3.5 m GD.

Two types of waves, wind-driven waves and vessel generated waves, were evaluated to establish the design wave criteria for site stability. A 1.0 m high and 3.2 s period design wave from the west governed design for bank stability. Based on this design event it is proposed that the banks are armoured with angular rock riprap with a D_{50} median diameter of 500 mm. Armouring should be no steeper than 2H:1V, 1.0 m thick, and be separated by both a granular and geotextile filter from the underlying material unless underlying conditions can be shown to negate the need for the geotextile filter.

9 CLOSURE

We trust this document meets your immediate requirements. As stated within this document, NHC can refine the assessment and provide review of concept or detail design/drawings as these materials are developed. It is recommended that the findings of this assessment be presented to the District of North Vancouver to obtain early acceptance of methodology and findings.

If you have any questions, please do not hesitate to contact Edwin or Dale at 604.980.6011, ewang@nhcweb.com, or dmuir@nhcweb.com.

Sincerely,

northwest hydraulic consultants ltd.

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2015-APRIL-[illegible]

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Associate Engineer

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PHOTOS

Photo 1: Noble Cove west - view east from Dollarton Hwy

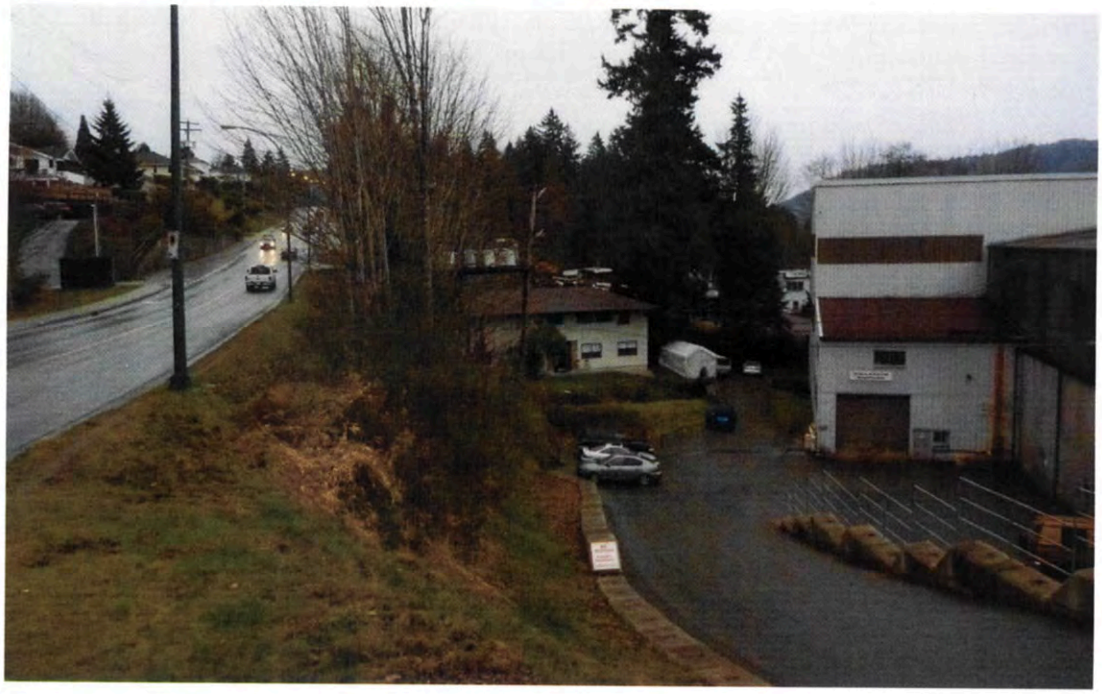

Photo 2: Noble Cove east - view south from Dollarton Hwy

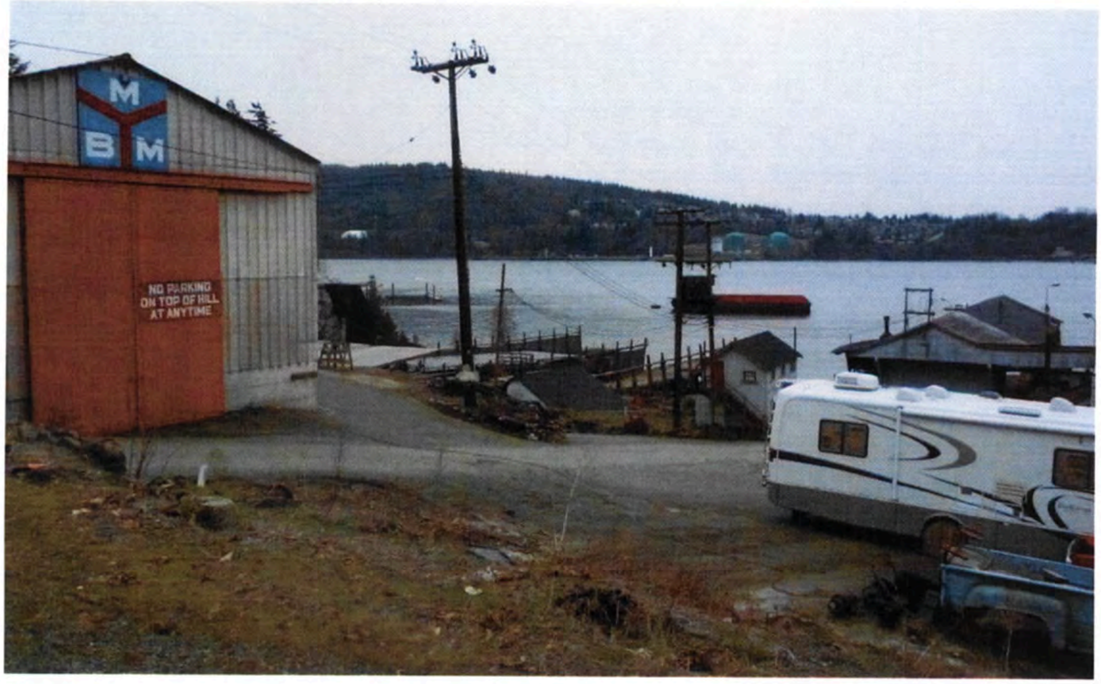

Photo 3: Noble Cove east - view from west side of property

Photo 4: Noble Cove east - view southwest at pier

Photo 5: Noble Cove west - view west of sand beach

Photo 6: View east from west end of property

Photo 7: Bank toe at Cates Park, signs of shoreline erosion where rock protection is not continuous

Photo 8: Upstream view of creek near east side of property

Photo 9: Upstream view of creek near centre of property, view towards Dollarton Hwy crossing

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October 31st, 2013

Mr. Doug Allan
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District of North Vancouver
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V7N 2K6

RE: Retail Feasibility — 3829 & 3919 Dollarton Highway, North Vancouver, BC

Mr. Allan

This letter is to outline the findings of a feasibility study conducted by Colliers International ("Colliers") to ascertain the viability of a retail use at Polygon Homes' ("Polygon") proposed Noble Cove development at 3829 & 3919 Dollarton Highway ("the Subject").

Potential service based retail viability is based on a confluence of factors, the most relevant of which are: size of the potential market; physical quality of the location (i.e. ease of access and visibility); the competitive landscape; and proximity to complimentary uses.

Colliers studied the Subject for the above factors and from them ascertained its potential demand from retail users—specifically service uses such as coffee houses.

Coffee houses are traditionally most successful in highly dense urbanized areas. They benefit from not only the density but also the youthfulness of city core demographics and small home size. The smaller the home the more often residents visit coffee shops, and for longer durations.

In areas with an older population base, living in larger homes and surrounded by nature and green spaces, coffee houses are in much less demand. They are viewed more as coffee 'stores' than meeting places, and are therefore best located in easily accessed areas in direct proximity to other service oriented retailers.

1. Potential Market

The subject location is located on Dollarton Highway along Burrard Inlet in a strip which is primarily undeveloped and is immediately surrounded by Roche Point Park and Cates Park. It is a scarcely populated area of North Vancouver with under 2,200 residents per square kilometer. The population is reduced by a third during daytime hours, to approximately 1,400, as there is limited industrial and commercial development in the area and the vast majority of residents commute elsewhere for work.

Both the permanent and daytime population of a potential location are important as the two dictate the potential of revenue streams for service based retail. Using a coffee shop as an example, a dense daytime population may suggest busy weekday hours focusing on morning and lunch and coffee meetings while a high residential population may increase the likelihood of strong weekend business and early morning traffic from commuting residents.

The ideal mix is both a high residential and daytime population, while conversely the least palatable population density mix is scarcity of both permanent and daytime populations. Unfortunately, the subject suffers from said scarcities.

2. Quality of Location

The physical location of the subject is also challenging for a retail use. The site is set back from the Dollarton Highway and will not be visible from the street. It is located on the steep face of a hillside which has an average drop from street to foreshore along Burrard Inlet of 50 feet. Access is also a challenge, with no signaled access making retail customer's access and egress difficult as well as potentially dangerous. Parking will also be extremely limited.

All of the above factors will contribute to the undesirability of the Subject by possible retail users.

3. Competition & Proximity to Complimentary Uses

Due to its low density and varying elevations, retail is accessed in North Vancouver primarily by vehicle (except for certain high-density nodes such as Lonsdale or Edgemont Village). Therefore, stand-alone retail is extremely rare. Due to this, competition for the potential Subject is found in the form of retail centres. These benefit from ease of access, high traffic counts, and ample parking. Notable nearby centres include:

Seymour Creek Power Centre
Size: Potential 400,000 square foot power centre
Retailers: Real Canadian Superstore
Parkgate Village Shopping Centre
Size: 90,000 square feet
Retailers: Safeway, Shoppers Drug Mart, Bean Around the World Coffee
Dollarton Shopping Centre
Size: 35,000 square feet
Retailers: Super Valu, Starbucks Coffee, BC Liquor Store, Royal Bank

All of the above centres benefit from complimentary tenant mixes, which allow consumers to view them as 'one stop shops'. Due to the subject's isolation, it benefits from no such proximities. Dollarton Shopping Centre is less than one kilometer from the Subject and has a Starbucks in the development.

The isolation and natural beauty of the Subject's location, which ideally situate it for residential development, are the same factors that make it unviable for service based retail. It suffers from a limited residential population catchment; limited access, visibility and parking; and established nearby competition.

These challenges are further exacerbated by the topographically dictated vehicular habits of North Vancouver's residential population which has fostered a culture of destination shopping based around centres and nodes. The direct proximity of the Dollarton Shopping Centre is especially troubling, as it has a highly visible Starbucks Coffee.

Due to the factors outlined in this report it is Colliers findings that a retail use would be unviable in Polygon's proposed development at 3829 & 3919 Dollarton Highway.

If you have any question or concerns, please do not hesitate to contact me.

Regards,

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POLYGON DEVELOPMENT 270 LTD.

3829/3919 Dollarton Highway Flood Hazard Report

File No. 12123
October 4th 2013

CREUS Engineering Ltd
200 – 901 W 16TH ST NORTH VANCOUVER, BC V7P 1R2
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Civil Engineers & Project Managers

TABLE OF CONTENTS

1. INTRODUCTION

Polygon Development 270 Ltd. (Polygon) are in the process of developing a site at 3829/3919 Dollarton Highway in the Roche Point neighborhood of the District of North Vancouver (DNV). Due to the proximity of the proposed structures to water bodies the DNV requires a Flood Hazard Report be prepared in accordance with the District's Master Requirement SPE 106. This report has been prepared to address this requirement and will discuss a number of items including:

- background information,
- property description
- design criteria & flood construction levels
- debris flow
- existing channel condition and capacity
- proposed channel works
- safe certification
- environmental & maintenance requirements

2. BACKGROUND INFORMATION

The subject property is located in the DNV between the Dollarton Highway and the Burrard Inlet to the West of Roche Point. The area is characterized by moderately sloping terrain with an average site grade of approximately 7% from north to south. The site is bisected by Roche Point Creek and there is a second smaller creek flowing to east of the property. There are numerous small watersheds in the vicinity of the site which have been the subject of several District of North Vancouver flood and hazard studies. Further to these reports Northwest Hydraulic Consultants (NHC) have prepared a memo, which addresses hazards to the proposed development posed by creak and coastal waters.

The NHC memo dated March 13, 2013 deals primarily with concerns arising from sea waters and specifies design criteria to overcome these concerns. As such all matters relating to protection from sea waters should be directed to and are dealt with in the NHC memo. NHC also comments on the two creeks mentioned above. A design flow rate is quantified for Roche Point Creek, which will be used as the basis for further analysis herein and flood construction levels are established in relation to both the creeks and the sea waters. The NHC memo should be reviewed in conjunction with this report and its recommendations considered in the design of this development.

Roche Point Creek will be re-graded and reconstructed as part of the proposed development. These works are to promote fish passage. This report will deal with any concerns arising from the proposed Roche Point Creek works.

3. PROPERTY DESCRIPTION

The site is made up of four adjacent properties, the address of the most westerly property is 3829 Dollarton Highway and the most easterly property is 3919 Dollarton Highway. The properties separate the highway from the Burrard Inlet. There is existing industrial infrastructure on the site including buildings, parking lot, driveways and a dock, which will be removed and replaced with a residential development. See Figure 1 and Picture 1 below.

Figure 1: Site Location Map

Picture 1: Aerial Photo – Existing Site

The legal descriptions of the lots from west to east are:

Lot 1, Blocks “A” and “D”, Plan 12037;
Lot 2, Blocks “A” and “D”, Plan 12037;
The center 1/3 of Lot A (Reference Plan 757);
The east 66 feet of the west 1/3 of Lot A (Reference Plan 757);
All of the Lots are in District Lot 230, Group one, New Westminster District.

The neighbouring lots to the west and north are single family residential and the site is bordered by Cates Park and the Burrard Inlet to the east and south respectively.

The proposed development will combine the four existing lots into one lot. The proposed lot will contain 5 two story townhomes – 15 units and 3 four story apartment buildings – an additional 80 units. There is also an existing dock area which will be removed and the foreshore will be remediated in that area.

4. DESIGN CRITERIA & FLOOD CONSTRUCTION LEVELS

The standard for flood protection works is to provide protection to the 200-year return period flood level. Flood protection typically consists of providing sufficient channel capacity to safely convey the design storm plus freeboard (typically 0.6 m). Surcharging at culverts and storm inlets is sometimes considered acceptable.

As mentioned above the site has previously undergone analysis by NHC. NHC have established a design flow event of 3.4 m^3/s for Roche Creek. This flow will be used as the basis for further analysis in this report. NHC have established a Flood Construction Level (FCL) for development adjacent to the creek of 1.0 m above the creek bed. There is a second creek to the east of the property. NHC have also established a FCL for development adjacent to this creek of 1.0 m above the creek bed.

Further to flooding hazards posed by the creek the site is subject to flood hazards posed by the sea. NHC have proposed a FCL of 5.3 m geodetic for the whole site. The approximate current location of the 5.3 m contour can be seen in Picture 2 from NHC below. For the majority of the site the 5.3 m FCL is the governing design criteria as it is generally higher than 1.0 m above the creek bed. NHC have identified a specific area to the west of the creek where particular attention should be paid to FCL in relation to the creek bed elevation. Here the existing ground is above 5.3 m geodetic but less than 1.0 m above the adjacent creek bed. See Figure 2 below and Picture 4 on page 4.

Picture 2- Approximation of coastal FCL of 5.3 m for current site geometry - from NHC

Figure 2- Location of low ground adjacent to creek - from NHC

5. DEBRIS FLOW

According to the NHC memo, upland slopes of the Roche Point Creek are subject to failure during extreme rainfall events. Slide material would enter the creek no closer than 80 m upstream of Dollarton Highway and based on the channel gradient the creek appears to lack the conveyance to transport substantial material downstream. The NHC memo notes that landslide or landslide debris blocking the Dollarton Culvert or the creek within the property is unlikely. Therefore the proposed development has not been designed to accommodate substantial debris flow events.

6. EXISTING CHANNEL CONDITION AND CAPACITY

Upstream of the subject property Roche Point Creek flows in its natural state, in a large forested gully. The creek flows under Dollarton Highway and enters the site via a 1.8 m diameter corrugated metal pipe (CMP) culvert. The culvert is perched above the creek bed creating a small plunge pool at the culvert outlet. From the culvert the creek flows in an open channel for roughly 20 m. The channel banks are steep and well defined with boulders, waste concrete and well vegetated soil. See Picture 3 and Picture 4 below. Downstream of the open channel the creek flows under a concrete deck before discharging to the Burrard Inlet.

Picture 3-Creek location

Picture 4- Upstream view of Roche Creek - from NHC note: low area to the left

Existing Channel - Typical Geometry

Channel Type	Bed Width (m)	Min. Depth (m)	Longitudinal Slope (%)	Eastern Bank Slope	Western Bank Slope
Open Channel	3.0	1.2	5.3	1h :1v	0.5 h : 1v

Existing Channel – Capacity

Channel Type	Channel Capacity (m^3/s)	Design Flow Event (m^3/s)	Design Flow Depth (m)	Freeboard (m)
Open Channel	30[1]	3.4[2]	0.33	0.8

1-Hydraflow Express Extension for AutoCAD Civil 3D 2013 – See Attached
2-From NHC memo

The existing channel has adequate capacity to safely convey the 200-year design flood through the subject property.

7. PROPOSED RECONSTRUCTION WORKS

The existing channel is to be reconstructed in conjunction with the proposed development. The channel bed will be regraded to improve fish access in line with environmental recommendations. The proposed channel banks will be at a shallower grade. In accordance with the NHC report the channel bed and banks will be constructed of semi-angular rock with a D50 of 350 mm.

Proposed Channel - Typical Geometry

Channel Type	Bed Width (m)	Min. Depth (m)	Longitudinal Slope (%)	Eastern Bank Slope	Western Bank Slope
Open Channel	2.0	1.0	5.3	2 h :1 v	2 h : 1 v

Proposed Channel – Capacity

Channel Type	Channel Capacity (m^3/s)	Design Flow Event (m^3/s)	Design Flow Depth (m)	Freeboard (m)
Open Channel	22[1]	3.4[2]	0.4	0.6

1-Hydraflow Express Extension for AutoCAD Civil 3D 2013 – See Attached
2-From NHC memo

An Additional creek crossing is to be constructed for a proposed driveway. The crossing will be constructed from a 3.96 m x 1.68 m corrugated steel pipe multi-plate arch and will have sufficient capacity to convey the design storm. See figure 3 attached.

8. SAFE CERTIFICATION

The proposed development at 3829/3919 Dollarton Highway could be subject to flood events from Roche Creek and a second creek to the east of the property. Roche Creek is being reconstructed in conjunction with the proposed development. The proposed channel will be designed with capacity to contain the design flood event. This will mitigate potential flood damage to the planned development from Roche Creek. Proposed landscape, infrastructure and building grades should be established in conformance with the design criteria established in this report and the memo by NHC to insure the development is considered "safe" for the use intended from hydrological events originating from the two creeks in question. The objectives of the proposed hazard mitigation measures are to reduce the consequences of flooding to the subject property and not the overall risk in the creek watersheds.

9. ENVIRONMENTAL AND MAINTENANCE REQUIREMENTS

The proposed mitigative measures for the subject property require works within Roche Creek and to the Roche Creek banks. Permits from the District of North Vancouver and the Ministry of the Environment may be required for the construction of the proposed works.

No regular maintenance is required for the proposed works.

10. SUMMARY AND RECOMMENDATIONS

Polygon Development 270 Ltd. (Polygon) are in the process of developing a site at 3829/3919 Dollarton Highway in the Roche Point neighborhood of the District of North Vancouver (DNV). The proposed site is bisected by Roche Creek. There is a second smaller creek flowing to the east of the property. Both of these creeks have been assessed by Northwest Hydraulic Consultants (NHC) with respect to the proposed development. NHC recommends minimum flood construction levels in relation to the creek beds. Roche Creek is being regraded and reconstructed to improve fish access in conjunction with the proposed development. The proposed creek has capacity to convey the 200-year design flood event through the property. This report outlines the proposed works and their effects on the proposed development.

The minimum FCL for any area of the site is 5.3 m geodetic. The minimum FCL for construction adjacent to the creeks is 1.0 m above the creek bed.

Yours Sincerely,

CREUS Engineering Ltd

R. WARREN

Keith Kelly, E.I.T.

Reviewed By: Russell Warren, P.Eng.

FIGURE 1: EXISTING CHANNEL - CAPACITY

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.
Tuesday, Sep 24 2013

Existing Channel Capacity - No Freeboard

Trapezoidal

Bottom Width (m)	= 3.0000
Side Slopes (z:1)	= 1.0000, 0.5000
Total Depth (m)	= 1.2000
Invert Elev (m)	= 4.0000
Slope (%)	= 5.3000
N-Value	= 0.030

Calculations

Compute by:	Q vs Depth
No. Increments	= 16

Highlighted

Depth (m)	= 1.2000
Q (cms)	= 30
Area (sqm)	= 4.6800
Velocity (m/s)	= 6.4771
Wetted Perim (m)	= 6.0387
Crit Depth, Yc (m)	= 1.2000
Top Width (m)	= 4.8000
EGL (m)	= 3.3399

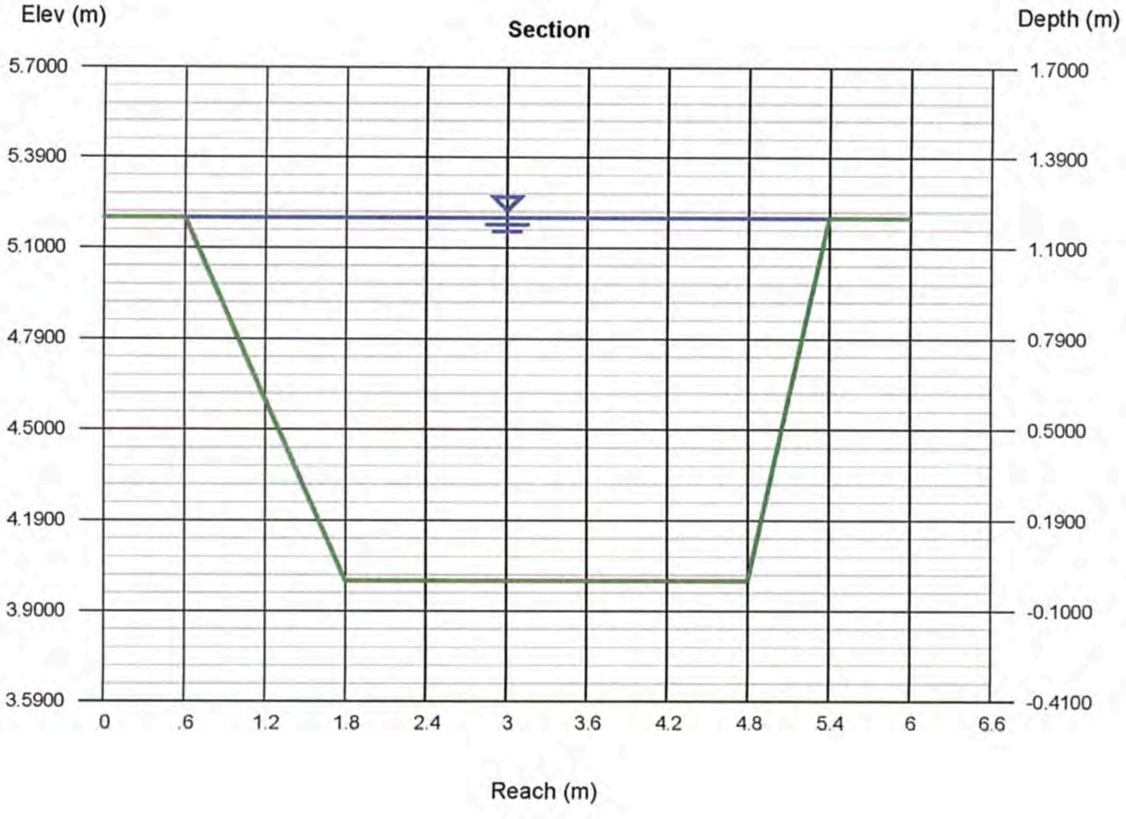


FIGURE 2: EXISTING CHANNEL – DESIGN STORM

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Sep 24 2013

Existing Channel Capacity - Design Flood

Trapezoidal
Bottom Width (m) = 3.0000
Side Slopes (z:1) = 1.0000, 0.5000
Total Depth (m) = 1.2000
Invert Elev (m) = 4.0000
Slope (%) = 5.3000
N-Value = 0.030

Calculations
Compute by: Known Q
Known Q (cms) = 3.4000

Highlighted
Depth (m) = 0.3261
Q (cms) = 3.4000
Area (sqm) = 1.0582
Velocity (m/s) = 3.2130
Wetted Perim (m) = 3.8259
Crit Depth, Yc (m) = 0.4877
Top Width (m) = 3.4892
EGL (m) = 0.8527

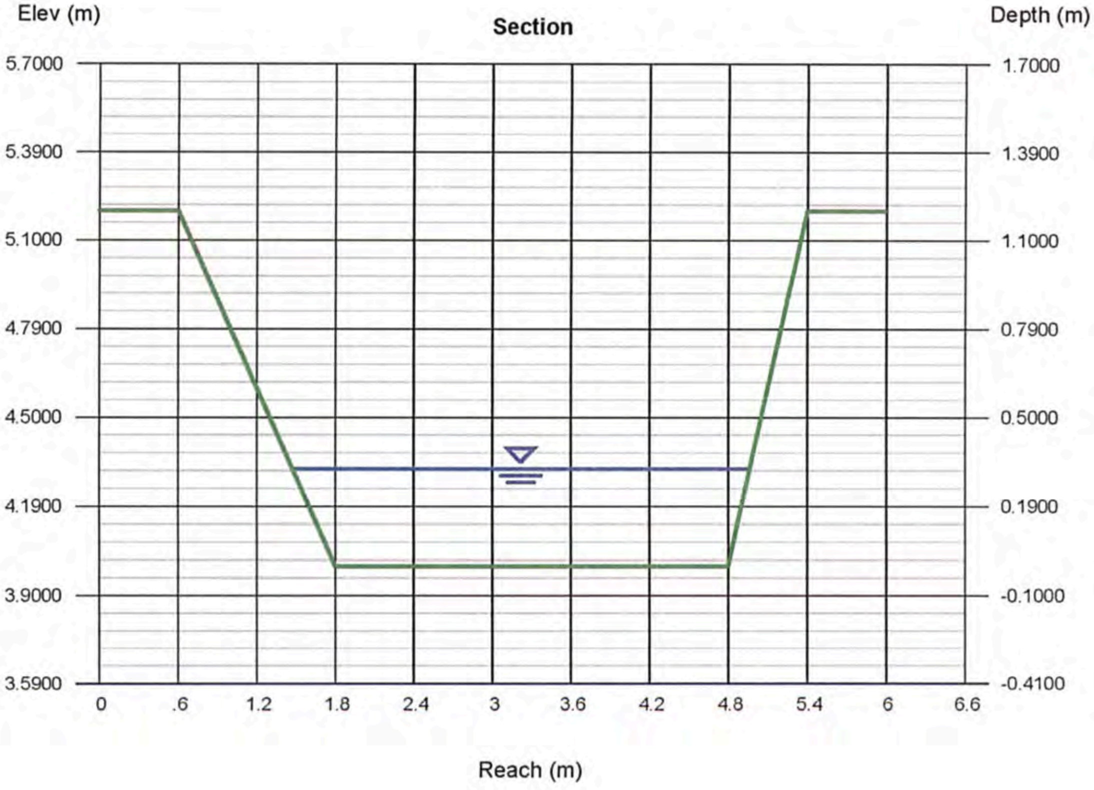


FIGURE 3/4: PROPOSED CHANNEL

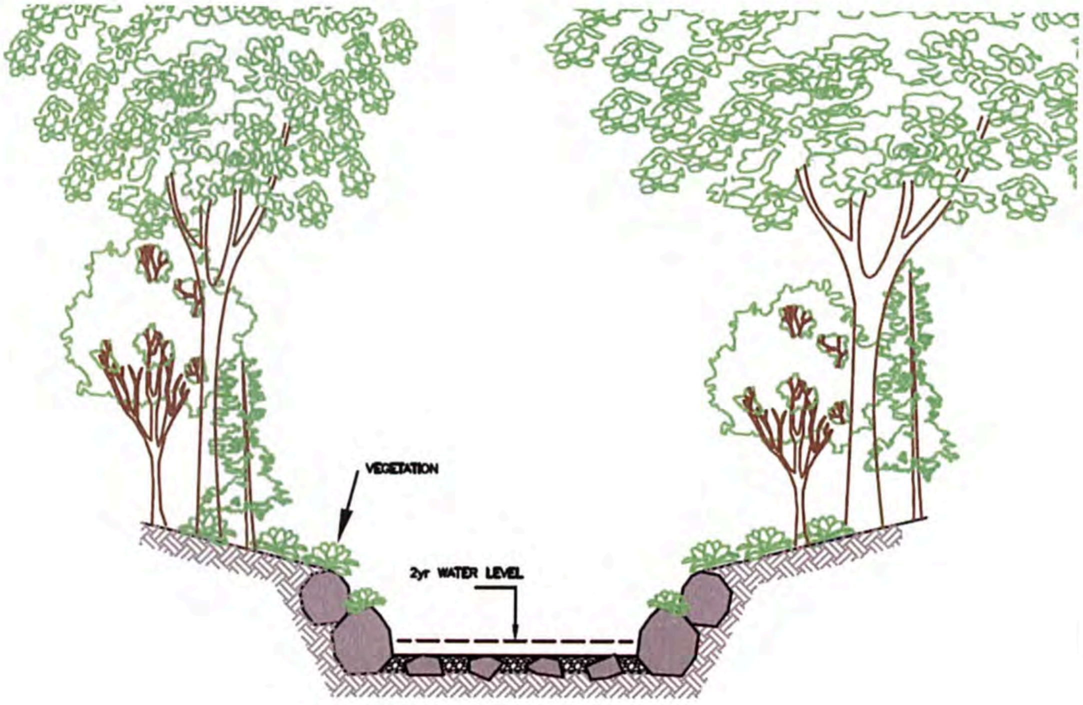


Figure 3- Proposed Typical Section

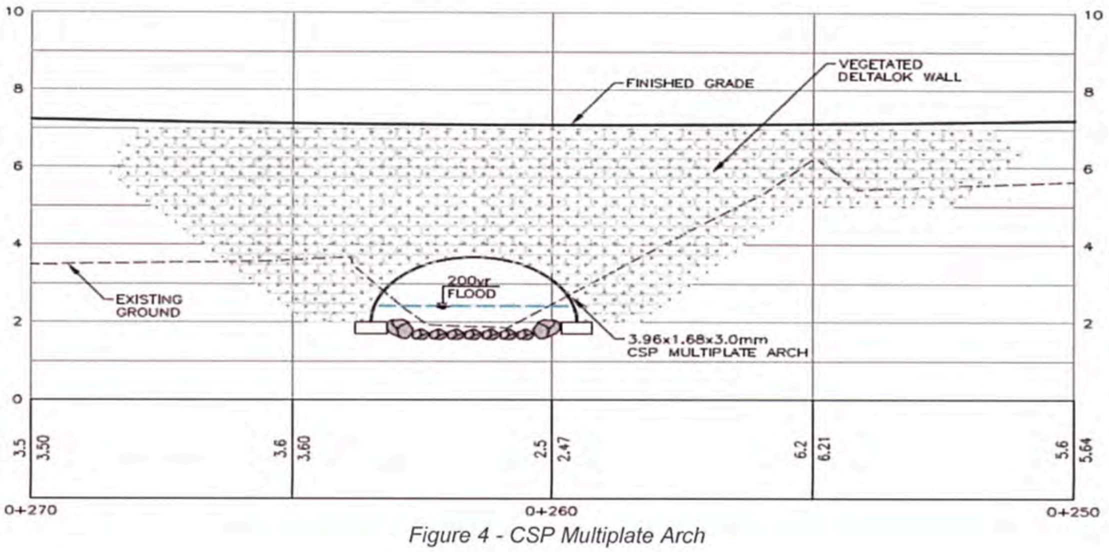


Figure 4 - CSP Multiplate Arch

FIGURE 5: PROPOSED CHANNEL CAPACITY

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Sep 26 2013

Proposed Channel - Capacity

Trapezoidal
Bottom Width (m) = 2.0000
Side Slopes (z:1) = 2.0000, 2.0000
Total Depth (m) = 1.0000
Invert Elev (m) = 4.0000
Slope (%) = 5.3000
N-Value = 0.030

Calculations
Compute by: Known Depth
Known Depth (m) = 1.0000

Highlighted
Depth (m) = 1.0000
Q (cms) = 22.2782
Area (sqm) = 4.0000
Velocity (m/s) = 5.5695
Wetted Perim (m) = 6.4721
Crit Depth, Yc (m) = 1.0000
Top Width (m) = 6.0000
EGL (m) = 2.5822

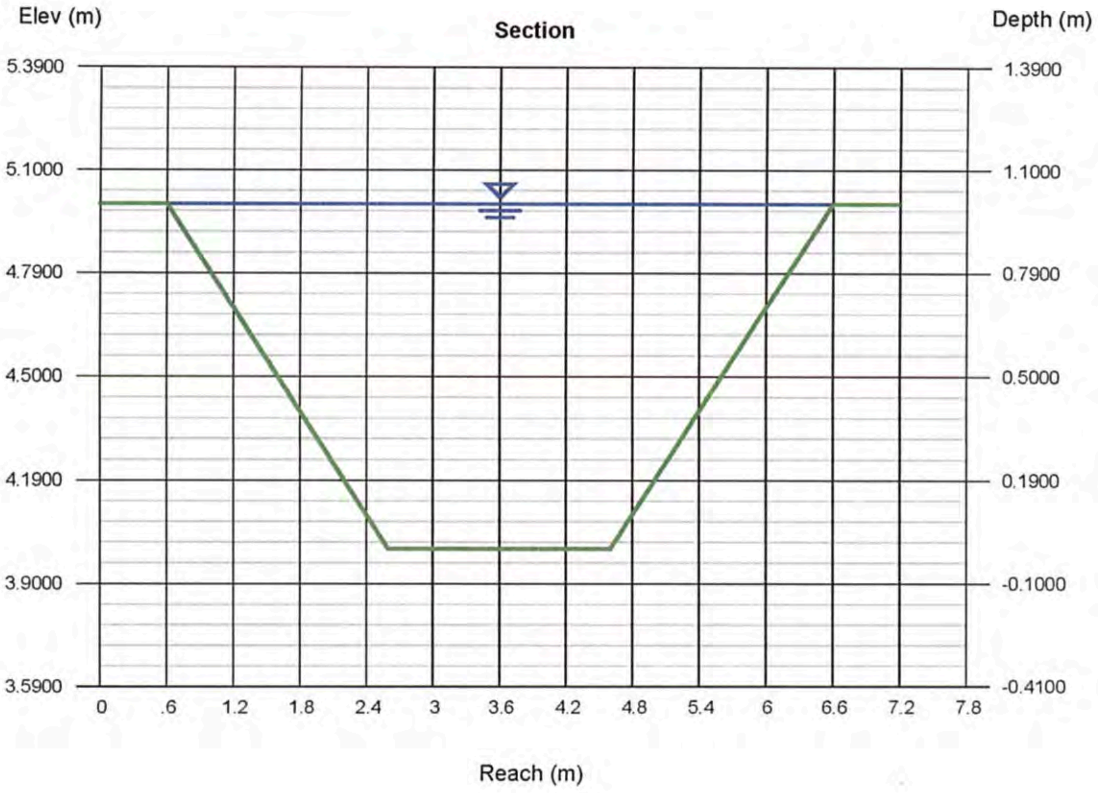


FIGURE 6: PROPOSED CHANNEL - DESIGN STORM

Channel Report

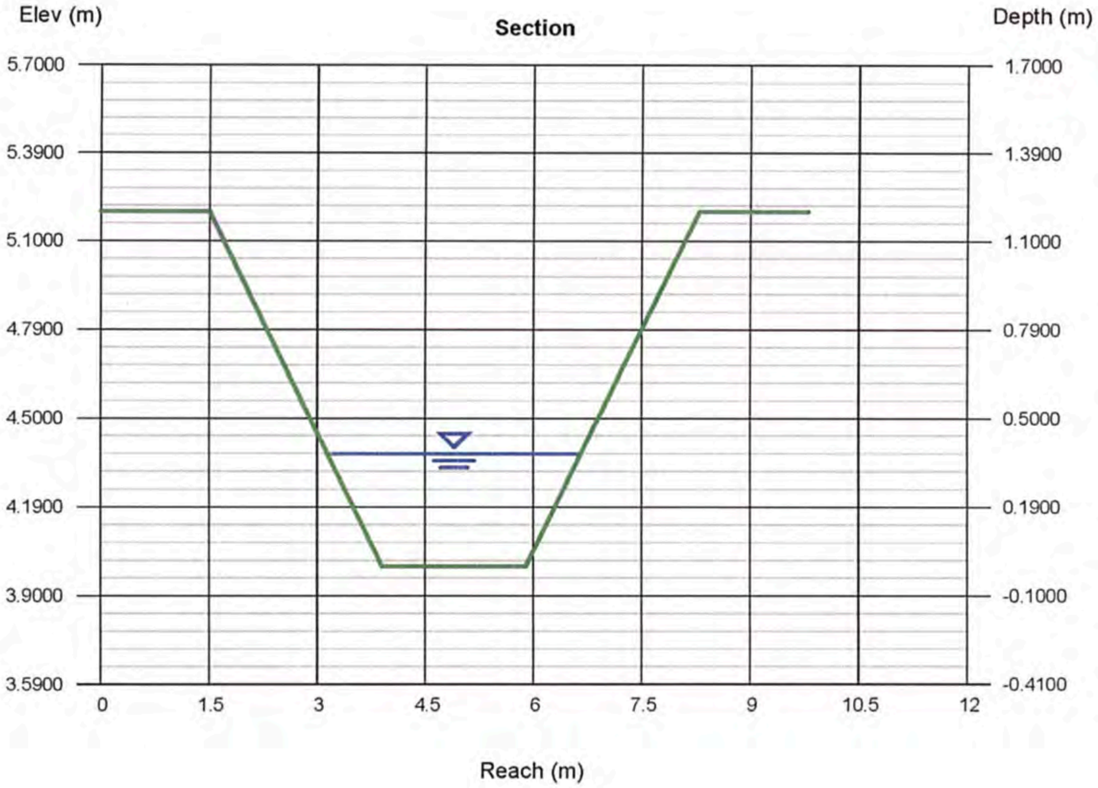
Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Sep 24 2013

Proposed Channel Design Flow

Trapezoidal
Bottom Width (m) = 2.0000
Side Slopes (z:1) = 2.0000, 2.0000
Total Depth (m) = 1.2000
Invert Elev (m) = 4.0000
Slope (%) = 5.3000
N-Value = 0.030

Calculations
Compute by: Known Q
Known Q (cms) = 3.4000

Highlighted
Depth (m) = 0.3780
Q (cms) = 3.4000
Area (sqm) = 1.0416
Velocity (m/s) = 3.2642
Wetted Perim (m) = 3.6903
Crit Depth, Yc (m) = 0.5517
Top Width (m) = 3.5118
EGL (m) = 0.9214



GeoPacific
Consultants Ltd.

#215 -1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Phone (604) 439-0922 / Fax (604) 439-9189

November 22 , 2010
File # 9170

Polygon Homes
Suite 900, 1333 West Broadway
Vancouver, B.C.
V6H 4C2

Attention: Cynthia Melosky

Re: Geotechnical Investigation Report: Proposed Noble Cove Residential Development 3829 and 3919 Dollarton Highway, North Vancouver, B.C.

1.0 INTRODUCTION

We understand that Polygon Homes proposes to construct a new residential development at the above referenced site, located on the north side of Burrard Inlet in North Vancouver, B.C.. It is understood that the development will consist of four, 4 storey, buildings over one level of parking along the north side of the site and five, 3 storey, buildings along the south (water) side of the site. The low-rise buildings along the north property line will have up to 30 feet of burial along the north foundations and up to one level of burial along the south foundations. The 3 storey buildings along the south property lines will have one level of burial along the north foundations with the buildings day lighting to the south, against Burrard Inlet. We anticipate that significant re-grading would be necessary to develop level building sites and on site roads.

This report presents the results of an investigation of the soil conditions beneath the site of proposed development and makes recommendations for the design and construction of buildings. The report was prepared exclusively for Polygon Homes for their use and the use of others on their design and construction team.

2.0 SITE DESCRIPTION

The proposed development site consists of two parcels of land between Dollarton Highway and Burrard Inlet in North Vancouver, B.C.. The site is bounded by residential developments to the west and Cates Park to the east. The site is an irregular rectangular in shape and measures approximately 236 metres from east to west and 77 metres from north to south. The site has a moderate slope from north to south, with a change in elevation of approximately 18 metres. The site slopes from the north, down, towards the south (Burrard Inlet), and locally towards a creek channel that is aligned essentially north to south on the east side of the westerly parcel.

The site is presently improved with a number of industrial buildings and infrastructure related to a shipyard that operated on the site. Some stockpiles of metals and debris were noted on the property. The site has some minor vegetation along the steeper slopes adjacent to Dollarton Highway and the central creek channel. The location of the site, the existing topography and buildings are shown on the attached plan, Drawing 9170-1.

3.0 FIELD INVESTIGATION

GeoPacific completed a total of 13 test holes on October 28th and 29th, 2010. The test holes were conducted using a truck mounted solid stem auger supplied by Uniwide Drilling Co. Ltd. Of Burnaby, B.C.. All test holes were logged in the field by a technician from our office and backfilled immediately upon completion of logging and sampling. The test holes were excavated to depths between 6.1 and 9.1 metres (20 and 30 feet) below current site grades. The test holes were supplemented with 5 Dynamic Cone Penetration Test (DCPT) soundings. The DCPT is used to assist in the classification of in situ density/consistency of the subsurface soils. Since the DCPT is conducted immediately adjacent to an auger test hole, the results are presented alongside the auger test hole results. The detailed test hole logs are shown on Figures A.1 through A.13 located in Appendix A.

The approximate locations of the test holes with respect to the site boundaries are shown on our Drawing number 9170-1, following the text of this report.

4.0 SOIL CONDITIONS

4.1 Soil Profile

According to Geological Survey of Canada Map 1484A, the site is underlain by glacial drift of the Vachon Formation, including minor flow till, lenses and interbeds of substratified glaciofluvial sand to gravel and layers and interbeds of glaciolacustrine laminated stony silt. The test holes showed some variation in subsurface conditions around the property, though in general the soils were noted to be very strong. Some fills and weaker colluvial soils were noted adjacent to the water front. A more specific description of subsurface conditions is provided below.

4.1.1 West of Creek

The soil conditions on the west side of the creek consists of fill over compact sand to sand and silt or very stiff to hard silt. The fills ranged in thickness from 0.4 to 1.5 metres at test holes TH10-3 through TH10-6, consisting of sand and silt to sand and gravel, noted as moist and compact. A thicker fill of 6.1 metres was noted at TH10-2 located along the rip-rap surfaced areas along the waters edge. The fills at TH10-2 consist of varying amounts of silt and sand, gravelly with traces of wood, glass and organics, and were noted as compact to loose, and moist to wet at depth.

A layer of soft silt to compact sand was found at two locations underlying the fill. At TH10-5, we encountered a soft silt layer from a depth of 1.2 to 3 metres below existing ground conditions. The silt was noted to contain trace sand and gravel, with trace wood and organics. At TH10-6, we encountered layers of silty sand containing some gravel, noted as compact to a depth of 1.2 metres.

Very stiff to hard silt or very dense silty sand (glacial till) was found to underlie silt and sand or fill layers to the final depths of the investigation. The glacial till was found at depths ranging from 0.2 to 6.0 metres to final depths at each test hole location.

4.1.2 East of Creek

The typical soil conditions on the east side of the creek consists of fill over a very dense sand to sand and silt, then very stiff to hard silt (glacial till). The fills ranged in thickness from 0.6 to 2.1 metres at test holes TH10-7 through TH10-13, consisting of cobbly sand to sand and gravel, noted as moist and compact. No fills were noted at TH10-11.

All test holes on the east side of the creek encountered very dense glacial till underlying the fills except for TH10-9 and TH10-13. The glacial till was comprised of layers of sand and gravel to sand to silty sand. These layers were noted as dense to very dense and moist and ranged in depth from ground surface to 5.2 metres below existing ground conditions at TH10-9.

At test hole location TH10-9, beneath the fills we encountered a silt and sand layer noted as compact to a depth of 5.2 metres. Below the silt and sand layer, we encountered a dense to very dense fine grained sand with trace silt.

At TH10-13, we encountered an organic silt layer underlying the fills from a depth of 0.9 to 1.5 metres below existing ground elevations. The organic silt was noted as firm, dark brown, with traces of sand and gravel. Below this silt layer, we encountered very dense glacial till

4.2 Groundwater Conditions

Groundwater was noted at the south end of the site at test hole locations TH10-2, TH10-3, TH10-9, TH10-10 and TH10-11 ranging in depth from 2.4 to 4.9 metres. These levels could vary with tidal influences due to the close proximity to Burrard Inlet. Typical groundwater levels that are tidally influenced are in the range of 0.5 to 1.0 metre geodetic.

Groundwater was also noted towards the north property line at TH10-1 and TH10-12 at 6.7 metres and 3.4 metres respectively within sandy layers. Perched water can develop above the ambient groundwater level where permeable layers overly less permeable layers. The flows from perched water will vary throughout the year.

We anticipate that groundwater flows would be light to moderate and that typical foundation drainage would be sufficient to control groundwater flows.

5.0 DISCUSSION

As noted, the proposed development is to consist of four, 4 storey buildings, with one level parking along the north side of the property, and up to 30 feet of burial along the north foundation walls along with five, 3 storey buildings along the south side of the property, and one level of burial along at the north foundation walls. Significant cuts and fills are anticipated throughout the site to construct level building pads and on site roads. We expect temporary excavations to be sloped were possible but anticipate that some shoring will be required for deeper excavations adjacent to Dollarton Highway.

The site currently has many older shipyard building and warehouses with retaining wall structures founded at unknown depths. Some piles of debris and other storage exist around the site. In addition on site access roads, concrete pads and other at grade structures exist at the site. We anticipate that all of the structures as well as any buried structures including pilings, dead man anchors would be removed during the demolition and site preparation phase of the project.

Based on the results of our investigation and the preliminary design plans provided to date, we anticipate that the soils at proposed underside of foundation would consist of very dense to hard glacial deposits. The buildings along the south end of the site (Burrard Inlet) will require some local over excavation of loose soils to achieve suitable bearing. Up to 6 metres of fill was identified at TH10-2, along the existing foreshore, west of the creek. The fills are generally mineral in composition and vary from loose to dense as demonstrated by the high degree of variation in the DCPT penetration resistance with depth. Given the proximity of this thicker fill to Burard Inlet, it may not be practical to sub-excavate this and deep in place compaction is expected to be the preferred option.

Light to moderate seepage should be expected from perched groundwater and tidal influences within sand layers of the till-like soils. Heavy seepage can be expected from fills located along Burrard Inlet. Seepage rates and groundwater levels in the fills would vary with tidal changes in sea level.

After performing the recommended ground treatment, we are of the opinion that the subsurface soils will not be considered prone to liquefaction or other forms of ground softening under the design earthquake defined under the 2006 British Columbia Building Code

We confirm from a geotechnical point of view that the proposed development is feasible provided that the following recommendations are implemented in the design and construction of the development.

6.0 RECOMMENDATIONS

6.1 Site Preparation

Prior to construction of foundations, floor slabs and new on-site roads all existing above grade structures, below grade structures, vegetation, topsoil, organic material, construction debris, and loose or otherwise unsuitable/disturbed soils must be removed from the construction areas to expose a subgrade of stiff to hard silt or compact to very dense sand. Our minimum stripping depths for foundations, floor slabs and new on-site roads are provided in Table 1.

Table 1: Recommended <u>Minimum</u> Stripping Depths for Foundations, Floor Slabs & On-Site Roads

Test Hole	Stripping Depth (metres)	Test Hole	Stripping Depth (metres)
TH10-1	**0.2**	**TH10-8**	**0.9**
TH10-2	**6.1***	**TH10-9**	**2.1***
TH10-3	**1.5**	**TH10-10**	**0.6**
TH10-4	**0.6**	**TH10-11**	**0.2**
TH10-5	**3**	**TH10-12**	**1.1**
TH10-6	**0.5**	**TH10-13**	**1.5**
TH10-7	**1.2**		

* **In situ deep densification anticipated at these locations and surrounding areas where deeper fills exist.**

We emphasize that the stripping depths are the minimum stripping depths at the test hole locations. It should be recognized that the thickness of unacceptable soil can vary throughout the site. In determining the minimum stripping depths, we have measured the distance from the ground surface to the top of the first suitable subgrade layer. Water softened/disturbed soils must be removed from the construction area. Where site stripping has been recommended, the stripping should extend outside of the building envelope a distance equivalent to the height of the required fill.

Where the depth of stripping exceeds proposed foundation level foundations can either be lowered or constructed on "engineered fill". Engineered fill is defined as clean sand to sand and gravel compacted in maximum 300 mm loose lifts to a minimum of 95% Modified Proctor (ASTM D1557) dry density at a moisture content within 2% of optimum for compaction.

The geotechnical engineer shall be contacted for the review of stripping and engineered fill placement and compaction.

6.2 Deep In Place Densification

A significant thickness of loose fills as well as some compact alluvial deposits were identified at our test holes adjacent to the existing creek on site. The thickness of loose to compact fills and alluvial deposits were up to 6 metres according to our test holes. These materials will require in situ densification to mitigate the risk of settlement under building loads and liquefaction in the event of a major earthquake, such as the 1:2,475 BCBC 2006 design earthquake. We anticipate that deep in place compaction using the Rapid Impact Compaction (RIC) method would be most suitable for this site.

6.3 Foundations and Bearing Pressures

Based on our geotechnical investigation and the preliminary drawings provided, the buildings are expected to be founded on the native dense to very dense sand or stiff to hard silt (glacial till), or possibly on engineered fill, where the stripping depth exceeds the proposed foundation level. Accordingly the proposed building can be founded on conventional spread foundations. Our recommended serviceability limit state bearing pressures of subgrades are provided in Table 2 below.

Footings should not be less than 450 mm (18 inches) in width for strip footings and not less than 600 mm (24 inches) for square or rectangular footings. All footings should be at least 450 mm (18 inches) below final grades for frost protection. We expect that the settlement of footings designed as recommended should be within the normally acceptable limits of 25 mm total and less than 20 mm differential over a 10 m span.

Foundation subgrades should be inspected by the geotechnical engineer prior to footing construction.

Table 2: Recommended Bearing Pressures

Stratum	Serviceability Limit State Bearing Pressures	
	kPa	psf
ENGINEERED FILL	120	2400
DENSE TO HARD GLACIAL SOILS	400	8,000

The factored geotechnical resistance at Ultimate Limit States (ULS) can be taken as 2 x the SLS bearing pressures given in Table 2.

6.4 Slab-On-Grade Floors

In order to provide suitable support for slab-on-grade floors we recommend that any general grading fill placed under the slab should be granular and essentially "clean" with not more than 5% passing the #200 sieve. In addition, this granular fill must be compacted to a minimum of 98% Standard Proctor (ASTM D698) maximum dry density with water content within 2% of optimum for compaction.

Floor slabs should be directly underlain by a minimum of 150 mm of 19 mm clear crushed gravel. A moisture barrier should underlie the slab directly above the free draining granular material.

Compaction of the slab-on-grade fill must be reviewed by the geotechnical engineer.

6.5 Seismic Design of Foundations

The subgrade conditions underlying the site may be classified as Site Class C as defined in Table 4.1.8.4.A of the 2006 BC Building Code.

After treatment of any loose fills on site, the subsurface soils within the buildings areas will not be considered prone to liquefaction or other forms of ground softening under the design earthquake defined under the 2006 British Columbia Building Code. Some loose fills zones were identified along the proposed foreshore. We anticipate that these fills would be treated using deep in place compaction to mitigate any potential liquefaction hazard.

6.6 Foundation Drainage

Perimeter drainage systems will be required for any structure with below grade construction to prevent the development of water pressure on the foundation walls and the basement floor slabs. We expect that the uphill side of structures will be constructed below grade. The downhill side of structures may be constructed at or above final outside grades.

From a geotechnical perspective, and for structures constructed at-grade, perimeter drainage is not required. provided that slab elevations are at least 100 mm (4 inches) above surrounding parking and landscape grades.

6.7 Temporary Excavations and Shoring

We expect that temporary excavations would be sloped where possible since it is more economical to do so. We would expect that slopes cut to 4V to 3H can be constructed in the existing dense glacial till and the hard silt. The surficial fills and silty sand should be benched back from the top of the excavation based on a 1 horizontal to 1 vertical setback defined by the height of the topsoil and silty sand. Temporary cut slopes in excess of 1.2 metres in height require inspection by a professional engineer in accordance with Work Safe BC guidelines.

Shoring will be required for excavations where sloped cuts are not possible. The natural soils are sufficiently strong that vertical cuts may be supported using anchored shotcrete. The use of hollow core (self-drilling) anchors should be anticipated within sandy zones of the till-like soils and saturated sand deposits. In addition, some face saving measures should be anticipated where wet sands are encountered.

Testing of all soil anchors will be required to ensure that each safely meets its required design capacity. A GeoPacific representative must be on-site for all soil anchor testing.

till-like soils. Moderate to heavy and continuous seepage should be expected below the static groundwater level. We expect that groundwater inflows can be controlled with conventional sumps and sump pumps, though well points may be required where persistent heavy seepage is encountered.

The geotechnical engineer should be contacted for the review of shoring installation and temporary excavations.

6.8 Earth Pressure on Basement Walls

Earth pressures against buried walls are dependent on factors such as, available lateral restraint along the wall, surcharge loads, backfill materials, compaction of the backfill and drainage conditions. We assume that the deep excavation cuts along Dollarton Highway would be shored, since there is inadequate room to slope, whereas the excavation would likely be sloped towards the south end. Thus a combination of shored vertical cuts and slopes are anticipated for the development.

We recommend that the foundation walls be designed to resist the following lateral earth pressures:

Static:	Triangular soil pressure distribution of 5.5H kPa, where H is equal to the total wall height in metres.
Seismic:	Inverted triangular soil pressure distribution of 6.5H kPa, where H is equal to the total wall height in metres.

The preceding loading recommendations assume that the backfill is a clean, free draining sand and gravel, the backfill is level behind the wall, and the wall is frictionless.

Our calculations assume that a back-of-wall drainage system will be installed to prevent the build up of any water pressure behind the walls.

6.9 On-Site Roads and Parking Areas

Following the recommended site preparation, we anticipate that grading fills would be placed to achieve final design grades for on site roads and parking. These grading fills should be placed in accordance with our recommendations for engineered fill, provided in Section 6.1, above. It is our opinion that the minimum asphalt pavement structure, provided in Table 3 below, will satisfactorily support conventional automobiles and light trucks.

Table 3: Recommended Minimum Pavement Structure

Material	Thickness (mm)
Asphaltic Concrete	75
Crushed gravel base course - 19 mm minus	150
Clean sand and gravel sub-base course, well graded - 100 mm minus	200

The thickness of asphalt may be reduced to 65 mm for areas of the site that are to be used strictly for light car parking.

The base and sub-base should be compacted to a minimum of 95% of the ASTM D1557 (Modified Proctor) maximum dry density at a moisture content that is within 2% of optimum for compaction.

Density testing should be conducted on these materials and the results forwarded to the geotechnical engineer for review.

6.10 Utilities Installations

We recommend that any trenches be sloped or shored as per the latest Work Safe B.C. regulations. The recommended maximum temporary cut slope angles are as given ins Section 6.7. We recommend that all service trenches be backfilled with clean granular material, which conforms to municipal standards, compacted to 95% "Modified Proctor" dry density (ASTM D1557) with a moisture content within 2% of optimum for compaction.

As noted in Section 6.7, some light to moderate seepage should be expected from perched groundwater and sandy lenses within the till-like soils. Moderate to heavy and continuous seepage should be expected below the static groundwater level, near to Burrard Inlet. We expect that groundwater inflows can be controlled with conventional sumps and sump pumps, though well points may be required where persistent heavy seepage is encountered.

Any excavation in excess of 1.2 metres (4 feet) in depth requiring man-entry must be reviewed by a geotechnical engineer.

6.11 Retaining Walls

Some MSE retaining walls may be needed to support design grades at the site. A number of different wall systems can be considered. GeoPacific can provide a design with tender specifications, if requested.

6.12 Re-Use of On Site Materials

The on site sandy gravels to gravelly sands (alluvial deposits) in proximity to the creek and the sandy till soils on the east side of the creek can likely be reused as engineered fill on site, though the till soils are generally moisture sensitive due to their comparatively high silt content. As a result they can only practically be used in the drier summer and fall months of the year.

7.0 DESIGN REVIEWS AND CONSTRUCTION INSPECTIONS

The preceding sections make recommendations for the design and construction of the proposed buildings, on-site roads and utilities and related earthworks. We have recommended the review of certain aspects of the design and construction. It is important that these reviews are carried out to ensure that our intentions have been adequately communicated. It is also important that any contractors working on the site review this document prior to commencing their work.

It is the responsibility of the contractor to contact GeoPacific a minimum of 48 hours in advance to notify us that a field review is required. In summary, field reviews are required for the following aspects of the work:

1. Review of site stripping
2. Review of shoring stages
3. Review of foundation subgrade prior to footing construction

4. Review of slab-on-grade fill compaction prior to slab construction
5. Review of the compaction of engineered fill
6. Review of pavement subgrade and proof rolling
7. Review of pavement base and subbase compaction
8. Any excavation in excess of 1.2 metres in height requiring man-entry

8.0 CLOSURE

This report has been prepared exclusively for Polygon Homes for the purpose of providing geotechnical recommendations for the design and construction of the proposed mixed residential development, site preparation, on site roads and related earthworks. The report remains the property of GeoPacific Consultants Ltd. and unauthorized use of, or duplication of, this report is prohibited.

We are pleased to be of assistance to you on this project and we trust that our comments and recommendations are both helpful and sufficient for your current purposes. If you would like further details or would like clarification of any of the above, please do not hesitate to call.

For:
GeoPacific Consultants Ltd.

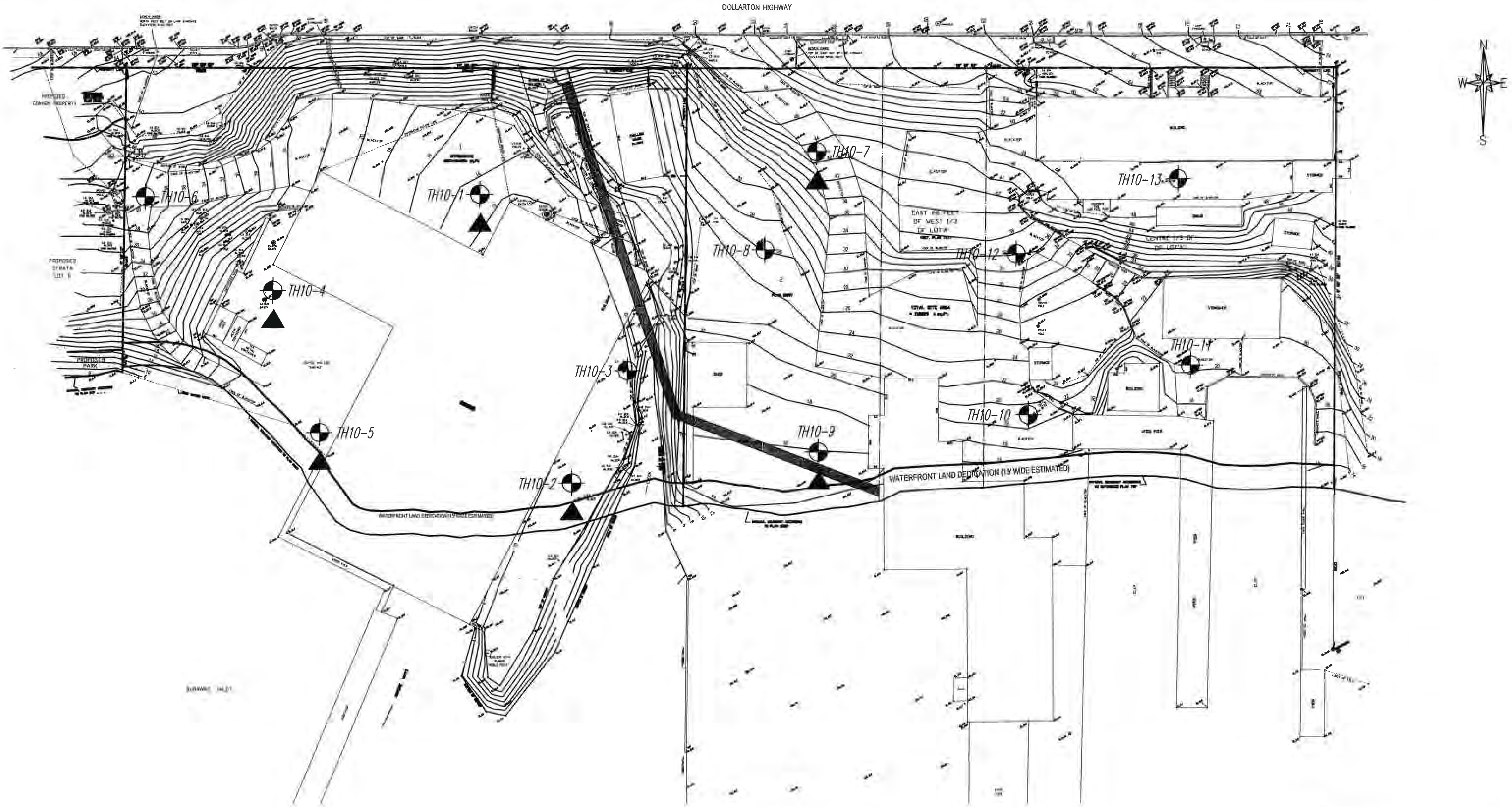
Reviewed by:

NOV 24 2010

M.J. KOKAN

Khidir Jorj, M.Sc.
Project Engineer

Matt Kokan, M.A.Sc., P. Eng.
Principal



L E G E N D :

TH-# ⊕ TEST HOLE LOCATION (TH)

DCPT # ▲ DYNAMIC CONE PENETRATION TEST

REFERENCE:
HOBBS, WINTER AND MacDONALD B.C.L.S
PROJ. NO.:
DATE:

215-1200 West 73rd Avenue
Vancouver, BC
V6P 6G5
Ph.(604) 439-0922
Fax (604) 439-9189

GeoPacific Consultants Ltd.

DATE: NOVEMBER 4, 2010
DRN. BY: MA
APP'D. MJK
SCALE: 1:750

PROPOSED MIXED RESIDENTIAL DEVELOPMENT
3829 AND 3919 DOLLARTON HWY, NORTH VANCOUVER, B.C.
TESTHOLE SITEPLAN

FILE NO.: 9170
DWG. NO.: 9170-1

REVISIONS:
REV.A
REV.B
REV.C

Test Hole Log: TH10-1

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

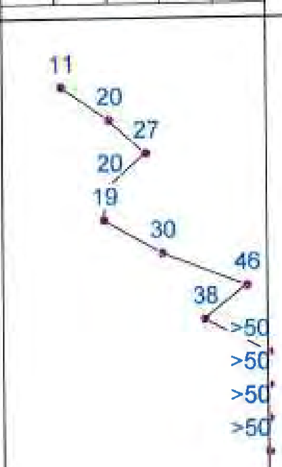
GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	Groundwater / Well	Remarks
Ground Surface	13.0 0.0			
ASPHALT (5" Thick)				
SILT Silt, clayey, light grey, dry/moist, very stiff				
SILT Silt, some gravel, trace sand, grey, moist, hard	-7.0 20.0		▼	GWL Noted at 22'
SAND Sand, some silt, trace gravel, grey, wet, very dense	-12.0 25.0			
End of Borehole	-17.0 30.0			

DCPT
(blows per foot)



Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.1
Page: 1 of 1

Test Hole Log: TH10-2

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

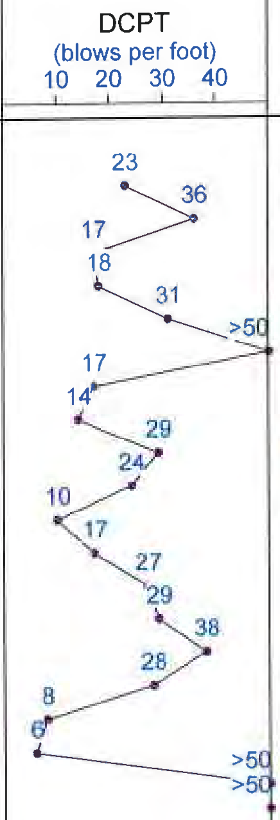
GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft)	Symbol	SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	Groundwater / Well	Remarks
0		Ground Surface	11.0 0.0			
0–20	▩	**FILL** 0' to 2' - Silt and Sand, gravelly, brown to grey, dry, compact 2' to 5' - Silt, trace sand and gravel, trace debris(brick, wood), grey, moist, stiff 5' to 10' - Silt and Sand, gravelly, trace debris(wood, glass, brick, grasses), grey to dark brown, moist, compact 10' to 20' - Sand, silty, gravelly, trace debris, brown/grey, moist/wet, compact to loose	-9.0 20.0		▼ (9')	GWL Noted at 9'
20–22	⁘	**SAND** Sand, silty, gravelly, brown, moist, dense Refusal at 22' on possible cobbles	-11.0 22.0			
22		End of Borehole				

Depth scale: ft 0–32; m 0–9



Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.2
Page: 1 of 1

Test Hole Log: TH10-3

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface	12.0 0.0				
0–5	▨	FILL Silt and Sand, gravelly, brown to grey, dry, compact	7.0 5.0				
5–20	▥	SILT Silt, grey, moist/dry, very stiff At 7' - Silt, trace to some sand, trace gravel, grey, moist/dry, very stiff to hard	-8.0 20.0			▼	GWL Noted at 10'
20 / 6		End of Borehole					

Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.3
Page: 1 of 1

Test Hole Log: TH10-4

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE							
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
ft 0 m 0		Ground Surface	12.0 0.0				
	▨	***FILL*** Sand and Gravel, trace silt, brown, moist, compact	10.0 2.0				
	▥	***SILT*** Silt, grey, moist/dry, very stiff to hard	-18.0 30.0				
		End of Borehole					

Depth scale (ft): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Depth scale (m): 0 1 2 3 4 5 6 7 8 9

Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.4
Page: 1 of 1

Test Hole Log: TH10-5

File: 9170

Project: Proposed Mixed Residential Development

Client: Polygon Homes

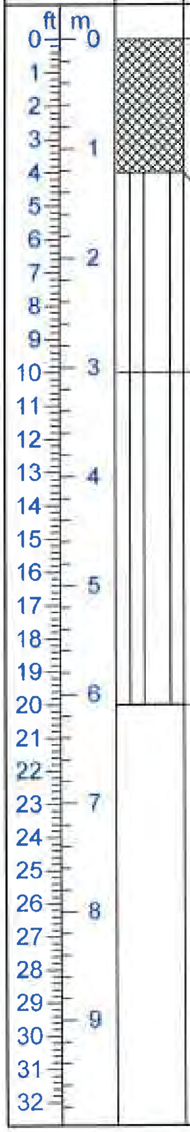
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

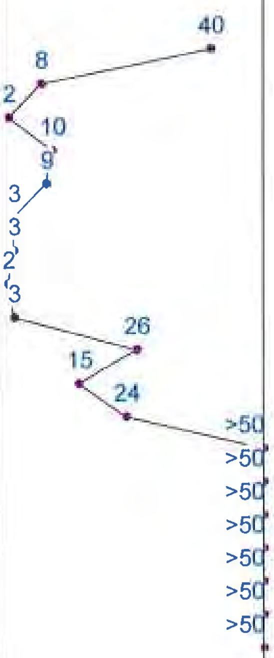
GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
		Ground Surface	10.0 0.0				
		FILL Sand and Gravel, trace wood and brick, brown, moist, compact	6.0 4.0				
		SILT Silt, trace to some sand and gravel, trace wood and organics, brown, moist, soft	0.0 10.0				
		SILT Silt, clayey, grey, moist/dry, very stiff to hard	-10.0 20.0				
		End of Borehole					





Logged: MA

Method: Truck Mounted Solid Stem Auger

Date: October 28 and 29, 2010

Datum: Ground Surface

Figure Number: A.5

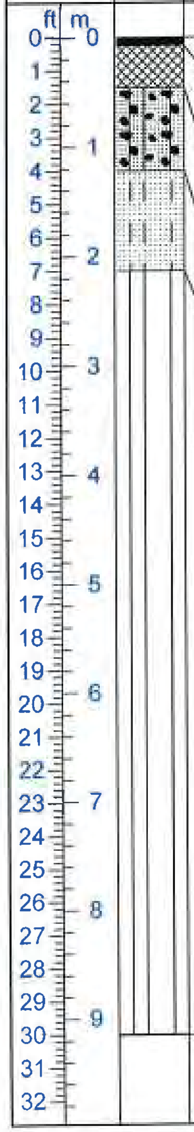
Page: 1 of 1

Test Hole Log: TH10-6

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.
215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE



SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
Ground Surface	40.0 0.0				
ASPHALT (2" Thick)					
FILL Sand and Gravel, trace wood and brick, brown, moist, compact	38.5 1.5				
SAND Sand, silty, some gravel to gravelly, dark brown to red/brown, moist to wet, compact	36.0 4.0				
SILT AND SAND Silt and Sand, some gravel, brown, moist, very dense	33.0 7.0				
SILT Silt, trace sand and gravell, grey, moist, very stiff At 10' - Silt, clayey, grey, moist/dry, very stiff to hard					
End of Borehole	10.0 30.0				

Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.6
Page: 1 of 1

Test Hole Log: TH10-7

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE							
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
		Ground Surface	43.0 0.0				
		ASPHALT (3" Thick)					
		FILL Sand, silty, some gravel, brown/grey, dry/moist, compact	39.0 4.0				
		SAND Sand, silty, some gravel, brown, moist, dense to very dense	33.0 10.0				
		SILT AND SAND Silt and Sand, some gravel, brown to grey, moist, very stiff	23.0 20.0				
		SILT Silt, trace sand and gravel, grey, moist, very stiff to hard	13.0 30.0				
		End of Borehole					

Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.7
Page: 1 of 1

Test Hole Log: TH10-8

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE							
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
		Ground Surface	26.0 0.0				
		FILL Sand, cobbly, some gravel, brown/grey, dry/moist, compact	23.0 3.0				
		SAND Sand, silty, some gravel, brown, moist, dense to very dense Refusal at 6' on 2 attempts	20.0 6.0				
		End of Borehole					

Depth scale:
ft: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
m: 0 1 2 3 4 5 6 7 8 9

Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.8
Page: 1 of 1

Test Hole Log: TH10-9

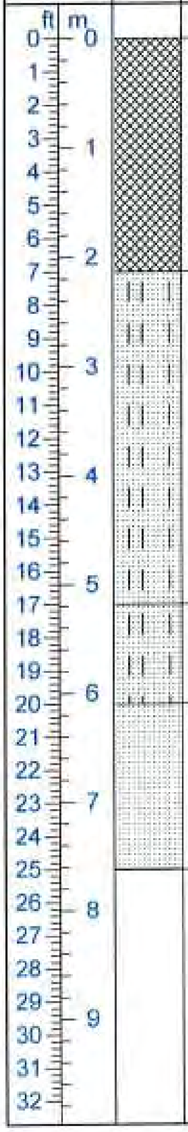
File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.

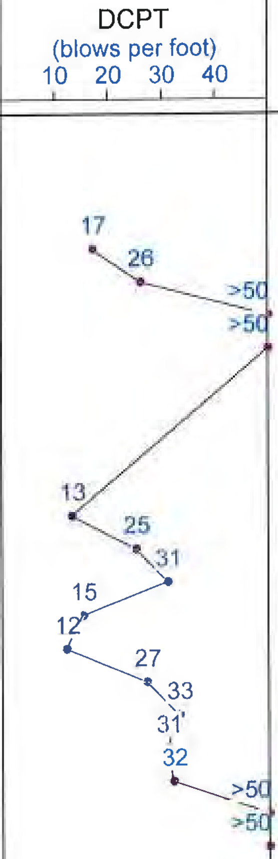
215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

SOIL DESCRIPTION	Depth/Elev (ft)	Remarks
Ground Surface	19.0	
FILL Sand, cobbly, brown, moist, compact 2' to 4' - Sand and Gravel, silty, trace wood, dark brown, moist, compact 4' to 7' - Sand and Gravel, cobbles, trace silt, brown, moist, compact	0.0	
SILT AND SAND Silt and Sand, trace to some gravel, brown, moist, firm/compact Cobbly to 11'	12.0 7.0	GWL Noted at 8' Drilled out DCPT from 7' to 11' due to cobbles
SAND Sand, fine grained, silty, brown, moist/wet, dense	2.0 17.0	
SAND Sand, fine to medium grained, trace silt, rust mottling, brown, wet, very dense	-1.0 20.0	
End of Borehole	-6.0 25.0	



Moisture Content (%)



Groundwater / Well

Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.9
Page: 1 of 1

Test Hole Log: TH10-10

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
ft m		Ground Surface	19.0 0.0				
		ASPHALT (3" Thick)					
		FILL Sand and Gravel, silty, dark brown, moist, compact	17.0 2.0				
		SAND Sand, some silt, some gravel, brown, moist, dense 5' to 8' - Sand, silty, gravelly, brown, moist, very dense	11.0 8.0				
		SILT Silt, sandy, fine grained, rust mottling, brown, moist, very stiff	9.0 10.0				
		SAND Sand, silty, gravelly, brown, moist, very dense	-1.0 20.0			▼	GWL Noted at 13'
		End of Borehole					

Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.10
Page: 1 of 1

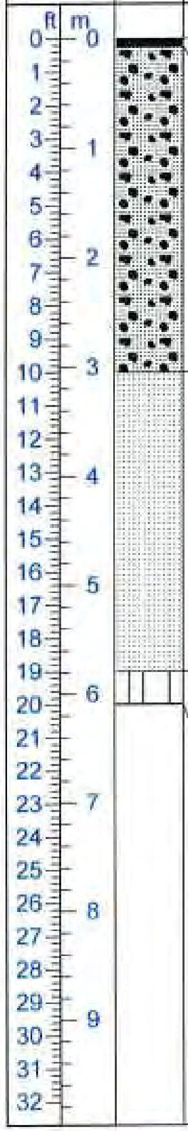
Test Hole Log: TH10-11

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE



SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
Ground Surface	20.0 0.0				
ASPHALT (4" Thick)					
SAND AND GRAVEL Sand and Gravel, some silt to silty, brown, very dense	10.0 10.0				
SAND Sand, some gravel, trace silt, brown, moist, very dense	1.0 19.0 0.0			▼	GWL Noted at 16'
SILT Silt, trace sand, trace gravel, brown, very stiff	20.0				
End of Borehole					

Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.11
Page: 1 of 1

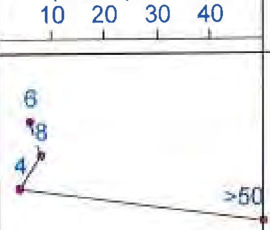
Test Hole Log: TH10-12

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.

215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE							
Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot)	Groundwater / Well	Remarks
0 / 0		Ground Surface	36.0 0.0				
	■	*ASPHALT (3" Thick)*					
	▩	*FILL* Sand and Gravel, silty, dark brown to red/brown, moist, loose	32.5 3.5		6 8 4 >50		
	▨	*SAND* Sand, some gravel, trace silt, brown, moist, very dense					
11						▼	GWL Noted at 11'
15		At 15' - Sand, silty, gravelly, brown, moist/wet, very dense					
20 / 6		End of Borehole	16.0 20.0				



Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

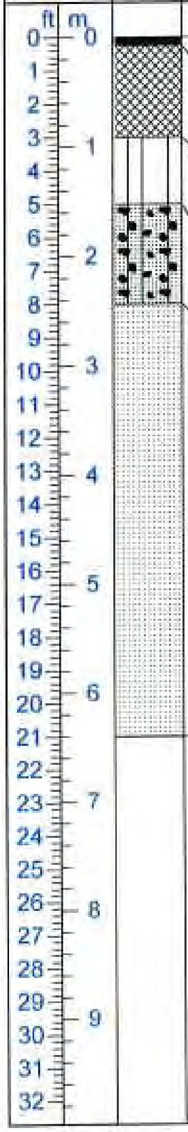
Datum: Ground Surface
Figure Number: A.12
Page: 1 of 1

Test Hole Log: TH10-13

File: 9170
Project: Proposed Mixed Residential Development
Client: Polygon Homes
Site Location: 3829 and 3919 Dollarton Hwy, North Vancouver, B.C.

GeoPacific
Consultants Ltd.
215 - 1200 West 73rd Avenue, Vancouver, BC, V6P 6G5
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE



SOIL DESCRIPTION	Depth/Elev (ft)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
Ground Surface	36.0 0.0				
ASPHALT (1.5" Thick)					
FILL Sand and Gravel, red/brown, moist, compact	33.0 3.0				
SILT (Organic) Silt, organic, trace wood, trace sand and gravel, dark brown, moist, firm	31.0 5.0				
SAND AND GRAVEL Sand and Gravel, silty, brown, moist, very dense	28.0 8.0				
SAND Sand, some silt, some gravel, brown, moist, very dense At 11' - Sand, silty, some gravel, brown, moist, very dense	15.0 21.0				
End of Borehole					

Logged: MA
Method: Truck Mounted Solid Stem Auger
Date: October 28 and 29, 2010

Datum: Ground Surface
Figure Number: A.13
Page: 1 of 1

core6 ENVIRONMENTAL

Core6 Environmental Ltd.
885 Dunsmuir Street, Suite 310
Vancouver, BC V6C 1N5

(604) 696-2673
www.core6.ca

October 31, 2013

Via E-mail: siteprofiles@gov.bc.ca

Ministry of Environment
Land Remediation Section
Second Floor, 10470 – 152nd Street
Surrey, BC V3R 0Y3

RE: Release Request, Site ID (3412/14456) 3829 to 3919 Dollarton Highway, North Vancouver, BC PID: 008-965-358, 008-965-404, 015-994-937, 015-994-902

This letter is provided in support of the release request submitted for the above-referenced site. As a Contaminated Sites Approved Professional Risk Assessment Specialist I make the following statements about the Preliminary Problem Formulation:

- The problem formulation conservatively screened in contaminants of interest as contaminants of potential concern if their maximum concentration exceeded the applicable chemical and media specific standard or guideline;
- The receptors selected for evaluation were appropriate for the future residential site use;
- Rationale was provided for receptor exposure pathways that will not be evaluated in the future human health and ecological risk assessment, subject to the data gap investigation;
- A risk assessment based on the problem formulation as described will identify areas at the site requiring further risk management or more detailed risk assessment.
- The risk assessment acknowledges that further investigation is required to address data gaps and that the Problem Formulation will need to reflect the collection of this additional data before completion of a risk assessment for the site.

The site is a high-risk site; however, remediation of high-risk conditions is achievable before occupancy or reuse of the land. The proponent has attached a letter indicating their commitment to remediation of the Site, including high-risk conditions, during site decommissioning and redevelopment.

If you have any questions or require clarification, please contact Marc Cameron at 250-686-0405.

Yours sincerely,
Core6 Environmental Ltd.

M Cameron

Marc Cameron, MSc, RPBio, CSAP
mcameron@core6.ca

File: 00098-01

PGL

Pottinger Gaherty
Environmental Consultants Ltd
1200 - 1185 West Georgia Street
T 604 682 3707
F 604 682 3497
Vancouver, BC Canada V6E 4E6
www.pggroup.com

October 29, 2013
PGL File: 1543-09.03

Via E-mail: **siteprofiles@gov.bc.ca**

Ministry of Environment
Land Remediation Section
Second Floor, 10470 – 152nd Street
Surrey, BC
V3R 0Y3

RE: RELEASE REQUEST, SITE ID (3412/14456)
3829 TO 3919 DOLLARTON HIGHWAY, NORTH VANCOUVER, BC
PID: 008-965-358, 008-965-404, 015-994-937, 015-994-902

This letter is provided in support of the release request submitted for the above-referenced site. As a Contaminated Sites Approved Professional, I make the following statements:

- All contamination at and originating from the proponent's parcel has been delineated on the proponent's parcel and neighbouring parcels;
- Remediation of contamination to applicable standards is achievable before occupancy or reuse of the land; and
- Once remediation is complete, the proponent's parcel will conform to applicable environmental quality standards and criteria in the Regulation and will be eligible for a Certificate of Compliance.

The parcel is a high-risk site; however, remediation of high-risk conditions is achievable before occupancy or reuse of the land. The proponent has attached a letter indicating their commitment to remediation of the Site, including high risk conditions, during site decommissioning and redevelopment.

I trust that this meets your needs. If you have any questions or require clarification, please contact Duncan Macdonald at 604-895-7639.

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.

Per:

Oct 30, 2013
D. G. MACDONALD
29517

Duncan Macdonald, B.Sc., P.Eng.
Senior Environmental Engineer

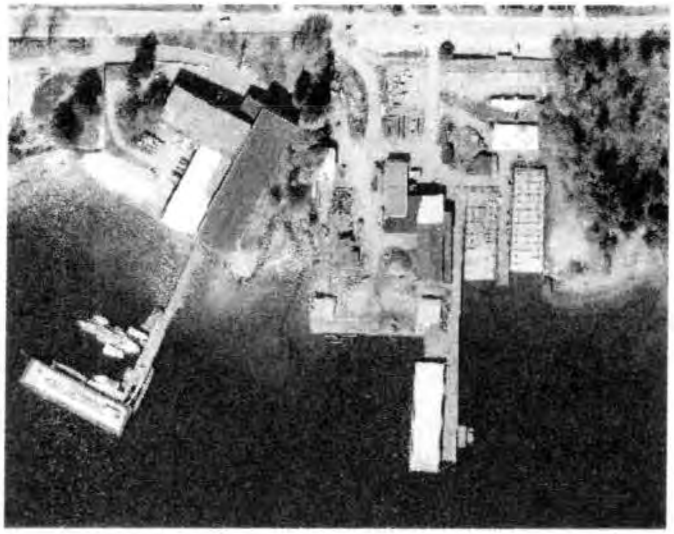
DGM/slr
P:\1400-1599\1543\09-03\I-1543-09-03-Release Request-Oct13.doc

2209031

Stage 2 Preliminary Site Investigation and Detailed Site Investigation

SCANNED
Doc # 2205700

3829 to 3919 Dollarton Highway
North Vancouver, BC



Prepared for:
Polygon Development 270 Ltd.
Suite 900, 1333 West Broadway
Vancouver, BC
V6H 4C2

Prepared by:
Pottinger Gaherty Environmental Consultants Ltd.
#1200 – 1185 West Georgia Street
Vancouver, BC
V6E 4E6

PGL File: 1543-09.03
MOE Site ID#: 3412 / 14456

October 2013

Executive Summary

Polygon Development 270 Ltd. (Polygon) retained Pottinger Gaherty Environmental Consultants Ltd. (PGL) to complete this Stage 2 Preliminary Site Investigation and Detailed Site Investigation report for 3919 and 3829 Dollarton Highway and adjacent leased Port Metro Vancouver lands to the south in North Vancouver, BC (the Site). This report forms part of PGL's overall submission to secure a release of re-development permit under BC Ministry of Environment Administrative Guidance 6.

The Site contains a terrestrial area of roughly 1.9 ha, and extends north from the foreshore of Burrard Inlet to the south side of Dollarton Highway in North Vancouver. The Site is comprised of four freehold fee simple lots and two partially filled water lots leased from Port Metro Vancouver. The freehold land at the 3829 Property comprises one legal lot, while the freehold land at the 3919 Property consists of three legal lots.

The Site is occupied by two industrial shipyard operators: Noble Towing to the west at 3829 Dollarton and McKenzie Barge and Marine Ways to the east at 3919 Dollarton. The Site is bounded by Cates Park to the east and residential properties to the west and across Dollarton Highway to the north. Roche Point Creek flows through the Noble Towing site.

Polygon has submitted a Development Permit Application to the District of North Vancouver to redevelop the fee simple portions of the Site for residential use. Future development plans for the Site include eight multi-tenant residential buildings containing 99 residential units. The water lot leased from Port Metro Vancouver is being addressed as part of the development for use by Port Metro Vancouver as a habitat bank.

The terrestrial freehold land use will be residential once the redevelopment is complete. The terrestrial leasehold will be riparian habitat reserve. The applicable soil, sediment, soil-vapour and groundwater standards are based on future land use and vary between the discrete Site areas as defined in this report.

PGL's Stage 1 Preliminary Site Investigation identified twenty-one onsite and one offsite areas of potential environmental concern (APECs) that warranted further investigation. The objective of Stage 2 Preliminary Site Investigation and Detailed Site Investigation work was to confirm the presence or absence of contamination from these APECs in soil, groundwater, sediment, and soil vapour and delineate identified areas of environmental concern (AECs) and their associated contaminants of concern (COCs).

PGL's Stage 2 Preliminary Site Investigation and Detailed Site Investigation identified eleven AECs for soil and groundwater, and one AEC for sediments at the Site. A summary of AEC is summarized in the table on the following page.

APECs, COCs, AECs and ZOCs

APEC	Name	PCOCs	AEC	COC or Rationale
APEC 1	General Shipbuilding and Brickyard Activities (3829 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH, TBT Secondary: PAH	Yes, AEC 1 (three areas)	AEC1-1: Soil: Metals (antimony, copper, tin, zinc); AEC 1-2: Groundwater: Dissolved Arsenic AEC 1-3: Soil: PAH (naphthalene and phenanthrene); MAH (benzene, ethylbenzene); VPH; and LEPH Groundwater: PAH, LEPH Soil Vapour: no contamination identified when attenuation factors applied
APEC 2	Sediments - Foreshore and Marine Ways – General Shipyard Activities	Primary: Metals, PAH, TBT Secondary: PCB	Yes, AEC 2	AEC 2: Soil/Sediment: Metals (arsenic, chromium, copper, lead, mercury, and zinc); PAH; and PCB (AEC 2-2 only) Groundwater: Not applicable Soil Vapour: Not applicable
APEC 3	Imported Fill East of Shipyard Building (3829 Dollarton)	Primary: Metals Secondary: LEPH/HEPH, PAH	Yes, AEC 3	AEC 3: Soil: Metals (arsenic, copper, zinc); and PAH Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors applied
APEC 4	In-filled Sandblasting and Painting Area with Accumulated Sandblast Grit (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH, VOC, TBT Secondary: PAH, PCB	Yes, AEC 4	AEC 4: Soil: Metals (antimony, arsenic, cadmium, chromium, copper, miolybdenum, nickel, zinc); and PAH Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors applied

APEC	Name	PCOCs	AEC	COC or Rationale
APEC 5	Offsite Filled Foreshore and Former Materials storage/ Burning Area East of Site	Primary: Metals, LEPH/HEPH, PAH, MAH, VPH, TBT Secondary: PCB, VOC	Yes, AEC 5	AEC 5: Soil: Metals (antimony, arsenic, chromium, copper, lead, mercury, miolybdenum, nickel, tin, zinc); PAH, LEPH; and MAH. Groundwater: PAH and LEPH Soil Vapour: no contamination identified when attenuation factors are applied
APEC 6	Historical Boiler House (3829 Dollarton)	Primary: LEPH/HEPH, PAH Secondary: None	No	No soil or groundwater contamination identified with this APEC
APEC 7	Historical Work Shop (3829 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH, VOC Secondary: PAH	No	No soil or groundwater contamination identified with this APEC
APEC 8	Machine Shop (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH, VOC Secondary: PAH	No, but carried forward as APEC 8	No investigation has taken place beneath the maintenance shop building
APEC 9	Shed on Western Side of 3919 Dollarton (former machine and blacksmith shop)	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PAH, PCB	No, see AEC 16	Soil contamination identified but is included as part of AEC 16 (Northwest boneyard)
APEC 10	Waste Dump (3829 Dollarton)	Primary: Metals, LEPH/HEPH, PAH Secondary: MAH, VPH, VOC	No	No soil or groundwater contamination identified with this APEC
APEC 11	Buried Barge and Metal Debris (Water Lot South of 3829 Dollarton)	Primary: Metals, PAH Secondary: None	No	APEC 11 was not directly investigated but is included in AEC 2
APEC 12	Historical Solvent and Paint Storage Area (3829 Dollarton)	Primary: Metals, VOC, VPH, LEPH/HEPH Secondary: MAH	Yes, AEC 12	AEC12: Soil: Metals (copper, zinc); HEPH; and PAH Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied

APEC	Name	PCOCs	AEC	COC or Rationale
APEC 13	Former Storage Area for Creosoted Ties (3919 Dollarton)	Primary: LEPH/HEPH, PAH Secondary: Metals	No, see AEC 16	Soil contamination identified but is included as part of AEC 16 (Northwest Boneyard)
APEC 14	Former Gasoline Underground Storage Tank and Outdoor Battery Storage Area (3919 Dollarton)	Primary: MAH, VPH, LEPH, Metals (for battery storage) Secondary: MTBE, EDB, DCA	Yes, AEC 14	AEC14: Soil: Metals (lead and cadmium); PAH (benzo(a)fluoranthene); LEPH/HEPH; and VPH Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied
APEC 15	Former Drum Rack (3919 Dollarton)	Primary: LEPH/HEPH, MAH, VPH, VOC Secondary: None	Yes, AEC 15	AEC15: Soil: MAH (ethylbenzene, xylene); Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied
APEC 16	Northwest Bone Yard (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PCB, VOC	Yes, AEC 16	AEC16: Soil: Metals (arsenic, chromiuim, copper, nickel, and zinc); PAH (benzo(b)fluoranthene); HEPH, and MAH (benzene). Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied
APEC 17	Northeast Bone Yard (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PCB, VOC	Yes, AEC 17	AEC17: Soil: Metals (antimony, arsenic, barium, chromium, copper, lead, molybdenum, tin, and zinc) Groundwater: TBT Soil Vapour: no contamination identified when attenuation factors are applied

APEC	Name	PCOCs	AEC	COC or Rationale
APEC 18	Staining and Stressed Vegetation in Area of Former Office/Bunkhouse/Cookhouse (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PAH, VOC, PCB	Yes, AEC 18	AEC18: Soil: Metals (barium, copper, molybdenum, tin and zinc); Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied
APEC 19	Winch Shed/Area Beneath Decking North of Marine Ways (3919 Dollarton)	Primary: Metals, LEPH/HEPH, PAH, MAH, PCB, TBT Secondary: None	Yes, AEC 19	AEC19: Soil: Metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, vanadium, and zinc) Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied
APEC 20	Paint and Solvent Storage Building (old office) (3919 Dollarton)	Primary: Metals, VOC, VPH Secondary: LEPH/HEPH, MAH	No, see AEC 18	Soil contamination identified but is included as part of AEC 18.
APEC 21	Regulated building materials	Primary: Asbestos, PCBs, etc. in building materials only Secondary: None	No, but carried forward as APEC 21	Regulated building materials were not investigated at the Site.
-	General Site Coverage	Primary: Metals, PAH	No, see AEC 14 and AEC 16	Soil contamination identified at BH12 is included as part of AEC 14. Soil contamination identified at BH64M and BH82 is included as part of AEC 16 (Northwest Boneyard)

Notes: LEPH/HEPH = light and heavy extractable petroleum hydrocarbons
PAH = polycyclic aromatic hydrocarbons
MAH = monocyclic aromatic hydrocarbons
VPH = volatile petroleum hydrocarbons
VOC = volatile organic compounds
PCB = polychlorinated biphenyls
EDB = 1,2-dibromoethane
DCA = 1,2-dichloroethane
TBT = tributyltin

The identified contamination is associated with the long term operation of shipyards and the use of contaminated fill material at the Site. All contaminated media has been at least coarsely delineated both vertically and horizontally. Delineation is incomplete in areas where access is limited by site improvements that are still in use.

PGL's investigation identified the following:

- Surface soils at the Site are widely contaminated with metals (ZOC1, ZOC3, ZOC4, ZOC5, ZOC16, ZOC17, ZOC18, ZOC19). The contamination appears to be sporadic but is a Site-wide issue and extends offsite into portions of Cates Park. Many of these shallow soils are also sporadically impacted with pockets of hydrocarbon contamination associated with surface spills;
- Deeper metals contamination is present in soils in the filled intertidal areas (ZOC3, ZOC4, and ZOC5);
- Despite widespread soil contamination, groundwater at the Site generally meets standards except for two areas where hydrocarbons are present (ZOC1-3 and ZOC5). Soil metals are not leachable and have not impacted groundwater. This was expected as most of the metals are low environmental availability because they are related to blasting grit;
- The entire offsite filled intertidal area southeast of the Site (ZOC5) contains impacted soil (metals and hydrocarbons) and groundwater (hydrocarbons), including hazardous waste concentrations of PAH in soil;
- Sediment contamination (metals and PAH) is widespread south of the Site (ZOC2).
- Soil contamination is present in the area surrounding the former UST tank nest at the Site (ZOC14);
- Tributyltin (TBT) contamination is present in groundwater beneath the painting shelter and northeast boneyard (ZOC17); and
- Dissolved arsenic contamination is present in groundwater exceeding the drinking water standard beneath the Noble Towing building (ZOC1-2).

Remediation Plan

The preliminary remediation plan for the Site is to remove soils that require removal as part of site development and soils of the greatest environmental risk:

- hazardous waste soils;
- soils in the Port Metro Vancouver fill zone southeast of the Site (AEC 5) where groundwater PAHs exceed applicable standards; and
- Soil east of the Noble Towing building where groundwater concentrations of PAH exceed applicable standards (AEC 1-3).

Groundwater will not be separately addressed because contaminated pore water will simply be excavated with soil. Excavation of source material of PAH contamination will be completed as much as is practicable.

Any contaminated soil and groundwater left in place will be risk assessed and risk managed as appropriate. Risk management measures are likely to include capping.

The conceptual plan for sediment remediation is to identify a toxicity threshold, and target soils exceeding that threshold for management. Soils below the threshold would be managed in place. Soils above the threshold could be capped, an option that is available based on the information that this area is subject to sediment deposition. Another alternative that could be considered if capping is not feasible for any reason would be dredging. Special management options will be developed for high value habitat that cannot reasonably be capped or dredged, if any.

We recommend that this report be submitted in support of an application for a Release of Development Permit under Administrative Guidance 6 that the Site has been delineated and has a remediation plan in place suitable to remediate the Site to numerical and risk-based standards for soil, soil vapour, sediment, and groundwater.

This Executive Summary is subject to the same standard limitations as contained in the report and must be read in conjunction with the entire report.

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FIGURES AND CORRESPONDING DATA TABLES

APPENDICES

List of Acronyms

AEC - area of environmental concern
APEC - area of potential environmental concern
bgs - below ground surface
BH## - borehole (no monitoring well)
BH##M - monitoring well
COC - contaminant(s) of concern
CSR - BC Contaminated Sites Regulation
DCE - dichloroethene
DSI - Detailed Site Investigation
HWR - Hazardous Waste Regulation
LEPH - light extractable petroleum hydrocarbons
MAH - monocyclic aromatic hydrocarbon
MOE - Ministry of Environment
MTBE - methyl tertiary-butyl ether
MW## - monitoring well
PAH - polycyclic aromatic hydrocarbons
PCBs - polychlorinated biphenyls
PCOC - potential contaminant(s) of concern
PERC - tetrachloroethylene
PGL - Pottinger Gaherty Environmental Consultants Ltd.
PSI - Preliminary Site Investigation
QA/QC - quality assurance and quality control
RL - Residential land use standards
RPD - relative percent difference
SV## - soil-vapour port
TBT - tributyltin
TCE - trichloroethene
TP## - test pit
US EPA - United States Environmental Protection Agency
VC - vinyl chloride
VH - volatile hydrocarbons
VOC - volatile organic compounds
VPH - volatile petroleum hydrocarbons
ZOC - zone of contamination

1.0 INTRODUCTION

Pottinger Gaherty Environmental Consultants Ltd. (PGL) was retained by Polygon Development 270 Ltd. (Polygon), to complete this Stage 2 Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI) report for a site including the properties at 3919 and 3829 Dollarton Highway and adjacent leased Port Metro Vancouver lands to the south in North Vancouver, BC (the Site, Figure 1).

This report was prepared, and the investigations were carried out, in accordance with the requirements of the Environmental Management Act and Contaminated Sites Regulation (CSR). This report may be submitted as part of an application for a Certificate of Compliance under the Roster of Approved Professionals provisions of the Environmental Management Act and CSR, and may be relied upon by the MOE and the Contaminated Sites Approved Professionals Society for this purpose.

1.1 Objective

We are seeking to obtain a Release of municipal permits for the Site under BC Ministry of Environment (MOE) Administrative Guidance 6, Scenario 5. The MOE Release will facilitate the redevelopment of the Site for residential use. Future development plans for the Site include 8 multi-tenant residential buildings containing 99 residential units.

1.2 Site Description

The terrestrial portion of the Site extends north from the foreshore of Burrard Inlet to the south side of Dollarton Highway in North Vancouver. The Site is comprised of four freehold fee-simple lots and two partially filled water lots leased from the Vancouver Port Authority doing business as Port Metro Vancouver. The freehold land at the 3829 Property comprises one legal lot, while the freehold land at the 3919 Property consists of 3 legal lots. A Site plan showing these lots is provided as Figure 2.

The topography of the Site slopes very steeply up to the north from Burrard Inlet towards Dollarton Highway. Roche Point Creek crosses the Site from north to south, creating a natural east-west divide between the two Site water lots. The creek runs through the property at 3829 Dollarton Highway, including underneath the northeast corner of the main building on that property.

The Site is occupied by two industrial shipyard operators: Noble Towing to the west at 3829 Dollarton Highway and McKenzie Barge and Marine Ways to the east at 3919 Dollarton Highway.

General information regarding location, land use, and ownership is summarized in Table A.

Table A: Site Identification Information

Civic Address	3829 to 3919 Dollarton Highway, North Vancouver, BC
PID	008-965-358 008-965-404 015-994-937 015-994-902
Legal Descriptions	LOT 1, Blocks A and D, District Lot 230, Plan 12037; LOT 2, Blocks A and D, District Lot 230, Plan 12037; The East 66 feet of the West 1/3 of Lot A (Reference Plan 757) District Lot 230 Group 1, New Westminster Land District; and The Centre 1/3 of Lot A (Reference Plan 757) District Lot 230 Group 1, New Westminster Land District.
Owner	M.A.N. Estates Ltd. (3829 Dollarton Hwy); McKenzie Enterprises Ltd. (3919 Dollarton Hwy)
Land Use	Industrial
Zoning	I-1 (Waterfront Industrial)
Proposed Land Use	Residential
Latitude*	49° 18' 13" North*
Longitude*	122° 57' 51" West*
Site Areas	Terrestrial Fee Simple Area = 19,236 m^2 Total (4 legal lots) In-filled Port Metro Vancouver Water Lot Leases = 5426 m^2 Total (Parcel A south of 3919 Dollarton is 5,196m^2 and Parcel C south of 3829 Dollarton is 230m^2) Port Metro Vancouver Water Lots = 31,960 m^2 Total (Parcel B south of 3919 Dollarton is 13,015m^2; Parcels A, B, D, and E south of 3829 Dollarton are 18,945m^2).
MOE Site #	3412 / 14456

* *Source: Google Earth*

** Port Metro Vancouver properties are not filed with the Land Title Office, therefore, there are no official legal descriptions or parcel identifier numbers.

2.0 REPORT PARTICIPANTS

David Bell, B.Sc. was the project manager for the Stage 2 PSI and DSI work completed in 2013. Kathy Minehan, M.Sc., P.Geo. was the project manager for previous Stage 2 Site Investigation work completed at the two properties.

Senior review was provided by Will Gaherty, M.S., P.Eng. The Approved Professional was Duncan Macdonald, P.Eng.

David Bell has more than nine years of consulting experience, which includes more than six years of experience in contaminated site assessments. David has managed projects, coordinated fieldwork, and completed reporting for numerous projects, in both urban and remote locations. He has supervised subsurface investigations as well as soil, groundwater, and soil-vapour remediation projects.

Kathy Minehan, M.Sc., P.Geo. has been an environmental consultant since 1990. Her work experience includes environmental site assessments, audits, contaminated sites investigation and remediation, waste management, and classification and transport of hazardous materials and wastes.

Duncan Macdonald is a senior environmental engineer and project manager, with more than 16 years of experience in contaminated sites environmental investigation and remediation. He was appointed to the Roster of Approved Professionals for Contaminated Sites in British Columbia as a standards assessor in 2007. As a roster member, Duncan has made 21 submissions to the MOE and is intimately familiar with both provincial and federal regulations.

Will Gaherty is an environmental engineer specializing in contaminant fate, environmental chemistry, and clean up. He has consulted on over 1,000 site investigations and audits since 1985, in environmental auditing, contaminated site investigation/clean up, landfill design and monitoring, landfill gas assessment, environmental toxicology, and groundwater assessment. His academic training includes contaminant hydrogeology and environmental toxicology. He has worked on projects across Canada, and in the United States, Mexico, and Taiwan. Will's project management experience includes complex projects and involves planning, design, execution, coordinating staff and contractors, liaising with clients and stakeholders, providing ongoing project updates, tracking and maintaining budgets, and dealing with provincial and federal regulatory authorities. He has extensive experience as an expert witness for legal proceedings.

3.0 STAGE 2 PSI/DSI

To assess the APECs and PCOCs identified in the Stage 1 PSI, PGL conducted soil, groundwater, sediment, surface water, and soil-vapour investigations at the Site.

3.1 Objectives

The objective of the Stage 2 PSI/DSI was to assess the presence/absence of soil, groundwater, sediment, and soil-vapour contamination at each area of potential environmental concern (APEC) and delineate the extent of contamination in each area of environmental concern (AEC) identified.

3.2 Site History and Background

Details of the Site history and background are provided in PGL's October 2013 Stage 1 PSI report.

The west part of the Site (currently 3829 Dollarton Highway) was first developed as a brickyard in the 1920s or 1930s and redeveloped as a shipyard in the late 1940s or early 1950s. Between 1950 and 1989 I.M. Matsumoto constructed aluminum fishing boats onsite. M.A.N. Estates purchased the property in 1989 and Noble Towing began its boat building and maintenance operations at that time.

The east part of the Site (currently 3919 Dollarton Highway) has been owned by the McKenzie family since 1931. The McKenzie Barge Company began building and repairing ships onsite at that time. Ship building activities have not been carried out on the property since 1989 but ship repair and maintenance operations continue to this day.

Both operations are considered an environmental risk.

3.3 Summary of Stage 1 PSI - Identified APECs and Potential Contaminants of Concern

The Stage 1 PSI identified twenty onsite and one offsite APECs and their associated potential contaminants of concern (PCOCs) related to current and historical uses of the Site. The identified APECs are shown on Figure 3 and Table B describes the APECs and their associated PCOCs.

Table B: APECS and PCOCs

APEC	Name/Activity	PCOCs	
		Primary	Secondary
1	General Shipbuilding and Brickyard Activities (3829 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, VOC, TBT	PAH
2	Sediments - Foreshore and Marine Ways – General Shipyard Activities	Metals, PAH, TBT	PCB
3	Imported Fill East of Shipyard Building (3829 Dollarton)	Metals, LEPH/HEPH	PAH
4	In-filled Sandblasting and Painting Area with Accumulated Sandblast Grit (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, VOC, TBT	PAH, PCB
5	Offsite Filled Foreshore and Former Materials Storage / Burning Area East of Site	Metals, LEPH/HEPH, PAH, MAH, VPH, TBT	PCB, VOC
6	Historic Boiler House (3829 Dollarton)	LEPH/HEPH, PAH	
7	Historical Work Shop (3829 Dollarton)	Metals, LEPH/HEPH, MAHs, VPH, VOC	PAH
8	Machine Shop (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, VOC	PAH
9	Shed on Western Side of 3919 Dollarton (former machine and blacksmith shop)	Metals, LEPH/HEPH, MAH, VPH	PAH, PCB

10	Waste Dump (3829 Dollarton)	Metals, LEPH/HEPH, PAH (screening parameters only, all waste was removed several years ago)	MAH, VPH, VOC
11	Buried Barge and Metal Debris (Water Lot South of 3829 Dollarton)	Metals, PAH	
12	Historical Solvent and Paint Storage Area (3829 Dollarton)	Metals, VOC, VPH, LEPH/HEPH	MAH
13	Former Storage Area for Creosoted Ties (3919 Dollarton)	LEPH/HEPH, PAH	
14	Former Gasoline UST and Outdoor Battery Storage Area (3919 Dollarton)	MAH, VPH, LEPH, Metals (for battery storage)	MTBE, EDB (1,2-dibromoethane), DCA (1,2-dichloroethane)
15	Former Drum Rack (3919 Dollarton)	LEPH/HEPH, MAH, VPH, VOC	
16	Northwest Bone Yard (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH	PCB, PAH, VOC
17	Northeast Bone Yard (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH	PCB, PAH, VOC
18	Staining and stressed vegetation in area of former office/bunkhouse/cookhouse (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH	PAH, VOC, PCB
19	Winch Shed / Area beneath decking north of Marine Ways (3919 Dollarton)	Metals, LEPH/HEPH, PAH, MAH, PCB, TBT	
20	Paint and solvent storage building (old office) (3919 Dollarton)	Metals, VOC, VPH	LEPH/HEPH, MAH
21	Regulated building materials	Asbestos, PCBs, etc. in building materials only	

Notes:
LEPH/HEPH = light and heavy extractable petroleum hydrocarbons
PAH = polycyclic aromatic hydrocarbons
MAH = monocyclic aromatic hydrocarbons
MTBE = methyl tertiary butyl ether
VPH = volatile petroleum hydrocarbons
VOC = volatile organic compounds
PCB = polychlorinated biphenyls
TBT = tributyltin

Based on the results of the Stage 1 PSI, PGL recommended the completion of a Stage 2 PSI/DSI to investigate the presence/absence of contamination associated with the identified APECs.

4.0 REGULATORY CONTEXT AND CONCEPTUAL SITE MODEL

A conceptual site model describes the potential sources of contamination on the Site, the potential receptors in the receiving environment, and the pathways along which contaminants might flow from the source to the receptors. Such a model serves as a scientific basis for structuring a site investigation, and judging the significance of contamination at a site, if any. This section develops a conceptual site model for the Site based on the CSR and BC Hazardous Waste Regulation (HWR) standards. Under section 11 (2) of the CSR, a site is not a contaminated site if the soil, surface, groundwater and soil vapour do not exceed the applicable Site-specific numerical criteria. The following sections describe the applicable standards for this Site. Table E summarizes the applicable standards at the Site.

4.1 Site Areas

For ease of reporting and explanation PGL has divided the Site into four discrete areas. Different soil, sediment, groundwater, and soil/vapour standards apply within these areas and different regulatory agencies have jurisdiction over these areas. The areas are shown on Figure 4.

- **Uplands** - all areas north of the historic high water mark, excluding the north portions of the marine ways at the McKenzie Barge property;
- **Filled Intertidal** - 3 discrete sections of land historically filled to extend further south into Burrard Inlet:
  - Noble Point west of the mouth of Roche Point Creek;
  - Sandblasting area east of the mouth of Roche Point Creek; and
  - Offsite filled PMV foreshore area east of the Site and south of Cates Park.
- **Intertidal** - the area between the current high and low water marks at the Site[1]. Soils in this area are underwater at the highest tide and exposed at the lowest tide; and
- **Subtidal** - the area south of the current low water mark.

4.2 Water Standards

Five categories of water use have CSR standards. In addition, some standards unrelated to use are mandatory.

4.2.1 Drinking Water and Schedule 10 Water Standards

Drinking water use applies at a site where the groundwater or surface water at or within 500m of the outer extent of the groundwater contamination source is currently used for drinking water. If groundwater flow direction has been reliably determined, nearby current uses may be limited to include drinking water wells or surface water intakes located 100m upgradient and 500m downgradient of the outer extent of the contamination source (Technical Guidance #6: Water Use Determination, February 2010).

If drinking water use does not currently apply, future drinking water applicability is evaluated.

The Drinking Water standards apply if the aquifer below a site has a hydraulic conductivity greater than 1 x 10^{-6}m/s and a yield greater than or equal to 1.3L/min. If this scenario is met, a

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[1] High and low water mark locations provided by Port Metro Vancouver

number of items are listed within Technical Guidance 6 to evaluate drinking water applicability, specifically, the natural water quality within the aquifer and the presence of a confining layer. Until Site-specific data is obtained, the Drinking Water standards are normally applied to all sites. If exceedences of Drinking Water standards are detected, Site-specific hydraulic conductivity tests can be initiated to further evaluate application of Drinking Water standards. In addition to the Drinking Water standards in Schedule 6, Schedule 10 standards are Drinking Water standards.

Recent hydraulic conductivity tests have not been completed at the Site. Norecol, Dames & Moore (NDM) completed order of magnitude hydraulic conductivity testing at the Site in 1993 and some calculations were less than 1 x 10^{-6}m/s while others were greater than 1 x 10^{-6}m/s.

If total dissolved solids (TDS) at a site exceed 4,000 mg/L, then Drinking Water standards will not apply to the Site. PGL sampled several wells for TDS during the 2013 DSI work and although two samples collected from wells near Burrard Inlet exceeded 4,000 mg/L, 13 of a total of 15 samples were below 4,000 mg/L. Groundwater TDS results are presented in Table 1.

The Filled Intertidal portions of the Site are located on filled land that extends the foreshore into Burrard Inlet below the historic high water mark. It is logical that groundwater south of the historic high water mark will be non-potable due to salt content. This rationale is supported by TDS data indicating that the two wells that exceeded 4,000 mg/L TDS were located in filled areas south of the historic high water mark. Drinking water Standards do not apply to groundwater south of the historic high water mark.

Based on available Site-specific hydraulic conductivity and TDS results, Drinking Water and Schedule 10 standards cannot be ruled out for the Uplands portion of the Site above the historic high water mark. Drinking water standards will be applied to groundwater beneath the uplands portion of the Site but not to the Filled Intertidal areas below the historic high water mark.

4.2.2 Aquatic Life Water Standards

Technical Guidance 6 determines the application of Aquatic Life standards. It states that Aquatic Life water standards are considered applicable to groundwater located within 500m of a surface water body containing aquatic life. Investigations must demonstrate that groundwater containing substances at concentrations greater than the applicable Aquatic Life water standards does not have the potential to migrate to within 500m of a surface water body used by aquatic life.

The nearest marine water body to the Site is Burrard Inlet, adjacent to the Site to the south. Marine Aquatic Life Standards have therefore been applied to groundwater beneath all areas of the Site.

The nearest freshwater body to the Site is Roche Point Creek which runs through the centre of the Site. Freshwater Aquatic Life use Standards have therefore been applied to groundwater beneath the Uplands area of the Site above the historic high water mark. Roche Point Creek is estuarine below the historical high water mark, therefore Freshwater Aquatic Life use Standards do not apply to groundwater beneath the Filled Intertidal or Intertidal areas of the Site.

4.2.3 Irrigation and Livestock Watering

Irrigation and livestock watering use applies if watering well intakes servicing those lands are located within 500m from the outer extent of a groundwater contamination source. The Site consists of two industrial properties located in a primarily residential area of North Vancouver and there is no farmland within 500m of the Site. No irrigation or livestock watering well intakes were identified in the BC Water Well Database search. Irrigation and Livestock watering standards do not apply at the Site.

4.2.4 Protocol 7

Protocol 7, Regulation of Petroleum Hydrocarbons in Water also stratifies application of gross petroleum hydrocarbon parameters for volatile and light extractable petroleum hydrocarbons based on proximity to water uses. Our tables reflect the appropriate standards.

4.2.5 Hazardous Waste Leachate

Based on groundwater concentrations, a site can be considered a hazardous waste site, but this does not necessarily make it a contaminated site (for example, a site with groundwater contamination can be a hazardous waste site but not be a contaminated site in a "no water use" scenario). Groundwater hazardous waste sites are identified by filtering groundwater through a 0.6µm–0.8µm filter using procedures specified in US EPA Method 1311. If the resulting filtrate exceeds the standards in Table 1 of Schedule 4 of the BC HWR (except benzene, ethylbenzene, toluene and xylenes, which are excluded by *Protocol 7, Regulation of Petroleum Hydrocarbons in Water*), the site contains hazardous waste. Consequently, we screen site groundwater (which is not tested by US EPA Method 1311 but groundwater results are roughly the same as a first approximation) for exceedences of Table 1 of Schedule 4 where it is not modified under Protocol 7. Generally this does not take the form of tabulation of the HWR standards, but rather a text discussion since the presence of hazardous waste does not define a contaminated site. If a site is a hazardous waste site, this triggers application of some provisions of the HWR. In this case, no HWR exceedences were noted in groundwater.

4.2.6 Groundwater Standards for Sodium, Magnesium, Iron, and Manganese

CSR Stage 8 Amendments (January 25, 2013) state that groundwater standards for iron and manganese only apply to sites that have one or more specific Schedule 2 Industrial and Commercial Purposes and Activities. Welding has taken place at the Site; therefore we have applied groundwater standards for iron. No Schedule 2 uses have occurred on the Site that warrant the application of groundwater standards for manganese.

CSR Schedule 6 Drinking water standards exist for sodium and magnesium to protect against taste and odour concerns. The concentrations of sodium and magnesium are known to be high in sea water and the Site is adjacent to Burrard Inlet. Accordingly, we have not flagged groundwater concentrations exceeding the Schedule 6 drinking water standards for sodium and magnesium as contamination in our data tables or figures. The presence of these dissolved metals in Site groundwater is not indicative of Site contamination.

4.3 Soil Standards

Land use is an important part of the conceptual site model, as it influences the way potential receptors interact with the Site. The CSR bases the applicability of soil criterion on land use. Standards are given in the CSR for five land use categories (Agricultural, Urban Park, Residential, Commercial, and Industrial) except in Schedule 10.

The Site development plan is for future residential Site use, with principal uses at grade being residential. CSR Residential land use (RL) standards are therefore applicable to the Site. The development plan for the foreshore areas of the Site includes a walkway along the historic foreshore line dedicated to the District of North Vancouver (DNV) and banked habitat on the Filled Intertidal portions of the PMV water lots. Parkland standards are applicable to these areas as well as offsite in Cates Park and on the PMV lands southeast of the Site. Commercial land use (CL) standards are applicable to Site soils below 3.0m.

Under the CSR, there are two types of numerical standards for soil contaminants; generic and matrix. These are based on the presence of pathways along which a contaminant can travel from soil to a receptor. The derivation of a matrix standard is described in the *CSST Policy Decision Summary* (CSST January 1996) and the *Workshop on the Development and Implementation of Soil Quality Standards for Contaminated Sites* (MacDonald, October 1995).

There are eight basic pathways covered by the CSR:

- Two pathways have a human receptor: intake of contaminated soil and groundwater used for drinking water; and
- Six pathways refer to non-human receptors: toxicity to soil invertebrates and plants, livestock ingesting soil and fodder, major microbial functional impairment, groundwater flow to surface water used by aquatic life, freshwater and/or marine/estuarine, groundwater used for irrigation watering, and groundwater used for livestock watering.

Irrespective of whether the intake of contaminated soil pathway and the toxicity to soil invertebrates and plants pathway are active on any given site, the related Schedule 5 standards are mandatory at all sites.

Table C summarizes the applicable standards for this Site.

4.3.1 Standard for Sodium

The application of CSR Schedule 5 sodium standards is explained in the MOE document *Finalization of Proposed 2007 Final Draft - Matrix Soil Standards for Sodium (Na+) and Chloride (Cl -)*. For the standard to be applicable, substances must be analyzed using methods specified in a director's protocol or alternate methods acceptable to the director. Historical sodium data for the Site was not analyzed using the specified saturated paste extraction method, so sodium standards have not been applied to the data. Sodium at the Site is expected to be from sea water and is not indicative of contamination.

4.3.2 Standard for Tributyltin

Tributyltin (TBT) is not regulated in soil in the CSR but tributyltin oxide (TBTO) is regulated in Schedule 10. TBT data have historically been reported in a number of different ways. A simple conversion based on the ratio of molecular weights was used to convert historical TBT data from the Site to a TBTO equivalent. These values were then compared to the Schedule 10 TBTO standards. The conversion is [TBTO]/g = [TBT]/g x 1.05263 as provided in the Puget Sound Dredged Disposal Analysis November 1998 Evaluation Framework. TBT in sediment is not regulated by the CSR.

4.3.3 Hazardous Waste Criteria for Soil

The HWR also applies to Site soils. Soil can be defined as hazardous waste based on total content/toxicity equivalent (oil and grease, dioxins furans, PAH, tetrachloroethylene) or leachability. Section 13 of the CSR covers conflicts between soil standards in the HWR and the CSR by altering some of the criteria in the HWR when the HWR would otherwise define a soil as hazardous waste based on total content. Nearly all hazardous waste sites would also be contaminated sites, but the presence of hazardous waste does not define a contaminated site, so generally our assessment of a site for hazardous waste does not take the form of including the HWR standards in the tables, but rather a text discussion. The presence of hazardous waste usually has its greatest impact on remediation costs. If a site is a hazardous waste site, this triggers application of some provisions of the HWR.

In this report, the toxicity characteristic leaching procedure (TCLP) was used to determine if Hazardous Waste was present in soils due to leachable metals and PAH content. The results of leachate analysis for metals and PAH are compared with TCLP Standards of Table 1, Schedule 4 of the HWR.

The HWR defines waste containing PAH as hazardous waste when the total concentration of PAH is greater than 100 parts per million measured as PAH TEQ (toxicity equivalent) by weight. PAH TEQ is a number that allows the toxicity of substances containing different PAHs to be compared. PAH TEQ is the amount of benzo[a]pyrene a substance would have to contain to have the same toxicity as the substance containing the different PAHs. Section 1 of the HWR describes how to calculate PAH TEQ.

4.3.4 Schedule 10 Toxic Substances in Soil

Schedule 10 includes substances in soil regulated solely to protect human health. These standards may be used as appropriate remedial targets at sites electing to remediate using the numerical standards approach. Sites containing a Schedule 10 substance in soil are eligible for a Certificate of Compliance if satisfactorily remediated to Schedule 10 standards. In addition, provided all other related requirements are met (i.e., see CSR Protocol 6), a site remediated to a MOE-approved standard for a Schedule 10 substance is eligible for certification under the Roster of Professional Experts process.

4.4 Sediment Standards

Sediments are defined in the CSR as "particulate material that usually lies below water." The Intertidal samples collected at the Site are located between the high and low-tide water marks, so are below the water at least some of the time. We have conservatively applied both soil and sediment standards to intertidal soil samples.

Sediment Standards are presented in Schedule 9 of the CSR. Guidance on the procedures and application of the Schedule 9 Standards are provided in the *Directors Criteria for Managing Contaminated Sediment in BC (EMA 2004).* Definitions or guidance provided in the document, which are relevant to this project, are presented and discussed below:

- There are two sets of sediment Standards presented in Schedule 9, for **typical** and **sensitive** sediment sites. Sensitive sediment sites include those that border habitat compensation areas. Typical sediment sites are those which are not sensitive, and which must be stable with respect to erosion.

To evaluate sediment quality, we compared analytical data for Intertidal and Sub-tidal sediments to the BC CSR Sediment Criteria for marine typical sites. Freshwater sediment sample results from Roche Point Creek were compared to the BC CSR Sediment Criteria for freshwater typical sites.

4.5 Soil Vapour Standards

The CSR mandates the application of soil-vapour sampling on sites with volatile PCOCs. CSR RL and PL standards for soil vapour are applicable at the Site depending on future proposed land use in sample locations. Vapour standards vary based on land use and selection of MOE-approved attenuation factors. Attenuation factors are selected based on indoor and/or outdoor exposure and the investigation location (crawlspace, sub-slab, preferential flow pathway, or subsurface). Subsurface attenuation factors vary based on the depth of the investigation location.

Residential and/or parkland standards are applicable to soil vapour on the Site.

4.5.1 Soil Vapour Attenuation Factors

PGL applied vapour attenuation factors to soil-vapour sample results, where applicable, based on the BC MOE *Technical Guidance 4 (September 2010).* At the time of this report, the proposed new development for the Site will consist of eight multi-tenant residential buildings. The area outside of the building footprints will be landscaping, roadways, or parkland. A maximum of one level of underground parking is proposed in the buildings, but the majority will be slab-on grade construction.

Attenuation factors were applied to represent future indoor and outdoor air concentrations at the proposed residential development. Based on the locations of future buildings in the proposed development plan and soil vapour sample depths, the following attenuation factors were applied to measured soil vapour concentrations collected from the Site:

- $1.5x10^{-6}$ (Outdoor - 1.0m depth) at NSV01, NSV03, SV03, SV04, and SV05;
- $1.2x10^{-6}$ (Outdoor - 1.5m depth) at NSV02, SV01, and SV02;
- $9.2x10^{-7}$ (Outdoor - 2.0m depth) at SV08;
- $2.8x10^{-3}$ (Indoor - 1.5m depth) at NSV04, SV06, and SV10; and
- $2.0x10^{-3}$ (Indoor - 2.4m depth) at SV09.

4.6 Surface Water Standards

To evaluate surface water quality, we compared analytical data from Roche Point Creek to the BC Water Quality Guidelines.

4.7 Summary

Table C summarizes the applicable pathways for the Site and offsite areas investigated.

Table C: Applicable Pathways and Standards

Pathway	Protective Standard	Uplands	Filled Intertidal	Intertidal	Sub-tidal
Groundwater	Drinking Water/Schedule 10	Yes	No	No	No
	Freshwater Aquatic Life	Yes	No	No	No
	Marine Aquatic Life	Yes	Yes	Yes	No
	Irrigation	No	No	No	No
	Livestock Watering	No	No	No	No
	Protocol 7 – Default Petroleum Hydrocarbon Standards	Mandatory	Mandatory	Mandatory	No
	Protocol 7 – Aquatic Sites	Yes	Yes	Yes	No
	Hazardous waste leachate (except for select monocyclic aromatic hydrocarbons)	Yes*	Yes*	Yes*	No
Soil	Intake of Contaminated Soil/Schedule 10	Mandatory	Mandatory	Mandatory	No
	Toxicity to Soil Invertebrates and Plants	Mandatory	Mandatory	Mandatory	No
	Groundwater used for Drinking Water	Yes	No	No	No
	Livestock Ingesting Soil and Fodder	No	No	No	No
	Major Microbial	No	No	No	No

Pathway	Protective Standard	Uplands	Filled Intertidal	Intertidal	Sub-tidal
	Functional Impairment				
	Groundwater Flow to Surface Water used by Freshwater Aquatic Life	Yes	No	No	No
	Groundwater Flow to Surface Water used by Marine Aquatic Life	Yes	Yes	Yes	No
	Groundwater used for Irrigation Watering	No	No	No	No
	Groundwater used for Livestock Watering	No	No	No	No
	Hazardous Waste Standards	Yes*	Yes*	Yes*	Yes*
Vapour	Air Concentration Criteria	Residential or Parkland	Parkland	No	No
Sediment	BC CSR Sediment Criteria for freshwater typical sites	Yes	No	No	No
	BC CSR Sediment Criteria for freshwater sensitive sites	No	No	No	No
	BC CSR Sediment Criteria for marine typical sites	No	No	Yes	Yes
	BC CSR Sediment Criteria for marine sensitive sites	No	No	No	No
Surface Water	BC Water Quality Guidelines	Yes	Yes	Yes	Yes

* Does not define a contaminated site, but defines a hazardous waste site

4.8 Site-specific PCOC Characteristics and Mechanism of Contamination

Characteristics of PCOCs for the Site were considered in the investigative approach:

4.8.1 Metals

Media at the Site most at risk of metals contamination are surface soils where sandblasting has taken place, areas where sandblast grit impacted soils may have been moved or used as fill, and fill from unknown sources.

The mechanism of surficial sandblast grit contamination is airborne deposition of grit material during sandblasting. Sandblast grit is often derived from metal slag. As a result it typically contains elevated metals concentrations, but environmental availability is low. Sandblasting at the Site is concentrated on boat hulls and used sandblast grit likely contains metals from marine paint chips and boat hulls in addition to any intrinsic metals.

Metals in soil do not typically migrate and are not expected to significantly change with time. If metals are leachable and become dissolved, their migration is controlled by groundwater gradients and geochemistry.

4.8.2 Petroleum Hydrocarbons

Media at the Site most at risk of petroleum hydrocarbon contamination are surficial soils in areas where fuelling or dumping has taken place and where machinery and equipment has been operated or stored. Also at risk are deeper soils and groundwater in the area of the former underground storage tank (UST). Except the area around the UST, contamination of Site groundwater with petroleum hydrocarbons would be unlikely in the absence of hydrocarbon impacts to soils above the water table.

Extractable petroleum hydrocarbons (EPH), monocyclic aromatic hydrocarbons (MAH), and volatile petroleum hydrocarbons (VPH) are lighter than water and hydrophobic, and therefore are classified as light non-aqueous phase liquid (LNAPL) and will float on the groundwater table. PCOCs associated with gasoline and diesel are highly degradable when dissolved in groundwater. Migration of LNAPL is generally governed by contaminant release volumes and depth to groundwater, where petroleum will pool on the water table surface and "pancake" outwards (and so have a limited ability to migrate upgradient). The resulting LNAPL plumes or dissolved plumes typically migrate according to groundwater gradients. Petroleum PCOCs have a high affinity for organic and fine-textured soils, and less of an affinity to coarse-textured mineral soils.

4.8.3 Polycyclic Aromatic Hydrocarbons (PAH)

Media at the Site most at risk of PAH contamination are soil and groundwater where creosote or heavy hydrocarbon fuels and oils have been used. Hydrocarbon spillage, leaks, and dumping at grade, buried creosote treated piles, and contaminated fill materials are the likely mechanisms of PAH contamination at the Site. PAH contamination in Site groundwater would be unlikely in the absence of PAH presence in to soils above the water table or the presence of creosote treated piles below grade.

PAHs are sparingly water soluble, generally form as a result of incomplete combustion, and so are common in waste oil, for example. They are also present in creosote, which has been identified as a significant risk on this Site. PAH presence is often indicated by blackened soil or creosote odours.

Low molecular weight PAHs, especially naphthalene, are a trace component of diesel and heavier hydrocarbon fuels, and so can be present at sites with this type of contamination, particularly when spills are fresh, but are usually not remedial drivers at those sites. They are primary PCOCs because the standards are stringent compared to typical concentrations.

PAH mobility in groundwater is surprisingly high considering their low water solubility, and can be enhanced by co-solvation in hydrocarbon plumes. The stringent standards coupled with the ubiquity of PAHs in the environment makes these contaminants common on many types of sites.

4.8.4 Volatile organic compounds (VOC)

Media at the Site most at risk of VOC contamination are soil, groundwater, and soil vapour in areas where paints and solvents have been used. Spillage, leaks and dumping at grade is the likely mechanism of VOC contamination at the Site. VOC contamination in Site groundwater would be unlikely in the absence of detectable VOC concentrations in soils above the water table. Paint is the main VOC risk at the Site and to a lesser extent solvents. Chlorinated solvents are not considered a risk at the Site. VOCs commonly used as carriers in paints are methyl isobutyl ketone and methyl ethyl ketone. The presence of these compounds and aliphatic solvents would be indicated by primary PCOCs MAH, VPH and LEPH.

VOC have widely varying characteristics, including density, solubility/mobility, and degradability. Parent solvents are generally denser than water, volatile, and sparingly soluble in water. Migration in soil is difficult to predict because of their low viscosity and interfacial tension coupled with their being denser than water. In dissolved phase they are highly mobile and tend to form narrow, hard-to-find groundwater plumes. Degradation products are generally more environmentally significant than parent solvents.

4.8.5 Tributyltin (TBT)

TBT is widely used in marine paints as an anti-fouling biocide. TBT presence at the Site would be expected in soils and sediments impacted with sandblast grit and in areas where boat painting and maintenance occurred. The mechanism of contamination would be deposition at grade in sandblast grit or spillage of TBT containing anti-fouling paints. Tributyltin compounds are moderately to highly persistent organic pollutants that can biomagnify in the food chain. TBT contamination in Site groundwater would be unlikely in the absence of TBT in soils above the water table. These compounds are sparingly soluble in water.

4.8.6 Polychlorinated Biphenyls (PCB)

PCBs were used as coolants and insulating fluids (transformer oil) for transformers and capacitors in specialized applications, and for a variety of other purposes where their stability was an asset. In many cases, PCB contamination originates from inadvertently tainted oils rather than directly from PCB applications. Due to their high octanol-water partition coefficients, PCBs accumulate primarily in the in the organic fraction of soil and sediment. Spillage, leaks and dumping at grade is the likely mechanism of PCB contamination at the Site. PCBs are not regulated in groundwater because of their very low solubility. They are extremely persistent.

4.8.7 Chlorinated Phenols

Pentachlorophenol and the lower chlorinated phenols, tetra- and trichlorophenols, developed for use as fungicides, herbicides, insecticides, and precursors in the synthesis of other pesticides. It is possible that chlorinated phenols would have been used at the Site for wood or boat hull treatment during shipbuilding. Spillage, leaks and dumping at grade is the likely mechanism of chlorinated phenols contamination at the Site. Chlorinated phenols contamination in Site groundwater would be unlikely in the absence of detectable chlorinated phenols concentrations in soils above the water table.

5.0 STAGE 2 PSI/DSI QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control (QA/QC) for data was a significant focus of our work. Quality assurance measures applicable to this report included:

- Document, data table and figure QA/QC activities by designated personnel;
- Use of electronically transferred data in all tables (no manual entry); and
- Analysis of duplicate sample results and laboratory internal QA/QC.

5.1 QA/QC Summary

A detailed review of QA/QC is provided in Appendix 1. A summary discussion of the detailed findings follows below.

Based on a review of the data quality indicators reviewed in Appendix 1, we conclude that the data quality objectives have been substantially achieved. PGL finds the dataset to be reliable for comparison against applicable standards. Generally, the MOE suggested frequency of 1 duplicate per 10 samples was met for all parameters.

As detailed in Appendix 1, data quality objectives were not met in all cases, including RPDs greater than the required level of precision, wetted well screen lengths greater than 1.8m during sampling, and hold time exceedences in select soil samples prior to laboratory analysis.

Elevated RPDs are not unexpected at the Site because Site soils and sediments are susceptible to nugget effects due to the nature of deposition and contaminants of concern. Much of the metals contamination in soil and sediment at the Site is due to small metal particulates created during sand blasting, and sample concentrations are greatly affected by how many particulates are included in a laboratory aliquot. Therefore, elevated RPDs are expected. Nugget effects are also expected for PAH parameters, especially in sediments and fill material where PAH impacted soils have been redistributed over an area.

Despite several wells at the Site having 3m well screens, only a few wells had a greater than 1.8m wetted screen during sampling and parameter concentrations in these wells were generally far enough below the standard that our conclusions with respect to sample exceedences do not change after considering potential dilution affects.

Where soil samples exceeded hold times prior to laboratory analyses, the results were all below the laboratory detection limits. One of these samples (BH35-05) vertically delineates soil PAH impacts and should not be relied upon to confirm remediation at the Site.

For those samples that have not met the data quality objectives, we concluded in all cases that the increased variability would not significantly affect the conclusions of this report. We conclude that the data quality objectives have been substantially achieved. Specific limitations of the dataset are discussed in Section 11.5.

6.0 STAGE 2 PSI/DSI METHODOLOGY

Since 2007, PGL has supervised multiple environmental investigations at the Site that comprised:

- Advancing 173 boreholes in the Uplands, Filled Intertidal and Intertidal Site areas;
- Completing 47 boreholes as monitoring wells;
- Installing 14 soil-vapour wells;
- Sampling marine sediments at 60 locations and freshwater sediment at 3 locations; and
- Sampling surface water in Roche Point Creek at one location.

Investigation locations were positioned across the Site, offsite to the east (Cates Park) and southeast (PMV filled foreshore), in PMV water lots south of the Site, and in sediments south of the PMV water lots (Figure 5) to address the APECs (Figure 6). Contractors were selected based on availability and experience at the Site.

Our methodology and rationale used in our Stage 2 PSI/DSI work are detailed in Appendix 2 along with detailed information covering PGL's investigation history at the Site. PGL's standard field protocols are also included in Appendix 2. PGL did not deviate from standard protocols.

Photographs of the field investigation are provided in Appendix 3. PGL's borehole and test pit logs are found in Appendix 4. PGL's field groundwater and soil-vapour monitoring well data sheets are found in Appendix 5.

6.1 Previous Investigations

In addition to our September 2013 Stage 1 PSI, PGL has access to five prior reports that address portions of the Site (Appendix 6):

- July 8, 1993, *Norecol, Dames & Moore. Preliminary Environmental Investigation Report, 3828 and 3919 Dollarton Highway, North Vancouver, British Columbia. Job No. 26674-002-313*;
- December 9, 2005, *Hemmera Envirochem Inc. Final Report, Phase 1 Environmental Site Assessment and Sediment Investigation, Waterlots Adjacent to 3785 and 3829 Dollarton Highway, North Vancouver, BC. File: 302-015.01*;
- January 24, 2006, *Hemmera Envirochem Inc. Addendum Report – Supplemental Coring Investigation, VPA Waterlots Adjacent to 3785 and 3829 Dollarton Highway, North Vancouver, BC. File: 302-015.02*;
- January 2010. *PGL Limited Stage 1 and 2 Environmental Site Investigation. McKenzie Barge and Marine Ways Ltd., 3919 Dollarton Highway, North Vancouver, BC*; and
- February 2010. *PGL Limited Stage 1 and Stage 2 Preliminary Site Investigation. Noble Towing, 3829 Dollarton Highway, North Vancouver, BC.*

During the Stage 1 PSI, PGL reviewed these reports. In general, PGL is satisfied that the data underlying the reports is accurate and reasonable, on the basis of review and corroborated by the consistency of the complete body of work. We have chosen to rely on these reports (NDM and Hemmera) only to the extent of using the data, but have formed our own independent conclusions from that data after duly considering each consultant's conclusions. The results have been incorporated into our Stage 2 PSI.

6.1.1 1993 Preliminary Environmental Investigation (Norecol, Dames & Moore)

The approach of the Norecol, Dames & Moore (NDM) Preliminary Environmental Investigation was to investigate areas most likely to be contaminated. NDM advanced a total of 18 boreholes at the Site (named O-BH1, O-BH2A, O-BH2B, and O-BH3 through O-BH17 in this report) and installed wells in seven of these boreholes (OW2A, OW2B, OW4, OW5, OW7 OW9, and OW10). NDM also collected nine sediment samples in three specific "Areas" at 3829 Dollarton (1-01 through 1-03, 2-01 through 2-03 and 3-01 through 3-03) and collected 31 surface soil or sediment samples in 13 specific "Areas" at 3919 Dollarton. NDM also collected seven foreshore sediment samples near the end of the dock at 3919 Dollarton (FS1 through FS7).

NDM did not identify specific APECs at the Site but did identify the following PCOCs:

- Metals from painting and sandblasting;
- Polychlorinated biphenyls (PCBs) from electrical equipment;
- Petroleum hydrocarbons from fuel storage and use as lubricants;
- Volatile organic compounds from solvent use; and
- Wood preservatives from treated wood.

NDM applied the regulatory standards of the day as follows:

- BC MOE's[2] Criteria for Managing Contaminated Sites in British Columbia was applied to the freehold portions of the Site;
- Canadian Council of Ministers of the Environment's Interim Canadian Environmental Quality Criteria for Contaminated Sites was applied to the portion of the Site leased from Port Metro Vancouver (south of the original high-water mark); and
- Environment Canada's Benthic Apparent Effects Thresholds were used to assess sediment quality.

NDM identified metals contamination (greater than Industrial Standards) in soil, and metals and polycyclic aromatic hydrocarbons (PAHs) contamination in sediments at 3829 Dollarton. NDM identified metals and hydrocarbon contamination (greater than Industrial Standards/Criteria) in soil and groundwater, and metals and polycyclic aromatic hydrocarbons contamination in sediments at 3919 Dollarton. Special Waste (now referred to as hazardous waste) was also identified in the north end of the eastern marine way at 3919 Dollarton.

PGL reviewed NDM's laboratory data relative to today's standards. To apply the appropriate Contaminated Sites Regulation Standard to metals in soil, which are pH dependent, we applied a pH from a nearby sample collected during our 2007 sampling program, since the older NDM data did not include pH analysis.

NDM's investigation and findings were used in our assessment of APECs and PCOCs at the Site and in the preparation of investigation plans for a Detailed Site Investigation.

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[2] BC Ministry of Environment, Lands and Parks in 1993

6.1.2 2005 Phase 1 Environmental Site Assessment and Sediment Investigation (Hemmera Envirochem Inc.)

The 2005 investigation by Hemmera Envirochem Inc. (Hemmera) comprised a Phase 1 Environmental Site Assessment and sediment investigation at 3829 Dollarton as well as the adjacent water lot to the west. The study area was not considered an environmentally sensitive area so standards for Typical Marine and Estuarine Sediments were applied.

Hemmera identified eight APECs at 3829 Dollarton as follows:

1. Boat Servicing Area: corresponds to the south end of the eastern marine way at 3829 Dollarton;
2. Waste Dump: Documented by the Vancouver Port Authority in a letter dated July 8, 2002. Waste steel drums, wood products, scrap metal, plastics, and other unknown materials were deposited in the southwest section of the shipyard building[3];
3. Dock and Wharf Head;
4. Former Metal Debris and Old Buried Barge Area; offshore, south of the warehouse building;
5. Hull Sandblasting and Painting Area (northern portion of the eastern marine way);
6. Former solvent and Paint Storage Area; corresponds to the southwest corner of the Site;
7. Possible PCB-containing Electrical Equipment; and
8. McKenzie Barge and Marine Ways at 3919 Dollarton.

In September 2005, Hemmera collected 22 surface sediment samples with a ponar grab sampler (SS05-12 through SS05-33) in Burrard Inlet south of the Site. Hemmera concluded that sediments were impacted with metals, PAHs, PCBs and organotins.

6.1.3 January 24, 2006. Hemmera Envirochem Inc. Addendum Report – Supplemental Coring Investigation, VPA Waterlots Adjacent to 3785 and 3829 Dollarton Highway, North Vancouver, BC. File: 302-015.02.

In 2006 Hemmera returned to the Site to complete a supplemental coring investigation to collect deeper sediment samples since the Site is in an area of sediment deposition. Using a barge-mounted drill rig, six sediment cores (C3 through C10) were advanced to a maximum of 1.5m depth. Metals impacts, including organotins, were identified south of the main shipbuilding marine ways.

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[3] This corresponds to an area reportedly cleaned up by Lark Noble. Extraneous materials were reportedly appropriately disposed of offsite

6.1.4 January 2010. PGL. Limited Stage 1 and 2 Environmental Site Investigation. McKenzie Barge and Marine Ways Ltd., 3919 Dollarton Highway, North Vancouver, BC.

Between January 2007 and April 2009 PGL conducted site inspections, interviews, a limited historical review, a soil, groundwater and two phases of sediment investigation at the McKenzie Barge property and associated PMV lease areas.

Both provincial and federal Standards were applied in the 2010 report. Provincial Standards were applied to the freehold (northern) portion of the Site. The provincial Standards as well as federal Guidelines/Standards were applied to the portion of the Site leased from Port Metro Vancouver.

PGL's investigation plan focused on filling data gaps in prior environmental investigations and providing better Site coverage. Twenty three boreholes were advanced at 3919 Dollarton (BH1 through BH22) and 15 of these were completed as monitoring wells. Sediment samples were collected from the sub-tidal zone and the intertidal marine ways south of 3919 Dollarton.

Based on the standards applied in 2010, soil, groundwater and sediment contamination was identified onsite.

6.1.5 February 2010. PGL. Limited Stage 1 and Stage 2 Preliminary Site Investigation. Noble Towing, 3829 Dollarton Highway, North Vancouver, BC.

Between February 2007 and November 2007 PGL conducted site inspections, interviews, a limited historical review, and a soil and groundwater investigation at the Noble Towing property and associated PMV lease areas.

Both provincial and federal Standards were applied in the 2010 report. Provincial Standards were applied to the freehold (northern) portion of the Site. The provincial Standards as well as federal Guidelines/Standards were applied to the portion of the Site leased from Port Metro Vancouver.

PGL's investigation plan focused on filling data gaps in prior environmental investigations and providing better Site coverage. Eleven boreholes were advanced at 3829 Dollarton (BH1 through BH11) and four of these were completed as monitoring wells.

Based on the standards applied in 2010, soil, groundwater and sediment contamination was identified onsite.

6.2 Definitions and Naming Conventions

Due to the existence of historical data by other consultants and previous work done by PGL at the two Site properties under separate scopes of work, historic sample names and investigation locations have been modified to prevent duplication and ease presentation of tables and figures.

6.2.1 Boreholes and Monitoring Wells (Soil and Groundwater Samples)

1993 NDM borehole locations have been re-labelled in PGL figures and tables with the prefix "O-". For example NDM's BH1 was re-labelled as O-BH1 to prevent duplication with PGL investigation locations. The names of other NDM investigation locations and groundwater wells were not changed for presentation in PGL figures and tables. 1993 NDM surficial hand auger samples were labelled with the convention 12-01, where the first digit represented an area on the Site and the second set of digits discrete sample locations within the area. 1993 NDM monitoring well locations were labelled as OW (observation well), e.g. OW4.

PGL conducted historical investigations at both 3829 and 3919 Dollarton Highway under separate scopes of work, resulting in duplicate naming of investigation locations (e.g. there was a BH01 at both properties). To reduce confusion, the names of 2007 PGL investigation locations at the Noble Towing property (3829 Dollarton) have been altered for presentation in figures and tables by adding an "N" before sample names. For example BH09M at 3829 Dollarton was re-labelled as NBH09M. All 2013 PGL investigation locations at the Noble Towing property continued to be named with this "NBH" convention. This convention was also applied to soil vapour wells installed at the Noble Towing property (e.g. NSV01).

PGL standard convention to differentiate between boreholes and monitoring wells is to add an "M" after the name of boreholes in which monitoring wells were installed. PGL soil samples are named consecutively with depth, for example BH10M-1 is a shallow sample while BH10M-2 is deeper.

6.2.2 Sediment Samples

Sediment sampling south of the Site has been conducted in several stages over the years by NDM, Hemmera, and PGL and several different naming conventions have been used.

Hemmera 2005 ponar grab samples were named SS05-01 through SS05-33. Hemmera 2006 core samples were named C1 through C10. NDM intertidal hand auger samples were labelled with the convention 1-01, where the first digit represented an area on the Site and the second set of digits discrete sample locations within the area. NDM sub-tidal ponar grab sediment samples were labelled 14-FS1 through 14-FS7.

PGL sediment samples collected from the McKenzie Barge marine ways from drill rig auger flights were labelled as SS1 through SS7. PGL intertidal and subtidal sediment samples collected as ponar grab samples or core samples were labelled as SSA through SSZ, followed by SSAA through SSZZ and concluded at SSAAA.

6.2.3 Naming Convention Summary

A summary of naming conventions used in this report to describe current data and historical data collected by PGL and other consultants is provided in Table D.

Table D: Naming Convention Summary

Investigation Description	**Original Nomenclature**	**PGL Stage2 PSI/DSI Report Nomenclature**
NDM Boreholes*	BH3, BH17	O-BH3, O-BH17
NDM Monitoring Wells	OW2A, OW10	unchanged
NDM Hand Auger Samples (surficial soil and intertidal sediment)	7-02, 12-03	unchanged
NDM Sub-tidal Sediment Samples	14-FS1 through 14-FS7	unchanged
Hemmera Sediment Samples (ponar grab)	SS05-1 through SS05-33	unchanged
Hemmera Sediment Samples (core)	C1 through C10	unchanged
PGL Boreholes and Monitoring Wells at Noble Towing property (3829 Dollarton Highway)*	BH1, BH9M	NBH01, NBH09M
PGL Boreholes and Monitoring Wells at McKenzie Barge property (3919 Dollarton Highway)	BH1, BH9M	BH01, BH09M
PGL Soil Vapour Wells at Noble Towing property (3829 Dollarton Highway)	N/A	NSV01 through NSV04
PGL Soil Vapour Wells at McKenzie Barge property (3829 Dollarton Highway)	N/A	SV01 through SV10
PGL Sediment Samples from McKenzie Barge marine ways	SS1 through SS7	unchanged
PGL Sediment Samples	SSA - SSZ; SSAA - SSZZ; and SSAAA	unchanged

* Historical naming convention changed for this report

7.0 GEOLOGY

The geology of the Site is consistent with expectations from surficial geology maps and experience in the area. The stratigraphy of the Site varies between the discrete Site areas as described in the following sections.

7.1 Uplands Terrestrial Area

The Uplands terrestrial area north of the historical high water mark contains generally undisturbed geology with the exception of varying thicknesses of fill material at grade. The Uplands stratigraphy generally consists of a thin layer of fill soils (usually less than 1m) overlaying native glacial till soils (sand and silt) to the maximum depth investigated (15.5m bgs).

7.2 Filled Intertidal Area

The Filled Intertidal area consists of three areas below the historic high water mark which were historically filled with imported or dredged material. Filling was completed to extend the shoreline south into Burrard Inlet.

7.2.1 Noble Point west of the mouth of Roche Point Creek

Fill materials east of the building at 3829 Dollarton and extending south into Burrard Inlet at Noble Point consist of sands and silts with varying gravel content. These fill soils exist at depths between 1.4m bgs near the northeast corner of the building to 5.8m bgs at the south end of Noble Point. The fill material was reportedly imported from East Vancouver in the early 1980s and is of unknown quality. Some brick debris is also evident in soils on the east and west sides of the building at 3829 Dollarton.

7.2.2 Sandblasting area east of the mouth of Roche Point Creek

Fill materials in the McKenzie Barge sandblasting area 3919 Dollarton consist primarily of sand and silt which is likely dredged material but the source of fill is not known. Fill at grade surface in this area contains visible sandblast grit.

7.2.3 Off-Site filled PMV foreshore area east of the Site and south of Cates Park

Fill materials in the off-Site filled area southeast of 3919 Dollarton Highway consists primarily of sand and silt which is likely a combination of dredged material and fill from other Site areas. The source of the fill is not known. Fill at grade surface in this area contains visible metals debris and sandblast grit.

7.3 Intertidal Area

The intertidal area south of the Site contains marine sediments. Some areas contain surface depositions of fill or sandblast grit extending from the filled intertidal areas and the marine ways.

7.4 Sub-tidal Area

The sub-tidal areas south of the Site contain marine sediments. Non-native material has likely been deposited above native sediments since shipbuilding activities began on the Site. Historical dredging has also likely taken place in the area.

8.0 HYDROGEOLOGY

No perched groundwater table has been identified at the Site. The aquifer at the Site is generally characterized as an unconfined aquifer hosted in native silts and sands. The aquifer is also present in fill soils overlaying native soils in the Filled Intertidal areas below the original high water mark.

The water table depth in the area varies with Site topography and distance from Burrard Inlet. The local topography slopes steeply down to the south towards Burrard Inlet. The groundwater surface is approximately 15m below ground surface near the northern property boundary and about 2m below ground in the south portion of the Site. Groundwater levels near Burrard Inlet fluctuate with the tides.

Roche Point Creek runs south through the centre of the Site and a DNV storm-water outflow daylights from a culvert at the south edge of Cates Park, approximately 80m east of the Site.

Groundwater flows in a south direction following the local topography and is confirmed by groundwater elevations, collected at high tide and low tide from the aquifer on September 27, 2013 (Figures 7a and 7b, respectively and associated Table).

8.1 Hydraulic Conductivity

Hydraulic conductivity tests were not completed at the Site during the Stage 2 PSI/DSI. NDM completed order of magnitude hydraulic conductivity testing at the Site in 1993 and some calculations were less than 1 x 10^{-6}m/s while others were greater than 1 x 10^{-6}m/s. Based on available Site-specific hydraulic conductivity and TDS results, Drinking Water and Schedule 10 standards cannot be ruled out and have been applied at the Site as discussed in Section 4.2.

8.2 Preferred Pathways

PGL assessed the impact of contamination on preferred pathways such as underground utilities beneath the Site and under Dollarton Highway.

8.2.1 On-Site

Several utilities are present onsite. These include five water services, one gas service, and three sanitary sewer connections. The depths of these utilities are all 1.5m or less and enter the Site near Dollarton Highway where the groundwater depth is approximately 15m below grade. Any onsite underground utilities are also assumed to be less than 1.5m in depth. Considering this, utility services do not provide preferred pathways for contaminant migration at the Site.

8.2.2 Offsite

There are utility corridors adjacent to the Site beneath Dollarton Highway to the north. Adjacent to the property line are the following utilities (with offset from the property line):

- Abandoned gas (0.4m offset to the north) at a depth of 0.6m bgs;
- Fortis BC (6.1m offset to the north) at a depth of 0.6mbgs;
- Sanitary sewers (4.8m, 5.4m, 14.0m and 14.75m offsets to the north) at approximate depths of 2.0m bgs;
- Storm sewer (9.3m and 15.0m offsets to the north) at approximate depths of 1.2m bgs; and
- Water (11.6m offset to the north) at an approximate depth of 1.5m bgs.

The utility corridors are all upgradient of the Site with respect to groundwater flow direction and are at significantly higher elevations than the groundwater table north of the Site. Considering this, utility corridors do not provide preferred pathways for contaminant migration at the Site.

9.0 FINDINGS BY APEC

Shallow soil is contaminated by metals, PAHs, and petroleum products, while groundwater effects are limited to a few individual locations on-Site and the offsite PMV Filled Intertidal land for a few contaminants of concern. Contamination was not identified in soil vapour when attenuation factors were applied. Contamination was delineated vertically and horizontally. Offsite investigation was required to the east in Cates Park, to the southeast on PMV Filled Intertidal land, and to the south, southeast, and southwest in intertidal and sub-tidal sediments in Burrard Inlet.

The results of the DSI indicate that the AECs have been delineated to the extent required for supporting a remedial plan. The investigation findings for each APEC are presented individually in the following sections.

Chemical results are presented graphically on Figure 8 through Figure 23 and in tabular format in associated Tables. Laboratory analytical reports are provided in Appendix 7. Borehole soil logs and monitoring well construction details are presented in Appendix 4.

9.1 APEC 1 – General Shipbuilding and Brickyard Activities - 3829 Dollarton Highway

A brickyard operated at the 3829 Dollarton property in the 1920s or 1930s and a shipyard has been onsite since the late 1940s / early 1950s. Investigation locations and PCOCs for this APEC are summarized below.

Table E: Investigation Locations in APEC 1

Investigation Locations	PCOCs
Soil (Uplands): O-BH1, O-BH3, NBH01, NBH03, NBH07, NBH08, NBH09M, NBH10, NBH11, NBH12, NBH13, NBH14, NBH15, NBH16, NBH17, NBH20, NBH21, NBH23, NBH26, NBH27, NBH31, NBH32, NBH35, NBH36 Soil and Groundwater (Uplands): OW2A, OW2B, NBH02M, NBH06M, NBH09M, NBH22M, NBH28M, NBH29M, NBH30M, NBH33M, NBH34M, Soil Vapour (Uplands): NSV01, NSV03, NSV04 Sediment (Freshwater): SED-01, SED-02, SED-03 Surface Water (Freshwater): SW01	Primary: Metals, LEPH/HEPH, MAH, VPH, TBT Secondary: PAH, VOC

9.1.1 Soil Chemistry

Metals and hydrocarbons exceeded applicable Standards in APEC 1. Concentrations of at least one metal (antimony, arsenic, copper, tin, and/or zinc) exceed the applicable CSR standards in soil at ten out of eighteen borehole locations in APEC 1. Hydrocarbon contamination (PAH, LEPH/HEPH, and/or MAH) was also identified in soil at seven locations in APEC 1. Concentrations of all other metals, LEPH/HEPH, PAH, MAH, VPH, and TBT (reported as TBTO) analyzed in soil samples from APEC 1 were less than the applicable CSR standards.

9.1.2 Groundwater Chemistry

Groundwater contamination in APEC 1 was in discrete wells.

- LEPH, PAH, MAH, and dissolved iron exceeded applicable Standards at NBH22M.
- PAH contamination was also identified further east at NBH28M near the edge of Roche Point Creek.
- Dissolved arsenic was identified at OW2A by NDM in 1993 and by PGL at NBH09M at concentrations exceeding the Drinking Water standard.

Benzo(a)pyrene concentrations at NBH02M exceeded the standard during two sampling events but subsequent samples show non-detectable concentrations. This has been discounted as a sampling artifact. Concentrations of MAH, VPH, and VOC and all other metals and PAH parameters were less than the applicable CSR standards in all groundwater samples analyzed at APEC 1.

9.1.3 Soil Vapour

Concentrations of soil vapour PCOCs at APEC 1 are below the applicable standards after the applicable attenuation factors are applied.

9.1.4 Freshwater Sediment

Freshwater sediments were sampled at three locations in Roche Point Creek. Samples were analyzed for metals, EPH and PAH concentrations. All were all below the applicable standards.

9.1.5 Surface Water

A surface water sample was collected from Roche Point Creek and analyzed for PAH concentrations. Concentrations of PAH were below the laboratory detection limits and met the applicable BC Water Quality Guidelines.

9.1.6 Discussion

The soil metals exceedences at APEC 1 are clustered in 3 separate areas and are attributable to three separate mechanisms of contamination.

The west edge of the gravel lot (also part of APEC 12 - Historical Solvent and Paint Storage Area) contains copper and zinc exceedences (NBH01, NBH26) that are comingled with shallow hydrocarbon contamination (NBH01, NBH26, and NBH27). The mechanism of contamination is likely spillage of waste oil in APEC 12 and is discussed further in Section 9.12.

Metals contamination detected on the east side of the Noble Towing building (O-BH1, NBH05, NBH06M, NBH07, and NBH23) is attributable to APEC 3 (Imported Fill) and is discussed further in Section 9.3. Hydrocarbons are also present in soil and groundwater in this area and the suspected mechanism of hydrocarbon contamination is shipyard activities in the adjacent marine way attributable to APEC 1.

Hydrocarbon contamination in soil and groundwater east of the Noble Towing building was likely caused by shipyard operations before the eastern marine way was covered (prior to 1980). Naphthalene concentrations exceeding the upper cap concentrations for freshwater aquatic life were observed in groundwater at NBH22M and adjacent to Roche Point Creek at NBH28M. A surface water sample collected from the creek in this area did not contain detectable concentrations of PAH. The identified groundwater contamination at NBH22M and NBH28M is delineated vertically by NBH29M, to the south by NBH06M, to the north (upgradient) and east by the hydraulic barrier of Roche Point Creek and grossly to the west by NBH33M and NBH09M.

In the east side of the gravel lot west of the Noble Towing building, metals exceedences of zinc (NBH02M), copper (NBH14), and tin and antimony (NBH31) were identified. Theses metals were likely deposited in soils during shipbuilding or brickyard activities and are attributable to APEC 1. This metals contamination is delineated vertically and laterally.

Groundwater arsenic contamination identified at NBH09M beneath the Noble Towing building is delineated vertically by NBH34M, and laterally by samples collected from surrounding wells. No cause (either related to site use or natural causes) is apparent. While arsenic is found broadly on the site, this is almost certainly related to slag-derived blasting grit, and so is not generally available under ambient conditions. Repeated testing of the monitoring well confirms it is persistently present.

APEC 1 was carried forward as AEC 1-1, AEC 1-2, and AEC 1-3 with the following COCs:

AEC 1-1: West side of Noble Towing building (NBH02M, NBH14, and NBH31):

- Soil metals (antimony, copper, tin, and zinc).

AEC 1-2: Beneath Noble Towing building (NBH09M):

- Groundwater dissolved arsenic.

AEC 1-3: East side of Noble Towing building (NBH07, NBH22M, and NBH28M):

- Soil MAH (benzene, ethylbenzene);
- Soil VPH;
- Soil LEPH;
- Soil PAH (naphthalene and phenanthrene);
- Groundwater LEPH; and
- Groundwater PAH.

9.1.7 Limitations

Investigation of all areas of APEC 1 was not possible due to the presence of facilities such as the concrete marine way. Additional investigation and remediation is required at APEC 1 during Site decommissioning.

VOCs were not tested in soil. This is not considered a major limitation because since MAH/VPH can be considered primary PCOCs for VOC and LEPH/HEPH.

9.2 APEC 2 – Sediments - Foreshore and Marine Ways - General Shipyard Activities

The sediments in the foreshore of Burrard Inlet and the marine ways south of the Site have been exposed to potential contaminants or concern due to long-term shipyard activities at both Site properties.

Table F: Investigation Locations in APEC 2

Investigation Locations	PCOCs
Intertidal: 1-01, 1-02, 1-03, 2-01, 2-02, 2-03, 3-01, 3-02, 3-03, , 7-02, 7-03, 7-04, 7-05, 8-02, 8-03, 8-04, 8-05, SS05-1, SS05-2, SS05-3, SS05-4, S05-12, SS05-13, SS05-14, SS05-15, SS05-16, SS05-17, SS05-22, C6, C7, C8, SS1, SS2, SS3, SS4, SS5, SS6, SS7, SSW, SSBB, SSII, SSTT, SSUU, NBH13, NBH31, NBH35, NBH36, BH33, BH34, BH35, BH99, BH100, BH101, BH102, BH105, BH106M, BH107M, BH116, BH117, BH118, BH119, BH120, BH134, BH135, BH136, BH137. Subtidal: 14-FS1, 14-FS2, 14-FS3, 14-FS4, 14-FS5, 14-FS6, 14-FS7, SS05-5, SS05-6, S05-7, SS05-8, SS05-9, SS05-10, SS05-11, SS05-16, SS05-18, SS05-19, SS05-20, SS05-21, SS05-23, SS05-24, SS05-25, SS05-26, SS05-27, SS05-28, SS05-29, SS05-30, SS05-31, SS05-32, SS05-33, C2, C4, C5, C9, C10, C11, SSA, SSB, SSC, SSD, SSE, SSF, SSG, SSH, SSI, SSJ, SSK, SSL, SSM, SSN, SSO, SSP, SSQ, SSR, SSS, SST, SSU, SSV, SSX, SSY, SSZ, SSAA, SSCC, SSDD, SSEE, SSFF, SSGG, SSHH, SSJJ, SSKK, SSLL, SSMM, SSNN, SSOO, SSPP, SSQQ, SSRR, SSSS, SSVV, SSXX, SSYY, SSZZ, SSAAA.	Primary: Metals, PAH, TBT Secondary: PCB

A total of 66 intertidal and 83 subtidal sediment locations have been sampled south of the Site.

The intertidal samples are located between the high and low-tide water marks, so are below the water at least some of the time. We have conservatively applied both soil and sediment standards to the intertidal samples. Soil standards related to drinking water or marine aquatic life do not apply to locations below the high tide mark.

Contamination of sediments is predominantly metals and PAHs in three main areas. The smaller areas are coincident with the Noble dock and marine ways. The larger area extends offshore and east from the marine ways at the Mackenzie property. Some intertidal areas will be inaccessible for testing until the overlying decking (in many places consisting of a steel plate) has been removed. With the exception of these covered areas, delineation was achieved for all parameters.

Metals

Metals in sediments (excluding tributyltin) are extensive, and for the most part appear to be those we would expect in blasting grit and paint.

- Concentrations of at least one metal (arsenic, chromium, copper, lead, mercury, or zinc) exceeded either the applicable CSR soil standards or CSR marine typical standards at 27 intertidal sediment investigation locations at APEC 2 (Figure 8); and
- Concentrations of at least one metal (arsenic, chromium, copper, lead, mercury, or zinc) were identified to exceed either the CSR marine typical standards at 14 sub-tidal sediment investigation locations at APEC 2 (Figure 8).

PAHs

PAHs, likely associated with the use of creosote in barge building and the extensive use of pilings, are extensive in sediment off the Mackenzie area.

- Concentrations of at least one PAH were identified to exceed either applicable soil or sediment standards at 22 investigation locations in the intertidal portion of APEC 2;
- Concentrations of EPH exceeding the applicable Schedule 4 soil standard were identified at three intertidal sampling locations, one south of APEC 4 (BH34) and two south of APEC 5 (BH99 and BH101); and
- Concentrations of at least one PAH constituent were identified to exceed the CSR marine typical standards at 31 sub-tidal investigation locations at APEC 2.

PCBs

PCBs were detected by Hemmera at one location exceeding the standard, but not elsewhere, and may be an artifact.

- PCBs exceeded the applicable standard at Hemmera intertidal investigation location C7. Two other samples analyzed for PCB in the intertidal area south of 3829 Dollarton contained concentrations below the applicable standards; and
- Concentrations of PCB in sediments were historically assessed at 12 sub-tidal locations. Sample SS05-6 collected by Hemmera contained total PCB at a concentration exceeding the applicable Standard. Additional samples collected in that location by Hemmera (C2) did not detect concentrations of PCB exceeding the Standard.

TBT

TBT was not identified as an issue in sediments. Given the nature of the use of the sites (aluminum boat building and barge building and repair predominating), the lack of elevated TBT is not particularly surprising.

- Intertidal soil samples analyzed for TBT met the applicable Schedule 10 Standards for TBTO. All intertidal sampling locations where soil samples were analyzed for MAH and VOC constituents also contained concentrations below the applicable standards; and

- TBT was tested in sub-tidal sediments at several locations. There is no applicable CSR standard for TBT in sediments but concentrations are lower than those observed in the intertidal and uplands areas where they met applicable standards after conversion to TBTO.

9.2.1 Discussion

PGL identified metals and PAH contamination in APEC 2 in intertidal and sub-tidal sediments. Contaminated sediments are predominantly located south and east of the McKenzie Barge property and appear to be sourced from activity in the marine ways there. Contaminated sediments have likely been mobilized to the east by tidal currents moving up Burrard Inlet towards Indian Arm. Some metals and PAH exceedences of lesser spatial magnitude were also located near the Noble Towing marine ways and south of the Noble Towing dock. The extent of identified contaminants in intertidal and sub-tidal sediments is laterally delineated.

APEC 2 was carried forward as AEC 2-1, AEC 2-2, and AEC 2-3 for the following COCs in sediment:

- Metals (arsenic, chromium, copper, lead, mercury, or zinc);
- PAH; and
- PCB (AEC 2-2 only).

The remedial option for sediments will depend on aquatic biota toxicity testing currently in progress.

9.2.2 Limitations

Vertical delineation of all contaminants in sediments could not be achieved at all investigation locations. This was due the vertical sampling limitations of a ponar grab sampler, and the limited penetration of core samplers due to the presence of cobbles and gravel beneath surficial sediments. Vertical delineation data is available at some sediment sampling locations, for example contamination at SSAA is vertically delineated between 1.5 and 1.8m below sediment surface.

The lack of complete vertical delineation in sediments south of the Site is not considered a major limitation because observed contaminant concentrations generally decrease with depth. The mechanism of sediment contamination is deposition or settlement of contaminated material through the water column, and impacts are concentrated in surficial sediments. The maximum depth of contamination can be inferred to be approximately 2m based on the mechanism of contamination, vertical delineation achieved above 1.8m at other locations; and the stratigraphy in the area (cobbles and gravel beneath surface sediments).

9.3 APEC 3 – Imported Fill Material East of the Shipyard Building (3829 Dollarton)

The area east of the current building at 3829 Dollarton was filled in the early 1980s during construction of the eastern section of the building. The fill in this area was reportedly imported from an unknown source in East Vancouver. Field indicators at multiple locations in the fill layer included:

- Hydrocarbon odours and/or staining;
- Miscellaneous debris;
- Crushed brick; and
- Wood waste.

PGL assessed soil, groundwater, soil vapour quality in the filled area east of the Noble Towing building as well as sediment and freshwater quality in the adjacent Roche Point Creek.

Table G: Investigation Locations in APEC 3

Investigation Locations	PCOCs
Soil (Uplands): O-BH1, , NBH07, NBH20, NBH21, NBH23 Soil and Groundwater (Uplands): NBH06M, NBH22M, NBH28M, NBH29M Soil (Filled Intertidal): NBH05, NBH18 Soil and Groundwater (Filled Intertidal): NBH19M Soil Vapour (Uplands): NSV01 Soil Vapour (Filled Intertidal): NSV02 Sediment (Freshwater): SED-01, SED-02 Surface Water (Freshwater): SW01	Primary: Metals Secondary: LEPH/HEPH, PAH

9.3.1 Soil Chemistry

PGL delineated metals and hydrocarbons contamination in fill soils in APEC 3:

- Metal contamination (arsenic, copper and/or zinc) was identified in soil at five investigation locations (NBH05, NBH06M, NBH07, NBH23, and O-BH1) in fill soils at APEC 3 between 0.2m and 4.6m bgs; and
- Hydrocarbon (PAH, LEPH, MAH and/or HEPH) contamination was identified in fill soils at APEC 3 (NBH05 and NBH18).

Hydrocarbon contamination was also identified further north (NBH22M and NBH07) near Roche Point Creek, but that contamination is associated with APEC 1 and was discussed in Section 9.1.

9.3.2 Groundwater Chemistry

No groundwater contamination was identified in APEC 3. Initial exceedence of pyrene standards at NBH19M is an artifact based on three subsequent samples. Groundwater contamination identified at NBH22M and NBH28M near the edge of Roche Point Creek is attributed to APEC 1 and was discussed in Section 9.1. Groundwater from other wells sampled at APEC 3 did not contain concentrations of PCOCs above the applicable standards.

9.3.3 Soil Vapour Chemistry

The concentrations of PCOCs in soil vapour samples collected at APEC 3 from two locations are below the applicable standards when appropriate attenuation factors are applied.

9.3.4 Freshwater Sediment

Freshwater sediments sampled at three locations in Roche Point Creek met applicable Standards for metals, LEPH and PAHs.

9.3.5 Surface Water

Water collected from Roche Point Creek was below the laboratory detection limits for PAHs and met the applicable BC Water Quality Guidelines.

9.3.6 Discussion

While the concentrations of PCOCs in some fill soil samples at APEC 3 were below the applicable Standards, a conservative look at the data suggests that the entire fill volume east of the building at 3829 Dollarton and west of Roche Point Creek is suspect. The contaminated soils exist at depths up to 3.4m to the north (at the south edge of Roche Point Creek) to a maximum depth of 4.6m to the south end of Noble Point at NBH05. Clean soil samples were obtained in the native silt layer below the fill material.

Metals contaminated fill soils are delineated to the west by the concrete lined marine way in the Noble Towing building. Further investigation of soils beneath the marine way is warranted during decommissioning. Contaminated fill is delineated to the east near the edge of Roche Point Creek by NBH20 and at NBH21, but these results may simply indicate the heterogeneous nature of the fill. Contaminated fill is delineated to the south edges of the fill. NBH19M which was drilled as far south as possible on Noble Point.

Soil contamination was identified in APEC 3. The APEC was carried forward as AEC 3 for the following COCs in soil:

- Metals (arsenic, copper, and zinc); and
- PAH

9.3.7 Limitations

Certain soil and groundwater exceedences could not be fully delineated to the east due to the presence of Roche Point Creek, and to the west due to the active marine way. This is not a major limitation to our investigation because sediment and surface water in the Creek do not appear to be impacted. Further investigation and remediation is required near the creek and beneath the building during Site decommissioning.

9.4 APEC 4 – In-filled Sandblasting and Painting Area with Accumulated Sandblast Grit (3919 Dollarton)

By 1974 filling of the foreshore south of the western portion of the McKenzie Barge property extended the western half of the Site about 50m south into Burrard Inlet. This in-filled area on the west side of the 3919 Dollarton property has since been used as a sandblasting and painting area.

PGL assessed soil, groundwater, soil vapour, and sediment quality of the filled sandblasting area Site through drilling and analysis of shallow soil samples from the borehole locations. Soil exceeded standards but no other medium did.

Table H: Investigation Locations in APEC 4

Investigation Locations	PCOCs
Soil (Filled Intertidal): 4-01, 4-02, 4-03, 5-01, 5-02, 5-03, 6-01, 6-02, 6-03, O-BH13, O-BH15, , BH20, BH30, BH31, BH32, BH36, BH37, BH38, BH39, BH40, BH41, BH65 Soil and Groundwater (Filled Intertidal): OW9, OW10, BH10M, BH18M, BH19M, BH21M Soil/Sediment (Intertidal): BH33, BH34, BH35 Soil Vapour: SV05	Primary: Metals, LEPH/HEPH, MAH, VPH, VOC, TBT Secondary: PAH, PCB

9.4.1 Soil Chemistry

The investigation delineated metals, PAHs and, to a lesser extent, hydrocarbon contamination in shallow fill in APEC 4.

- Metals (antimony, arsenic, cadmium, chromium, copper, molybdenum, nickel, and/or zinc) exceeded standards at seven investigation locations;
- At least one PAH constituent is present at concentrations exceeding the applicable standards at seven locations; and
- LEPH and HEPH contamination was identified at BH34 and LEPH contamination at BH36.

MAH, VOC or phenols contamination was not identified in soils at APEC 4. TBT was non-detectable in soils.

9.4.2 Groundwater Chemistry

No wells tested by PGL exceeded applicable standards for MAH, VPH, LEPH/HEPH, PAH, VOC, or TBT at APEC 4. In 1993, OW10 in APEC 4 and OW9 to the east exceeded the applicable standard for copper. These wells were not available for re-sampling to assess current dissolved metals concentrations. A lack of groundwater contamination at the other wells in APEC 4 indicates that NDM's 1993 dissolved metals results do not represent current Site conditions.

9.4.3 Soil Vapour Chemistry

Soil vapour was assessed at SV05 in APEC 4 due to the detection of volatile parameters in soil and groundwater. The concentrations of PCOCs in soil vapour at SV05 are below the applicable standards when the applicable attenuation factor is applied.

9.4.4 Hazardous Waste

A sample from BH37 that contained visible sandblast grit was analyzed for leachable metals content. Concentrations of all leachable metals in the sample were below the Hazardous Waste Regulation standards. The only detectable leachable metals were copper, magnesium and zinc (Table 3).

9.4.5 Discussion

The soil metals and PAH impacts at APEC 4 are generally located within the top metre of fill soils. The exception is copper at BH36 (exceeds the sediment standard at 3-3.5m bgs) and PAH at BH35 (contamination extends to at least a depth of 2.1m and is vertically delineated at a depth of 2.7m bgs) and BH37 (vertically delineated at 1.5m bgs).

The predominance of contamination in the upper 1m of soil at APEC 4 indicates that the contamination was caused by surficial deposition, likely during sandblasting, boat maintenance, and painting activities. The identified contaminants in deeper fill soils could have been sourced from contaminated fill or nearby sediments that were dredged to fill the area at APEC 4.

APEC 4 was carried forward as AEC 4 for the following COCs in soil:

- Antimony, arsenic, cadmium, chromium, copper, molybdenum, nickel, and zinc; and
- PAH.

9.5 APEC 5 – Offsite In-filled Foreshore and Former Materials Storage, Boat Building, and Burning Area

Aerial photographs indicate that this former foreshore area southeast of the Site was filled in the late 1950s. After this, the area was reportedly used for burning scrap wood from the building of wooden boats up until about 1995.

PGL assessed soil, groundwater, soil vapour, and sediment quality of the offsite filled former boatbuilding, scrap and burning area through drilling, hand augering, and analysis of soil, groundwater, soil vapour and sediment samples from the borehole locations.

Fill at APEC 5 is extensively contaminated with metals, PAH, LEPH/HEPH and MAH, and the effect extends to the adjacent exposed native intertidal sediment. Groundwater is also impacted with PAH and LEPH.

Table I: Investigation Locations in APEC 5

Investigation Locations	PCOCs
Soil (Filled Intertidal): 9-01, 9-02, BH15, BH77, BH78, BH85, BH86, BH94, BH95, BH96, BH105, BH108, BH109, BH110, BH111, BH112, BH113, BH114, BH115, BH121, BH122, BH129, BH130, BH131, BH132, BH133 Soil and Groundwater (Filled Intertidal): OW5, BH22M, BH42M, BH43M, BH44M, BH74M, BH75M, BH76M, BH79M, BH97M, BH98M Soil/Sediment (Intertidal): BH99, BH100, BH101, BH102, BH116, BH117, BH118, BH119, BH120, BH134, BH135, BH136, BH137, SSW, SSII Soil/Sediment and Porewater (Filled Intertidal): BH106M, BH107M, Soil Vapour: SV01, SV02, SV03	Primary: Metals, LEPH/HEPH, PAH, MAH, VPH, TBT Secondary: PCB, VOC

9.5.1 Soil and Sediment Chemistry (Filled Intertidal and Intertidal)

Fill in this area appears to be fully impacted. Soil metals (antimony, arsenic, chromium, copper, lead, mercury, and/or zinc) and PAH contamination was identified at most of the investigation locations at APEC 5. LEPH/HEPH contamination was also extensive at APEC 5. The identified metals contaminants are located between grade surface and a maximum depth of 3.3m bgs (at BH43M). Molybdenum, nickel and tin exceeded in a few locations.

Concentrations of VOC (9-01), TBT (BH15, BH22M) and PCB (BH22M) tested in APEC 5 soils during previous investigations were below the applicable standards.

9.5.2 Groundwater Chemistry

Extensive PAH effects on groundwater are unique to APEC 5, with eight wells exceeding Standards. The concentration of LEPH in groundwater exceeds the standard at BH97M and BH98M. PAH and LEPH concentrations in groundwater at APEC 5 are delineated vertically at BH79M.

Concentrations of dissolved metals in samples collected at APEC 5 by PGL did not exceed the applicable standards. The concentration of dissolved cadmium at OW5 exceeded the standard when it was sampled by NDM in 1993. This well could not be located for re-sampling but dissolved cadmium concentrations in nearby wells were below the standard.

TBT tested in groundwater at BH22M did not exceed the applicable standard.

MAH, VPH and VOC concentrations in groundwater at APEC 5 were below the applicable standards.

9.5.3 Soil Vapour Chemistry

Soil vapour was assessed at 3 locations in APEC 5 due to the detection of volatile parameters in soil and groundwater. The concentrations of PCOCs in soil vapour at APEC 5 are below the applicable standards when the appropriate attenuation factors are applied.

9.5.4 Hazardous Waste

Soil sample BH85-02 from APEC 5 contains a PAH TEQ concentration exceeding the Hazardous Waste Regulation (HWR) standard (Table 5). A PAH TCLP analysis was completed on this sample and benzo(a)pyrene results meet the HWR standard for leachate quality (Table 4).

Leachable metals concentrations were analyzed in a soil sample collected from the north end of the west marine way at 3919 Dollarton that contained very high concentrations of metals and the visible sandblast grit. Concentrations of all leachable metals in the sample (BH70-01) were below the Hazardous Waste leachate quality standards. Only copper, iron, lead, magnesium and zinc were detected (Table 3).

9.5.5 Discussion

The offsite filled intertidal area (APEC 5) extends from the eastern edge of the east marine way (above former wooden dock) north to the original shoreline border with Cates Park, northeast to the squatter shack and east to a makeshift retaining wall made of creosoted wood and metal. Soil results indicate that this entire filled area is impacted with metals, PAH, LEPH/HEPH and MAH. Groundwater in the area is also impacted with PAH and LEPH.

The likely mechanism of metals contamination at APEC 5 is airborne depositions of sandblast grit from the adjacent marine ways to the west as well as physical dumping of grit in the area. Sandblast grit impacted surficial soils and sediments extend in all directions from the marine ways through airborne deposition. To delineate the extent of surficial metals contamination, investigation was required to the east on the foreshore, to the north in Cates Park, and to the south in marine sediments.

The mechanism of identified MAH, LEPH/HEPH and PAH contamination in soil and LEPH and PAH contamination in groundwater at APEC 5 was likely historical use of the area for boat building, painting, equipment storage, and burning of materials. Dumping or spilling of chemicals during boat maintenance and the presence of creosote treated piles in the buried dock adjacent to the marine way are also likely contributors.

Delineation of soil metals contamination has been obtained to the north in Cates Park and to the east on the foreshore. Metal debris is evident on the foreshore south of the filled area and we have assumed that this will be cleaned up during development. PAH and metals contamination in soil appears to extend south into the sediments which are impacted south of the Site water lots.

Aerial photographs, topography, and investigation results indicate that these activities only took place on the filled foreshore and not up the slope in Cates Park. The topography slopes up steeply from the original high water mark to the north into Cates Park. MAH and LEPH/HEPH contamination in soil concentrated near the border with Cates Park was likely caused by spilling or dumping in the area where NDM documented a former painting shed. Soil samples collected to the north in the park did not contain concentrations of PAH exceeding the standards.

Groundwater at APEC 5 is tidally influenced and shallow relative to other areas on the Site. Vertical migration of dumped or spilled hydrocarbons has caused groundwater contamination in the area.

The Filled area is proposed to be remediated by excavation and source removal. APEC 5 was carried forward as AEC 5 for the following COCs:

- Soil metals (antimony, arsenic, chromium, copper, lead, mercury, molybdenum, nickel, tin, and zinc);
- Soil and groundwater PAH;
- Soil and groundwater LEPH; and
- Soil MAH.

9.5.6 Limitations

Groundwater contamination identified at BH98M is not directly delineated to the north because a groundwater well could not be installed within the heavily forested area of Cates Park. Impacts to groundwater to the north are unlikely, given the topography, direction of groundwater flow, suspected mechanism of contamination, and the marginal exceedence of pyrene in BH98M that is likely attributable to a sampling artifact. Groundwater in this well was turbid (>10 NTU) during sampling and pyrene concentrations marginally exceed the applicable standard.

9.6 APEC 6 – Historic Boiler House (3829 Dollarton)

A former boiler house at 3829 Dollarton was identified in the 1965 fire insurance map.

PGL assessed soil quality in the area of the former boiler house by drilling one borehole and collecting soil samples. No contamination has been identified associated with this APEC and it has not been retained as an AEC.

Table J: Investigation Location in APEC 6

Investigation Location	PCOCs
Soil (Uplands): NBH08	Primary: LEPH/HEPH, PAH

9.6.1 Soil Chemistry (Uplands)

No detectable concentrations of LEPH/HEPH were present in shallow soils at NBH08. There were detectable concentrations of some PAH and metals constituents, but at concentrations below the applicable standards.

9.6.2 Groundwater Chemistry

Groundwater was not assessed at APEC 6 because soil contamination was not detected at NBH08M and the potential mechanism of contamination would have been spillage at grade.

9.6.3 Soil Vapour

As naphthalene was non-detectable in soil and there are no other volatile PCOCs for this APEC, soil vapour was not assessed.

9.7 APEC 7 – Historic Work Shop (3829 Dollarton)

A former workshop at the north end of the easternmost marine way was identified in the 1965 insurance map.

PGL assessed soil quality in the area of the former boiler house by drilling one borehole and collecting soil samples.

No contamination has been identified associated with this APEC and it has not been retained as an AEC.

Table K: Investigation Location in APEC 7

Investigation Location	PCOCs
Soil (Uplands): NBH11	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PAH, VOC

9.7.1 Soil Chemistry (Uplands)

No detectable concentrations of LEPH/HEPH, MAH or VPH were present in shallow soils at NBH11. There were detectable concentrations of some PAH and metals constituents, but at concentrations below the applicable standards.

9.7.2 Groundwater Chemistry

Groundwater was not assessed at APEC 7 because soil contamination was not identified and the potential mechanism of contamination would have been spillage at grade.

9.7.3 Soil Vapour

As naphthalene was non-detectable in soil and no detectable concentrations of MAH or VPH were present in soil, soil vapour was not assessed at APEC 7. VOCs were not tested in soil at APEC 7 but they were screened out as a secondary PCOC due to the lack of detection of MAH or VPH parameters.

9.8 APEC 8 – Machine Shop beneath McKenzie Barge Office Building (3919 Dollarton)

A machine shop beneath the main office building has been present since at least 1965.

Due to the thickness of the slab and ongoing use of the machine shop, PGL assessed soil, groundwater, and soil vapour quality to the south, immediately adjacent and downgradient of the machine shop.

No contamination associated with APEC 8 was identified; however it is carried forward as APEC 8 because further investigation is required directly beneath the machine shop slab during Site decommissioning.

Table L: Investigation Locations in APEC 8

Investigation Locations	PCOCs
Soil/Groundwater (Uplands): BH11M, BH51, BH52 Soil Vapour: SV10	Primary: Metals, LEPH/HEPH, MAH, VPH, VOC Secondary: PAH

9.8.1 Soil Chemistry

Cadmium was identified in shallow soil at BH11M at a concentration exceeding the applicable standards. Due to its location south of the machine shop, the cadmium contamination identified in shallow soils at BH11M is attributed to APEC 14 (Former UST and Outdoor Battery Storage Area) rather than APEC 8 and is further discussed in Section 9.14.

Detectable concentrations of HEPH and PAHs were detected in shallow soil at BH11M but meet the applicable standards. Concentrations of MAH were not detectable at BH11M or BH52.

9.8.2 Groundwater Chemistry

No detectable concentrations of LEPH/HEPH, MAH, VPH, or PAH were detected. Chloroform exceeded the applicable standard in 2007 but no other VOC compounds were detected. This concentration of chloroform is unlikely to be the result of Site contamination, as there is no site related use of chloroform. PGL believes the chloroform concentration is attributable to chlorinated municipal water leaks and not to contamination.

It is not the responsibility of the Site owner, or the intention of the Contaminated Sites Regulation, to address chloroform caused by municipal water supply, as this is a societal risk choice and not a result of Schedule 2 activity. PGL has left this data in the tables and report for completeness, but is not highlighting it as an exceedence caused by contamination by the Site.

9.8.3 Soil Vapour Chemistry

Soil vapour was assessed at SV10 due to the volatile PCOCs associated with APEC 8. Concentrations of PCOCs in soil vapour are below the applicable standards when the appropriate attenuation factor is applied.

9.8.4 Limitations

Further investigation of APEC 8 is warranted during Site decommissioning to assess the presence of PCOCs directly beneath the machine shop slab and in the area of a reported but not identified oil-water separator.

9.9 APEC 9 – Shed Containing Former Maintenance Shop and Blacksmith (3919 Dollarton)

The shed near the western property line of the McKenzie Barge property contained a maintenance shop and adjacent blacksmith in the 1965 fire insurance map. ASTs and electrical equipment were also identified in the shed in recent years.

PGL assessed soil, groundwater, and soil vapour quality in the area of the former maintenance shop and blacksmith.

Table M: Investigation Locations in APEC 9

Investigation Locations	PCOCs
Soil: 11-01, 11-02, BH26, BH27 Soil/Groundwater: BH04M, BH05M Soil Vapour: SV04	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PAH, PCB

9.9.1 Discussion

Shallow soil metals contamination (arsenic, chromium, copper, and zinc) was identified at APEC 9 that appears to be similar in nature and contiguous with contamination observed to the north at APEC 16 (Northwest Boneyard). Accordingly, APEC 9 has not been retained as an AEC on its own but has been incorporated into AEC 16 and is discussed in Section 9.16

9.10 APEC 10 - Waste Dump (3829 Dollarton)

Hemmera's Phase 1 report identified a waste dump in the southwest section of the building at 3829 Dollarton. The waste was reportedly removed years ago but we have identified this area as an APEC.

Due to the presence of a filled/capped former marine way, PGL could only assess the area just north of APEC 10. NDM advanced 2 hand auger samples in the intertidal zone at APEC 10 and did not submit these samples for analysis, indicating a lack of field indicators of contamination. NDM submitted a soil/sediment sample 2-03 for metals analysis south of and adjacent to APEC 10. Lark Noble indicated that materials from the waste dump were removed.

PGL assessed soil quality in the area adjacent to the waste dump to the north by drilling one borehole (NBH10) and collecting soil samples. PGL also advanced a shallow borehole NBH35 in the intertidal area west of APEC 10.

No contamination has been identified associated with APEC 10 and it has not been retained as an AEC.

Table N: Investigation Location in APEC 10

Investigation Location	PCOCs
Soil (Uplands): NBH10 Soil/Sediment (Intertidal): 2-01, 2-02, 2-03, NBH35	Primary: Metals, LEPH/HEPH, PAH (screening parameters only, all waste was removed several years ago) Secondary: MAH, VPH, VOC

9.10.1 Soil and Sediment Chemistry (Uplands and Intertidal)

No detectable concentrations of LEPH/HEPH were present in soil at NBH10. There were detectable concentrations of some PAH and metals constituents, but at concentrations below the applicable standards. The concentration of TBT in soil at NBH10 meets the applicable BC CSR Schedule 10 standard when converted to tributyltin oxide (TBTO). Secondary PCOCs were not analyzed in soil at APEC 10 due to the lack of primary COCs identified.

Metals concentrations in soil/sediment samples collected from 2-03 and NBH25 adjacent to APEC 10 were below the applicable soil and sediment standards.

9.10.2 Groundwater Chemistry

Groundwater was not assessed at APEC 10 because soil contamination was not detected and the mechanism of groundwater contamination would have been migration through soils from grade.

9.10.3 Soil Vapour Chemistry

Soil vapour was not assessed because field indicators and screening for primary PCOCs did not indicate a need to test for volatile secondary PCOCs.

9.11 APEC 11 - Offshore Buried Barge and Metal Debris (3829 Dollarton)

Hemmera's Phase 1 report identified an offshore barge and buried metal debris in the foreshore southwest of the shipyard building at 3829 Dollarton.

No direct investigation of the barge at APEC 11 has taken place although it is located within the larger area of AEC 2 and sediment samples from the surrounding area have been analyzed for metals and PAH PCOCs.

Table O: Investigation Locations near APEC 11

Investigation Location	PCOCs
Sediment (Sub-tidal): SS05-12, SS05-13, SS05-16, C6	Metals, PAH

9.11.1 Discussion

The barge exists in an area of APEC 2 that has been identified as AEC 2-2 for PAH and metals COCs in sediments. This indicates that aside from the barge as a physical object, it does not appear to have affected sediments in the area more than they already are.

APEC 11 has not been retained as an AEC.

9.12 APEC 12 - Historical Solvent and Paint Storage Area (3829 Dollarton)

Hemmera's Phase 1 report identified an area of historical solvent and paint storage in the current gravel parking lot area southwest of the shipyard building at 3829 Dollarton Highway.

PGL assessed soil, groundwater, and soil vapour quality in the area of the historical solvent and paint storage area. As discussed in Section 9.1, this APEC overlaps with APEC 1 (General Shipbuilding and Brickyard Activities). Soil metals contaminants (NBH02M, NBH14, and NBH31) and groundwater arsenic contamination (OW2A) identified on the east side of APEC 12 is associated with APEC 1 and was discussed in Section 9.1.

The west side of the parking lot in APEC 12 contains copper, zinc, and hydrocarbon contamination in shallow soils that was likely caused by a surficial spill of waste oil in the area.

Table P: Investigation Locations in APEC 12

Investigation Locations	PCOCs
Soil: OW2A, OW2B, O-BH3, NBH01, NBH03, NBH12, NBH13, NBH14, NBH15, NBH16, NBH17, NBH26, NBH27, NBH31, NBH32, NBH35, NBH36	Primary: Metals, VOC, LEPH/HEPH, Secondary: PAH, MAH
Soil/Groundwater: NBH02M, NBH30M	
Soil Vapour: NSV03, NSV04	

9.12.1 Soil Chemistry

Concentrations of at least one metal (antimony, arsenic, copper, tin, and/or zinc) were identified to exceed the applicable CSR standards in five borehole locations within APEC 12 (NBH01, NBH02M, NBH14, NBH26, and NBH31).

Concentrations of HEPH and PAH parameters were identified to exceed the applicable CSR standards in shallow soils at NBH01 and NBH26. Two PAH parameters (benzo(a)pyrene and benzo(b)fluoranthene) also exceeded the applicable standards in shallow soils at NBH27.

Concentrations of all other metal, LEPH/HEPH and PAH parameters as well as MAH, VPH, and TBT (reported as TBTO) were less than the applicable CSR standards in all other soil samples analyzed at APEC 12.

9.12.2 Groundwater Chemistry

Benzo(a)pyrene concentrations at NBH02M exceeded the standard during two sampling events but subsequent samples show non-detectable concentrations. This has been discounted as a sampling artifact.

Concentrations of MAH, VPH, and VOC and all other metals and PAH parameters were less than the applicable CSR standards in all groundwater samples analyzed at APEC 12.

9.12.3 Soil Vapour

Concentrations of all PCOCs in soil vapour are below the applicable standards after applying the appropriate attenuation factors.

9.12.4 Discussion

The contamination identified at APEC 12 is delineated vertically within the top 1m of soil and does not extend to the depth of groundwater. The area is located at the base of a steep slope down from the west and contamination is delineated horizontally to the west by NBH30M which had to be drilled at the top of the hill due to access limitations.

APEC 12 has been retained as AEC 12 following COCs in soil:

- Metals (copper, and zinc);
- HEPH; and
- PAH.

9.12.5 Limitations

VOC is listed as a primary PCOC for APEC 12 and are not present in groundwater but were not tested in soil. All samples analyzed for MAH and VPH at APEC 12 contained concentrations below the method detection limits. This is not considered a major limitation because the presence of VOCs in soil sourced from paint and aliphatic solvents would be indicated by MAH/VPH.

9.13 APEC 13 – Former Storage Area for Creosoted Ties (3919 Dollarton)

An area formerly known to be used for storage of creosoted ties is located in the northwest portion of the McKenzie Barge property.

PGL assessed soil and groundwater quality in the area of the former storage of creosoted ties. Metals (copper and barium) and benzo(b)fluoranthene contamination was identified in shallow soils at APEC 13.

Table Q: Investigation Locations in APEC 13

Investigation Locations	PCOCs
Soil: 12-01, 12-02, 12-03, O-BH16 Soil/Groundwater: BH06M, BH07M, BH63M	Primary: LEPH/HEPH, PAH, Metals

9.13.1 Discussion

The shallow soil contamination (copper, barium, and benzo(b)fluoranthene) identified at APEC 13 appears to be similar in nature and contiguous with contamination observed to the west at APEC 16 (Northwest Boneyard). PAHs suggestive of creosote were not found at APEC 13. Accordingly, APEC 13 has not been retained as an AEC on its own but has been incorporated into AEC 16 and is discussed in Section 9.16

9.14 APEC 14 – Former Gasoline UST and Outdoor Battery Storage Area (3919 Dollarton)

A gasoline UST and associated fuel pump was removed from the area south of the McKenzie Barge office building in 2012. A certificate documenting the UST removal is included as Appendix 8. Remediation did not take place when the UST was removed. In this area in 2007, a PGL Site inspector also noted two pallets containing about 30 waste batteries stored on a gravel area adjacent to the UST nest.

PGL assessed soil, groundwater, and soil vapour quality in the area of the former UST and battery storage area. Soils at APEC 14 exceed the applicable standards for LEPH, HEPH, VPH, benzo(b)fluoranthene, lead and cadmium. The identified contamination was likely caused by fuel spillage during UST filling and use of the pump island and is delineated vertically and laterally in all directions.

Table R: Investigation Locations in APEC 14

Investigation Locations	PCOCs
Soil: 13-01, 13-02, CS01, CS02, CS03, CS04, TP01, TP02, BH51, BH52, BH66	Primary: MAH, VPH, LEPH, Metals (for battery storage)
Soil/Groundwater: BH11M, BH53M Soil/Soil Vapour: SV09	Secondary: MTBE, EDB (1,2-dibromoethane), DCA (1,2-dichloroethane)

9.14.1 Soil Chemistry

Soil concentrations of LEPH, HEPH, VPH, and benzo(b)fluoranthene exceed the applicable standards in a soil sample collected during the installation of SV09 adjacent to the former UST tank nest. The concentration of VPH also exceeded the applicable standard at confirmatory samples CS03 (west wall) and CS04 (base) collected during the UST removal. All of these soil exceedences are at 2.4-2.7m bgs. The concentration of lead in soil at confirmatory sample CS03 (west wall) exceeds the applicable standard.

As previously discussed in Section 9.8, cadmium concentrations in shallow soil at BH11M exceed the applicable standard.

Other soil samples analyzed from APEC 14 did not contain concentrations of MAH, VPH, LEPH, HEPH, or PAH that exceeded the applicable standards.

9.14.2 Groundwater Chemistry

No detectable concentrations of LEPH/HEPH, MAH, VPH, or PAH were detected in BH11M in 2007 or 2013 or in BH53M in 2013, with the exception of MTBE at a concentration well below the applicable standard.

As discussed Section 9.8.2 (APEC 8), a concentration of chloroform exceeded the applicable standard in BH11M in 2007 but no other VOC compounds were detected. This concentration of chloroform is unlikely to be the result of Site contamination.

9.14.3 Soil Vapour Chemistry

Soil vapour was assessed at SV09 adjacent to the former UST tank nest. The concentrations of all PCOCs in the soil vapour sample meet the applicable standards after the application of the appropriate attenuation factor.

9.14.4 Discussion

Soils in the area of the former UST tank nest at APEC 14 exceed the applicable standards for LEPH, HEPH, VPH, benzo(b)fluoranthene, lead and cadmium. The identified contamination is delineated vertically by samples analyzed from BH11M and BH53M and laterally in all directions.

The contamination at APEC 14 was likely caused by fuel spillage during UST filling and use of the pump island. Observations during UST removal, soil delineation, and the absence of groundwater contamination downgradient of the former UST, all indicate that the UST and associated piping did not have major fuel leaks.

APEC 14 has been retained as AEC 14 for the following COCs in soil:

- LEPH/HEPH;
- VPH;
- Benzo(b)fluoranthene; and
- Metals (lead and cadmium).

9.14.5 Limitations

The cadmium contamination in shallow soil identified at BH11M is delineated vertically and to the east, west, and south by BH51, BH52, and BH53M, respectively where all metals concentrations met the applicable standards. The cadmium exceedence at BH11M has not been delineated to the north due to the location of the McKenzie Barge office building. As discussed in Section 9.8.5, further investigation is warranted during Site decommissioning beneath the machine shop slab and in the area of a reported but not identified oil-water separator.

The secondary PCOCs EDB (1,2-dibromoethane) and DCA (1,2-dichloroethane) were not tested in soil but given that they were non-detectable in groundwater at BH11M and soil vapour at SV09, this is not considered a major limitation.

9.15 APEC 15 – Former Drum Rack (3919 Dollarton)

A former drum rack for storage of miscellaneous chemicals was present at 3919 Dollarton south of the former UST.

PGL assessed soil and groundwater quality in the area of the former drum rack. A soil vapour well was advanced but a sample could not be recovered due to high vacuum in the well.

MAH contamination was present in shallow soils during the NDM investigation in 1993. No contamination was identified at APEC 15 in subsequent investigations. The contamination is delineated vertically and laterally and has not impacted groundwater in the area.

Table S: Investigation Locations in APEC 15

Investigation Locations	PCOCs
Soil: 13-01, 13-02, O-BH6, O-BH08, BH67	Primary: LEPH/HEPH, MAH, VPH, VOC
Soil/Groundwater: BH13M, BH54M	
Soil Vapour: SV07	Secondary: PAH

9.15.1 Soil Chemistry

Ethylbenzene and xylenes (MAH) exceed the applicable soil standards at NDM investigation location O-BH8 in 1993. No other locations in APEC 15 contained detectable concentrations of MAH, LEPH/HEPH or PAH. All soil metals concentrations in APEC 15 were below the applicable standards.

9.15.2 Groundwater Chemistry

No concentrations of LEPH/HEPH, MAH, VPH, VOC or PAH were detected in groundwater at APEC 15 and meet the applicable standards. Concentrations of dissolved metals at APEC 15 meet the applicable standards.

9.15.3 Soil Vapour Chemistry

Soil vapour was not assessed at SV07 because the well vacuum was unacceptable for sampling. We consider it a low risk for exceeding the applicable Standards due to marginal detections of volatile parameters in soil at O-BH08 in 1993 and no detection of MAH/VPH in soil or MAH/VPH and VOC in groundwater at APEC 15 in subsequent investigations in 2007 or 2013.

9.15.4 Discussion

The MAH contamination was likely caused by minor chemical spillage in the area of the drum rack during chemical transfer. The volatile nature of the contaminants detected by NDM in 1993 and the lack of detections in subsequent investigations, indicates that contamination may no longer be present in APEC 15.

Despite this, APEC 15 has been retained as AEC 15 for the following COCs in soil:

- MAH (ethylbenzene and xylenes).

9.15.5 Limitations

VOC is listed as a primary PCOC for APEC 15 and was not present in groundwater but was not tested in soil. With the exception of O-BH8 sampled in 1993, the remainder of soil samples analyzed for MAH and VPH at APEC 15 contained concentrations below the method detection limits. This is not considered a major limitation because the presence of VOCs in soil sourced from paint and aliphatic solvents would be indicated by MAH/VPH.

9.16 APEC 16 - Northwest Boneyard (3919 Dollarton)

The northwest boneyard at the McKenzie Barge property was formerly used to store creosote-treated wood beams, a pile of tires, an old generator, an old forklift, and currently contains scrap metal and old vehicles.

PGL assessed soil and groundwater quality in the northwest boneyard. Concentrations of shallow metals, HEPH, and benzene exceed the applicable standards in soil. Groundwater and soil vapour concentrations meet applicable standards.

As discussed in Sections 9.9 and 9.13, results at APEC 9 and APEC 13 indicate the same area and mechanism of contamination as at APEC 16. The results from those three APECs are discussed in the following sections.

Table T: Investigation Locations in APEC 16

Investigation Locations	PCOCs
Soil: O-BH11, O-BH12, BH01, BH02, BH03, BH24, BH25, BH28, BH29, BH80, BH81	Primary: Metals, LEPH/HEPH, MAH, VPH
Soil/Groundwater: BH04M	Secondary: PCB, PAH, VOC

9.16.1 Soil Chemistry

Concentrations of at least one metal (arsenic, chromium, copper, nickel, and/or zinc) exceeds the applicable standards in surface soils at 11-01, 12-01, O-BH12, BH02, BH07, and BH27 exceeded the applicable standards in soil samples collected from APEC 9, APEC 13 and APEC 16. Metals concentrations in the remainder of samples analyzed at these APECs met the applicable standards.

Concentrations of HEPH exceed the applicable standards in soil at BH02 and BH24 and benzo(b)fluoranthene exceeds in BH07M.

A marginal detection of benzene in a duplicate sample collected from shallow soil at BH02 exceeds the applicable drinking water standard. At O-BH12 and O-BH13 benzene was not detected but the detection limit was above the drinking water standard. Additional MAH constituents were detected in soil at BH02 and O-BH12 but at concentrations below the applicable standards.

Concentrations of LEPH/HEPH, PAH, MAH, VPH, LEPH, VOCs, and PCB were below the applicable standards at other locations in APEC 9, APEC 13 and APEC 16.

9.16.2 Groundwater Chemistry

No concentrations of LEPH/HEPH, MAH, VPH, PAH or VOC were detected in groundwater at APEC 9, APEC 13, or APEC 16 and meet the applicable standards. Metals concentrations at the APECs were below the applicable standards.

9.16.3 Soil Vapour Chemistry

Soil vapour was assessed at SV04 due to detections of volatile constituents in soil at BH02 at APEC 16. The concentrations of soil vapour PCOCs are below the applicable standards after the application of the appropriate attenuation factor.

9.16.4 Discussion

Shallow soil contamination identified at APEC 9 to the south and APEC 13 to the east of APEC 16 contains similar COCs and mechanism of contamination.

APEC 9, APEC 13, and APEC 16 have been retained as a larger area defined as AEC 16 for the following COCs in soil:

- HEPH;
- MAH (benzene);
- PAH (benzo(b)fluoranthene; and
- Metals (arsenic, chromium, copper, nickel, and zinc).

9.16.5 Limitations

Investigation did not take place directly in the area where creosoted ties were formerly stored due to the slope in the area. This is not considered a major limitation because investigation locations surround APEC 13 and groundwater was sampled immediately downgradient at BH07M.

Vertical delineation of shallow soil contamination at O-BH12, BH02, BH07M and 12-01 has not been achieved at the specific investigation locations. The contamination is delineated laterally in shallow soils in all directions and the lack of groundwater contamination indicates lack of widespread contamination. Vertical delineation is inferred to be within the top 1m of soil because the identified concentrations of COCs marginally exceed the applicable standards in surface soils and the mechanism of contamination is deposition at grade.

Further investigation at AEC 16 is warranted during Site decommissioning.

9.17 APEC 17 - Northeast Boneyard (3919 Dollarton)

This area along the northeast Site property line formerly contained scrap wood and metal and empty pails of anti-fouling paint and currently contains wood planks.

PGL assessed soil, groundwater and soil vapour quality in the northeast boneyard. Metals contamination was identified in soils at APEC 17. Off-site investigation was required to delineate shallow metals present in Cates Park to the east. The mechanism of contamination is deposition of sandblast grit through dumping or airborne transfer during sandblasting in nearby marine ways.

Table U: Investigation Locations in APEC 17

Investigation Locations	PCOCs
Soil: BH87, BH88, BH89, BH90, BH91, BH92, BH93, BH124, BH125, BH126, BH127, BH128 Soil and Groundwater: BH14M, BH45M, BH46M, BH47M, BH84M Soil Vapour: SV08	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PCB, PAH, VOC

9.17.1 Soil Chemistry

Metals contamination in soil was identified at seven investigation locations in APEC 17 (BH14M, BH45M, BH46M, BH89, BH90 and BH93). The metals exceeding the standards are antimony, arsenic, barium, chromium, copper, lead, molybdenum, tin and zinc.

Concentrations of MAH, LEPH/HEPH, PAH, PCBs and TBT were detected in soil at APEC 17 but at concentrations below the applicable standards. VOCs were below the laboratory detection limits in soil at APEC 17.

9.17.2 Groundwater Chemistry

The concentration of TBT in groundwater at BH14M exceeded the applicable standard in 2007, but met the applicable standard in 2013. The concentration of TBT at BH46M exceeded the applicable standard in 2013. TBT concentrations in downgradient (BH45M) and cross-gradient (BH47M) monitoring wells met the applicable standards.

Concentrations of dissolved metals were below the applicable standards at APEC 17.

Marginal detections of select PAH parameters have been observed in groundwater at BH14M, BH45M, and BH47M. The concentration of benzo(a)pyrene in these samples straddles the standard which is equal to the applicable drinking water standard. The latest sample collected from BH45M exceeds the standard for benzo(a)pyrene but this has been discounted as a sampling artifact.

No concentrations of LEPH/HEPH, VPH, or VOC were detected in groundwater at APEC 17 and all groundwater meets the applicable standards for these parameters.

With the exception of a detectable concentration of xylenes at BH46M, no MAH were detected in groundwater at APEC 17 and all MAH parameters meet the applicable standards.

9.17.3 Soil Vapour Chemistry

Soil vapour was assessed at SV08 due to detections of volatile MAH constituents in soil and xylenes in GW at APEC 17. The concentrations of soil vapour PCOCs at SV08 are below the applicable standards after the application of the appropriate attenuation factor.

9.17.4 Hazardous Waste

Leachable metals concentrations were analyzed in a soil sample collected from the northwest boneyard (BH46M-01) that contained high concentrations of metals and the visible presence of sandblast grit. Concentrations of all leachable metals in the sample were below the Hazardous Waste leachate quality standards. TCLP leachable metals results are shown in Table 3.

9.17.5 Discussion

The metals contamination at APEC 17 is widespread in surficial soils and extends to a depth of up to 1.5m on-Site and to depths of 0.5m up the slope in Cates Park to the east. The mechanism of contamination is deposition of sandblast grit through dumping or airborne transfer during sandblasting in nearby marine ways. Topography slopes steeply and immediately up to the east into Cates Park from the Site property line. Taking the slope and mechanism of contamination into consideration, vertical delineation of soil metals was assessed with respect to depth from surface rather than geodetic elevation.

Groundwater TBT contamination identified at BH46M is less than 2x the freshwater aquatic life standard and just over 2x the marine aquatic standard. The TBT concentration cannot currently be delineated to the west or southwest due to the presence of Site structures, or to the north due to a steep slope. The identified contamination does not extend offsite. Further investigation is required during decommissioning to delineate the vertical and lateral extent of TBT contamination identified in groundwater at AEC 17.

APEC 17 has been retained as AEC 17 for the following COCs in soil and groundwater:

- Soil - metals (antimony, arsenic, barium, chromium, copper, lead, molybdenum, tin and zinc); and
- Groundwater – TBT.

9.18 APEC 18 - Staining and Stressed Vegetation in Area of Former Office/Bunkhouse/Cookhouse (3919 Dollarton)

During the 2007 PGL Site visit at 3919 Dollarton, vegetation in the grassy area northwest of the western marine way was identified as stressed and surficial staining was evident.

PGL assessed soil and groundwater quality in the area of the stressed vegetation. Shallow soil metals contamination was identified at APEC 18. The mechanism of contamination is likely airborne deposition or placement of sandblast grit. No contamination was identified in groundwater or soil vapour.

Table V: Investigation Locations in APEC 18

Investigation Locations	PCOCs
Soil: 10-01, 10-02, 10-03, BH16, BH17M, BH23, BH55, BH56, BH57, BH68, BH69 Soil/Groundwater: OW7, BH17M Soil Vapour: SV06	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PAH, VOC, PCB

9.18.1 Soil Chemistry

Copper (10-01 and 10-02, BH68), zinc (10-01, 10-03, BH57, and BH68), barium (10-03), and tin (BH69) exceed applicable standards in shallow soils (0-0.3m bgs) at APEC 18. Molybdenum exceeds the standard at BH58.

MAH, LEPH/HEPH, PAH, and PCB concentrations in soil at APEC 18 and APEC 20 were below the applicable standards.

9.18.2 Groundwater Chemistry

VOC and MAH (toluene and xylenes) were detected in groundwater at OW7 in 1993 but at concentrations below the applicable standards. No detectable concentrations of MAH or VPH were detected in groundwater in BH17M in 2007 or 2013.

There were no detectable concentrations of LEPH/HEPH or PAH in groundwater at APEC 18 or APEC 20 and all concentrations of dissolved metals were below the applicable standards.

9.18.3 Soil Vapour Chemistry

Soil vapour was assessed at SV06 southwest of APEC18 at the location of OW7 due to detections of volatile constituents in groundwater in 1993. The concentrations of soil vapour PCOCs at SV06 are below the applicable standards when the appropriate attenuation factor is applied.

9.18.4 Discussion

Soil contamination identified at APEC 18 and APEC 20 includes soil metals (barium, copper, tin and zinc). As discussed in Section 9.20, shallow metals impacts at APEC 20 are similar in nature to COCs detected at APEC 18 and will be included together as AEC 18.

APEC 18 has been retained as AEC 18 for the following COCs in soil:

- Metals (barium, copper, molybdenum, tin and zinc.

9.18.5 Limitations

Further investigation is warranted at AEC 18 during demolition of the former office building (APEC 20) because investigation of soil and groundwater beneath the building was not possible during the DSI.

9.19 APEC 19 - Winch Shed and Area beneath Decking North of Marine Ways (3919 Dollarton)

The winch shed and adjacent areas beneath the decking north of the marine ways have been identified as APEC 19. The APEC includes the area beneath a diesel AST and beneath the painting shelter.

PGL assessed soil, groundwater and soil vapour quality in the area of the winch shed and beneath the decking. Metals and PAH soil contamination has been identified at APEC 19. The mechanism of contamination is sandblasting and boat maintenance activities that have deposited and spilled sandblast grit and paints over time.

Table W: Investigation Locations in APEC 19

Investigation Locations	PCOCs
Soil: O-BH6, 7-01, 7-02, 7-03, 8-01, 8-02, 8-03, SS1, SS7, BH70, BH71, BH72, BH73 Soil/Groundwater: BH13M, BH14M, BH17M Soil Vapour: SV06, SV08	Primary: Metals, LEPH/HEPH, PAH, MAH, PCB, TBT

9.19.1 Soil Chemistry

The concentrations of several metals parameters (antimony, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, vanadium and zinc) are elevated in surficial soils adjacent to the marine ways at APEC 19 and exceed the applicable standards at most investigation locations.

LEPH/HEPH concentrations in shallow soils exceed the applicable standards at BH71 and BH73. PAH concentrations exceed the applicable standards at 7-02, 8-02, BH71 and SS7.

MAH/VPH, PCBs and VOC concentrations in soil were below the applicable standards in samples analyzed from APEC 19. TBT in soil at BH14M to the northwest of APEC 19 did not exceed the Schedule 10 standard for TBTO after applying a conversion factor.

9.19.2 Groundwater Chemistry

Groundwater was not directly investigated beneath APEC 19 due to inaccessibility for drilling and the presence of ocean water in the marine ways.

Groundwater in surrounding areas met the applicable standards to the northeast and northwest. Groundwater to the southeast is impacted in APEC 5 but this is likely due to spillage or dumping in that area and not contamination related to APEC 19.

9.19.3 Soil Vapour Chemistry

Soil vapour was assessed at SV06 and SV08 to the east and west of APEC19. The concentrations of soil vapour PCOCs are below the applicable standards with the application of appropriate attenuation factors.

9.19.4 Hazardous Waste

Soil sample BH71-01 from APEC 19 contains a PAH TEQ concentration exceeding the Hazardous Waste Regulation (HWR) standard. PAH TEQ calculations are shown in Table 5. A leachable PAH TCLP analysis was completed on this sample and leachable concentrations of several PAH constituents were present. The results meet the only existing HWR standard for leachate quality which is for benzo(a)pyrene. PAH TCLP results are presented in Table 4.

9.19.5 Discussion

Contamination in groundwater at APEC 19 is unlikely based on groundwater results from the surrounding areas and in areas where similar PAH and metals contaminants were present in soils but not in groundwater.

A soil sample (BH70-01) collected from the north end of the west marine way contained very high concentrations of metals and the visible presence of sandblast grit. This sample was analyzed for leachable metals content and concentrations of all leachable metals were below the Hazardous Waste leachate quality standards. With the exception of copper, iron, lead, magnesium and zinc, no leachable concentrations of other metals were detected. TCLP leachable metals results are shown in Table 3 and indicate that metals contaminants at the Site are not leachable and no Hazardous Waste metals are present.

APEC 19 has been retained as AEC 19 for the following COCs in soil:

- Metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, vanadium and zinc).

9.19.6 Limitations

Investigation locations at APEC 19 were limited by the presence of Site facilities and the steel decking which prevented penetration with a drill rig. Further investigation in this area is warranted during Site decommissioning.

9.20 APEC 20 - Paint and Solvent Storage Building (Old Office at 3919 Dollarton)

Paints and solvents are stored on the ground floor of the old McKenzie Barge office building northwest of the marine ways.

PGL assessed soil and groundwater quality in the area downgradient of the paint and solvent storage building. Shallow soil metals contamination was identified at APEC 20. Since the COCs and mechanism of contamination is similar to those at APEC 18, these two APECs were combined into AEC 18.

Table X: Investigation Locations in APEC 20

Investigation Locations	PCOCs
Soil: BH23, BH57, BH58, BH59, BH60, BH68 Soil/Groundwater: OW7, BH09M Soil Vapour: SV06	Primary: Metals, VOC, VPH Secondary: LEPH/HEPH, MAH

9.20.1 Soil Chemistry

Concentrations of MAH, LEPH/HEPH, and PAH in soil at APEC 20 are below the applicable standards.

Soil and sediment chemistry results are presented on Figures 8 through 14 and in associated Tables.

9.20.2 Groundwater Chemistry

The concentrations of all PCOCs tested in groundwater at APEC 20 (LEPH/HEPH, dissolved metals, PAH, MAH, VOC, and VPH) were below the applicable standards.

Groundwater chemistry results are provided on Figures 15 through 20 and in associated Tables.

9.20.3 Soil Vapour Chemistry

Soil vapour was assessed at SV06 adjacent to APEC 20. The concentrations of all soil vapour PCOCs at SV06 are below the applicable standards when the appropriate attenuation factor is applied.

Soil vapour chemistry results are provided on Figures 21 and 22 and in associated Tables.

9.20.4 Discussion

Metals contamination was identified at APEC 20 (copper, molybdenum, and zinc). These metals are present only in shallow soils and area delineated vertically and horizontally. The contaminants and mechanism of contamination are similar to those observed in the adjacent APEC 18. As discussed in Section 9.18, these COCs have been included as part of AEC 18.

The COCs identified at APEC 20 have been included as part of AEC 18 and APEC 20 has not been retained as an AEC.

9.21 APEC 21 - Hazardous Building Materials

Based on the age of the current Site buildings, regulated building materials may have been used in their construction. PCOCs for this APEC are as follows:

- Asbestos;
- Polychlorinated biphenyls (PCBs);
- Mercury; and
- Lead (paint).

Due to the ages of the buildings, building components that are regulated in some circumstances, such as asbestos, lead paint and PCBs (in light ballasts) may be present. Potentially asbestos-containing materials at the Site may include drywall joint compound, roofing membrane, pipe lagging, acoustic plaster/texture coat, ceiling tiles, and vinyl flooring. These items are common in buildings of this age and are not a hazard unless disturbed, as in renovation or demolition. Several Site buildings have fluorescent fixtures that could have PCB-containing ballasts. If regulated building materials are present, building owners have certain obligations to protect workers under the *BC Workers' Compensation Act*. PGL has not conducted a regulated building materials survey as part of this investigation, as it is best dealt with prior to demolition.

APEC 21 has been carried forward as APEC 21 because hazardous building materials have not yet been investigated at the Site.

9.22 Additional Investigation Locations - General Site Coverage

Additional soil and groundwater investigation took place outside of defined APECs at the Site in order to provide increased sample density.

Shallow copper contamination was identified in an area to the north of AEC 16 and due to the location and similar mechanism of contamination has been incorporated into AEC 16 (Northwest Boneyard).

Shallow cadmium contamination was identified at BH12 south of the McKenzie Barge office building and was delineated laterally and vertically by step out boreholes (BH48, BH49, and BH50). There is no clear source of this contamination but it has been included as AEC 14-2 (former UST and battery storage area).

Table Y: Investigation Locations for General Site Coverage

Investigation Locations	General Site PCOCs
Soil: O-BH17, BH12, BH48, BH49, BH50, BH61, B82, BH83, BH103, BH104, Soil/Groundwater: OW4, OW9, BH08M, BH62M, BH64M, NBH04M, NBH24M, NBH25M	Primary: Metals Secondary: LEPH/HEPH, PAH

9.22.1 Soil Chemistry

Copper was identified in soil at BH64M and BH82 at concentrations exceeding the applicable standard. Cadmium exceeded the applicable standard in shallow soils at BH12.

The concentrations of LEPH/HEPH, PAH, MAH, VPH and metals at all other general coverage investigation locations were below the applicable standards.

9.22.2 Groundwater Chemistry

Naphthalene and cadmium exceeded the standard in NDM well OW4 in 1993. Copper exceeded the applicable standard in NDM well OW9 in 1993.

Arsenic exceeded the applicable Drinking Water standard in several samples collected at NBH04M, but was below the standard in subsequent sampling events.

The concentrations of LEPH/HEPH, PAH, MAH, VPH, VOC and metals at the other general Site coverage investigations were below the applicable standards.

9.22.3 Discussion

The shallow copper contamination at BH64M and BH82 is contained in the top 1m of soils. The source of the copper is unclear, but may be due to equipment storage in the parking area near Dollarton Highway. Due to the location and similar mechanism of contamination, this area will be included as part of AEC 16 (Northwest Boneyard).

The shallow cadmium contamination at BH12 was delineated laterally and vertically by step out boreholes (BH48, BH49, and BH50). There is no clear source of this contamination but cadmium was also identified in shallow soil further west at BH11M (AEC 14) further west at a similar location south of the McKenzie Barge office building. The cadmium contamination at BH12 has been included as AEC 14-2 and although it has been delineated, further investigation of fill material beneath the McKenzie Barge office building should be assessed for cadmium upon building demolition.

Groundwater contamination detected by NDM in 1993 could not be verified because the wells do not exist. PGL did not detect dissolved copper or cadmium exceedences in any wells at the Site and groundwater naphthalene exceedences were only located at AEC 1 and AEC 5.

10.0 STAGE 2 PSI/DSI CONCLUSIONS

PGL has identified twelve AECs (Figure 24), with COCs as indicated in Table Z. These AECs and COCs were delineated in the Detailed Site Investigation (DSI) to identify Zones of Contamination (ZOCs) which are defined as the spatial area within an AEC caused by a single contaminant source. These ZOCs represent Zones of Soil, Groundwater and Soil Vapour Contaminant Plumes.

Table Z: APECs, COCs, AECs and ZOCs

APEC	Name	PCOCs	AEC	COC or Rationale	ZOC
APEC 1	General Shipbuilding and Brickyard Activities (3829 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH, TBT Secondary: PAH	Yes, AEC 1	AEC1-1: Soil: Metals (antimony, copper, tin, zinc); AEC 1-2: Groundwater: Dissolved Arsenic AEC 1-3: Soil: PAH (naphthalene and phenanthrene); MAH (benzene, ethylbenzene); VPH; and LEPH Groundwater: PAH, LEPH Soil Vapour: no contamination identified when attenuation factors applied	ZOC1-1: Soil: Depth: to 1.1m bgs Area: 300m^2 ZOC1-2: Groundwater: Est. Area: 900m^2 ZOC1-3: Soil: Depth: to 3.4m bgs Area: 400m^2 Groundwater: Est. Area: 400 m^2
APEC 2	Sediments - Foreshore and Marine Ways – General Shipyard Activities	Primary: Metals, PAH, TBT Secondary: PCB	Yes, AEC 2	AEC 2: Soil/Sediment: Metals (arsenic, chromium, copper, lead, mercury, and zinc); PAH; and PCB (AEC 2-2 only) Groundwater: Not applicable Soil Vapour: Not applicable	ZOC2-1: Sediment : Depth: to 1.5m bgs Area: 34,500m^2 ZOC2-2: Sediment : Depth: to 1.0m bgs Area: 2,250m^2 ZOC2-3: Sediment : Depth: to 1.0m bgs Area: 3,100m^2
APEC 3	Imported Fill East of Shipyard Building (3829 Dollarton)	Primary: Metals Secondary: LEPH/HEPH, PAH	Yes, AEC 3	AEC 3: Soil: Metals (arsenic, copper, zinc); and PAH Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors applied	ZOC3: Soil: Depth: 0.2 to 4.6m bgs Area: 775m^2

APEC	Name	PCOCs	AEC	COC or Rationale	ZOC
APEC 4	In-filled Sandblasting and Painting Area with Accumulated Sandblast Grit (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH, VOC, TBT Secondary: PAH, PCB	Yes, AEC 4	AEC 4: Soil: Metals (antimony, arsenic, cadmium, chromium, copper, miolybdenum, nickel, zinc); and PAH Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors applied	ZOC4: Soil: Depth: grade to a maximum of 3.5m bgs Area: 2,220m^2
APEC 5	Offsite Filled Foreshore and Former Materials storage/ Burning Area East of Site	Primary: Metals, LEPH/HEPH, PAH, MAH, VPH, TBT Secondary: PCB, VOC	Yes, AEC 5	AEC 5: Soil: Metals (antimony, arsenic, chromium, copper, lead, mercury, miolybdenum, nickel, tin, zinc); PAH; LEPH; and MAH. Groundwater: PAH and LEPH Soil Vapour: no contamination identified when attenuation factors are applied	ZOC5: Soil: Depth: grade to a maximum of 4.0m bgs Area: 2,300m^2 Groundwater: Est. Area: 900m^2
APEC 6	Historical Boiler House (3829 Dollarton)	Primary: LEPH/HEPH, PAH Secondary: None	No	No soil or groundwater contamination identified with this APEC	
APEC 7	Historical Work Shop (3829 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH, VOC Secondary: PAH	No	No soil or groundwater contamination identified with this APEC	
APEC 8	Machine Shop (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH, VOC Secondary: PAH	No, but carried forward as APEC 8	No investigation has taken place beneath the maintenance shop building Carried forward as APEC 8	

APEC	Name	PCOCs	AEC	COC or Rationale	ZOC
APEC 9	Shed on Western Side of 3919 Dollarton (former machine and blacksmith shop)	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PAH, PCB	No, see AEC 16	Soil contamination identified but is included as part of AEC 16 (Northwest Boneyard)	See AEC 16
APEC 10	Waste Dump (3829 Dollarton)	Primary: Metals, LEPH/HEPH, PAH Secondary: MAH, VPH, VOC	No	No soil or groundwater contamination identified with this APEC	
APEC 11	Buried Barge and Metal Debris (Water Lot South of 3829 Dollarton)	Primary: Metals, PAH Secondary: None	No	APEC 11 was not directly investigated but is included in AEC 2	See AEC 2-2
APEC 12	Historical Solvent and Paint Storage Area (3829 Dollarton)	Primary: Metals, VOC, VPH, LEPH/HEPH Secondary: MAH	Yes, AEC 12	AEC12: Soil: Metals (copper, zinc); HEPH; and PAH Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied	ZOC12: Soil: Depth: to 1.1m bgs Area: 125m^2
APEC 13	Former Storage Area for Creosoted Ties (3919 Dollarton)	Primary: LEPH/HEPH, PAH Secondary: Metals	No, see AEC 16	Soil contamination identified but is included as part of AEC 16 (Northwest Boneyard)	See AEC 16
APEC 14	Former Gasoline Underground Storage Tank and Outdoor Battery Storage Area (3919 Dollarton)	Primary: MAH, VPH, LEPH, Metals (for battery storage) Secondary: MTBE, EDB, DCA	Yes, AEC 14	AEC14: Soil: Metals (lead and cadmium); PAH (benzo(a)fluoranthene); LEPH/HEPH; and VPH Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied	ZOC14-1: Soil: Depth: to 4.0m bgs Area: 75m^2 ZOC14-2: Soil: Depth: to 2.2m bgs Area: 15m^2

APEC	**Name**	**PCOCs**	**AEC**	**COC or Rationale**	**ZOC**
APEC 15	Former Drum Rack (3919 Dollarton)	Primary: LEPH/HEPH, MAH, VPH, VOC Secondary: None	Yes, AEC 15	AEC15: Soil: MAH (ethylbenzene, xylene); Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied	ZOC15: Soil: Depth: to 1.5m bgs Area: 4m^2
APEC 16	Northwest Bone Yard (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PCB, VOC	Yes, AEC 16	AEC16: Soil: Metals (arsenic, chromiuim, copper, nickel, and zinc); PAH (benzo(b)fluoranthene); HEPH, and MAH (benzene). Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied	ZOC16: Soil: Depth: to 1.0m bgs Area: 1,340m^2
APEC 17	Northeast Bone Yard (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PCB, VOC	Yes, AEC 17	AEC17: Soil: Metals (antimony, arsenic, barium, chromium, copper, lead, molybdenum, tin, and zinc) Groundwater: TBT Soil Vapour: no contamination identified when attenuation factors are applied	ZOC17: Soil: Depth: to 2.5m bgs onsite, to 0.6m bgs offsite in Cates Park Area: 360m^2 Groundwater: Est. Area: 75m^2
APEC 18	Staining and Stressed Vegetation in Area of Former Office/Bunkhouse/Cookhouse (3919 Dollarton)	Primary: Metals, LEPH/HEPH, MAH, VPH Secondary: PAH, VOC, PCB	Yes, AEC 18	AEC18: Soil: Metals (barium, copper, molybdenum, tin and zinc); Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied	ZOC18: Soil: Depth: to 1.0m bgs Area: 550m^2

APEC	Name	PCOCs	AEC	COC or Rationale	ZOC
APEC 19	Winch Shed/Area Beneath Decking North of Marine Ways (3919 Dollarton)	Primary: Metals, LEPH/HEPH, PAH, MAH, PCB, TBT Secondary: None	Yes, AEC 19	AEC19: Soil: Metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, vanadium, and zinc) Groundwater: No contamination identified Soil Vapour: no contamination identified when attenuation factors are applied	ZOC19: Soil: Depth: to 1.0m bgs Area: 650m^2
APEC 20	Paint and Solvent Storage Building (old office) (3919 Dollarton)	Primary: Metals, VOC, VPH Secondary: LEPH/HEPH, MAH	No, see AEC 18	Soil contamination identified but is included as part of AEC 18.	See AEC 18
APEC 21	Regulated building materials	Primary: Asbestos, PCBs, etc. in building materials only Secondary: None	No, but carried forward as APEC 21	Regulated building materials were not investigated at the Site Carried forward as APEC 21	
-	General Site Coverage	Primary: Metals, PAH	No, see AEC 14 and AEC 16	Soil contamination identified at BH12 is included as part of AEC 14. Soil contamination identified at BH64M and BH82 is included as part of AEC 16 (Northwest Boneyard)	See AEC 14-2 and AEC 16

Cross section Figures showing Site topography, stratigraphy, and select investigation locations with contaminated soil and groundwater are provided as Figure 25 through Figure 28.

11.0 UNCERTAINTIES

All environmental investigations of this nature involve uncertainty including statistical variability in analytical results, false negatives, and extrapolation and interpolation between data points. In the case of this project, several uncertainties merit specific mention.

11.1 Mineral Oil and Grease

NDM analyzed several soil samples for Mineral Oil and Grease (MOG) which was formerly regulated under the CSR but is not currently regulated. No current standard is applicable to Mineral Oil and Grease data. In order to use the data as an indicator of contamination, we conservatively applied the CSR RL standards for LEPH/HEPH to historical MOG data presented on Figure 9 and in associated data Tables.

11.2 NDM Groundwater dissolved metals exceedences

NDM findings related to metals in groundwater could not be replicated and so have been discounted, but there is a slight possibility this is incorrect. Several locations sampled by NDM in 1993 exceeded groundwater standards for certain dissolved metals:

1. OW4 cadmium concentration was 17ug/L and OW5 was 6ug/L. The highest concentration of dissolved cadmium observed at the Site in any sample collected by PGL was 0.648ug/L at BH62M. Most of the data was below laboratory detection limits; and
2. OW9 and OW10 contained concentrations of dissolved copper of 54ug/L and 27ug/L respectively. The highest dissolved copper concentration measured by PGL was 17 ug/L at BH45M and 13ug/L at NBH02M. The remainder of the dissolved copper concentrations were below 10ug/L.

These are at odds with our much larger and more recent dataset to the point where they appear incorrect. The difference is unlikely to be that dissolved metals in Site groundwater have cleaned up significantly since 1993, and so an assumption of analytical or sampling anomaly is appropriate.

11.3 Chloroform

We have discounted a 2007 chloroform exceedence in groundwater (BH11M) as unlikely to be the result of contamination at the Site. PGL believes the chloroform concentration is likely attributable to chlorinated drinking water leaks beneath the office building or from the City water supply. This is based in the absence of chloroform as a PCOC, common observance of this parameter originating from drinking water leaks, and proximity of the sample location to the occupied building.

It is not the responsibility of the Site owner, or the intention of the Contaminated Sites Regulation, to address chloroform caused by municipal water supply, as this is a societal risk choice and not a result of Schedule 2 activity. PGL has left this data in the tables and report for completeness, but is not highlighting it as an exceedence caused by contamination at the Site.

11.4 Soil Vapour

Only one round of soil vapour testing has been completed at the Site. Samples were collected in summer (dry) season in generally coarse grained soils, suggesting that this sample set would be worst case. Further, a number of site specific factors mitigate against soil vapour contamination:

- The Site uses would not have been volatiles-intensive;
- Volatiles have not proven to be a significant soil or groundwater contaminant, and so the absence of soil vapour effects is not surprising; and
- Much of the high activity areas along the waterfront are over water or have tidally flushed groundwater, resulting in conditions not conducive to retention of volatiles.

In this context, the absence of seasonal testing is not a significant limitation in this case.

11.5 Data Quality Objectives

As discussed in Section 5.0 and detailed in Appendix 1, a detailed review of QA/QC concluded that the overall dataset for the Stage 2 PSI/DSI is reliable. Specific limitations of the dataset where data quality objectives were not met and the data could be influenced are as follows:

PAH data from soil sample BH35-05 should not relied upon to confirm remediation at the Site due to a hold time exceedence prior to laboratory analysis; and

Arsenic concentrations in NBH09M and NBH34M could potentially be affected by dilution effects due to saturated well screen lengths in excess of 1.8m. Natural tidal flushing of these well screens would have more significant dilution effects than the potential effect of screen length. We would also not expect arsenic concentrations to be vertically stratified as there is no clear source (i.e. it is not migrating from grade). The longer well screen lengths noted in Appendix 1 do not affect our conclusions with respect to exceedences of the applicable standards.

12.0 REMEDIATION PLAN

Polygon has submitted a Development Permit Application to the District of North Vancouver. The uses would be as follows:

1. Re-zone and redevelop the Uplands, freehold portion of the Site with multi-tenant residential condominiums and townhouses. Most planned structures will be slab on grade but the development plan includes under-building parking that will be below grade in some areas;
2. Dedicate a public use walkway along the original high water mark on Freehold land (parkland use);
3. The Filled Intertidal Areas may include a small area of public access areas immediately along the walkway (parkland use). The balance would be banked riparian and intertidal habitat that would exclude access by humans from the land side with barrier planting (wildlands use); and
4. Enhancement and rehabilitation of habitat in Roche Point Creek that will include enhanced riparian habitat that would exclude access from the land side by humans with barrier planting (wildlands use).

Because the development is comparatively low density in consideration of community concerns and zoning guidance from the District of North Vancouver (DNV), aggressive approaches to soil management would make the project uneconomic. For this reason, it is fortunate that most of the contaminants on the sites show minimal environmental availability. Securing these materials in-place to eliminate direct exposure, combined with removal of more highly impacted soils is the most feasible remediation plan. Select removal would be applied to soils that require removal as part of site development and soils of the greatest environmental risk:

- Hazardous waste soils;
- Soils in the Port Metro Vancouver fill zone southeast of the Site (AEC 5) where groundwater PAHs exceed applicable standards; and
- Soil east of the Noble Towing building where groundwater concentrations of PAH exceed applicable standards (AEC 1-3).

Soil left in place will be risk assessed and risk managed as appropriate. Risk management measures are likely to include capping.

The following Sections discuss the Site remediation plan with respect to identified ZOCs. ZOCs have been grouped together for ease of discussion where the remediation and/or risk assessment plan for the ZOCs is similar.

The risk assessment problem formulation has been prepared under separate cover, and addresses this in additional detail. The following plan is conceptual.

12.1 Metals and hydrocarbons in shallow soils (ZOC1-1, ZOC3, ZOC4, ZOC12, ZOC15, ZOC16, ZOC17, ZOC18, ZOC19)

Fill soils (predominantly shallow) and surface soils at the Site are sporadically contaminated with various metals parameters. The native till material (silts and sands) underlying Site fill and surface soils is generally not contaminated with metals.

During Site redevelopment and construction, fill soils and surface soils in many Site areas will be disturbed, and some contaminated soils will be removed from the Site. The final development plans will indicate the areas where soil disturbance will occur and will help determine where soil removal or surface capping / risk assessment are feasible remedial options.

In areas where shallow hydrocarbon impacts are present at grade (ZOC1-1, ZOC4, ZOC16, ZOC18, ZOC19), some hot-spot excavation of these soils may be incorporated into the remediation plan. Hazardous waste concentrations of PAH detected in ZOC19 will be excavated and disposed of at an approved facility.

A conservative look at the data from ZOC3 suggests that the entire fill volume east of the building at 3829 Dollarton and west of Roche Point Creek is contaminated. The contaminated soils exist at depths up to 3.4m to the north (at the south edge of Roche Point Creek) to a maximum depth of 4.6m to the south end of Noble Point. Except for planned removal of hydrocarbon contamination in soil and groundwater at ZOC1-3 which overlaps with ZOC3, soils at ZOC3 will be risk assessed and remain in place.

An acceptable remedial/risk assessment option must be explored in conjunction with the DNV and Tsleill- Waututh Nation who co-manage Cates Park to deal with offsite soils in Cates Park (ZOC17 and ZOC5) that are impacted with shallow metals contamination. Subject to stakeholder approval, these offsite affected soils would be removed.

12.2 Metals and Hydrocarbons in Deeper Soil and Groundwater (ZOC1-3 and ZOC5)

The preliminary remediation plan for the Site is to excavate and remove hazardous waste and PAH contaminated soil and pore water from ZOC1-2 and ZOC5 for offsite disposal in coordination with bulk excavation during development. Groundwater will not be separately addressed because contaminated pore water will simply be excavated with soil. Over-excavation of source material will be completed as necessary. As required, the resulting area will be restored to pre-filling conditions (grades, surface cover).

Contamination at the offsite filled intertidal area (ZOC5) extends from the eastern edge of the east marine way (above former wooden dock) north to the original high water mark (border with Cates Park), northeast to the squatter shack, and east to a makeshift retaining wall made of creosoted wood and metal. Soil and groundwater results indicate that this entire filled area is impacted with metals and PAH, including some hazardous waste (PAH TEQ). Delineation has been obtained to the north in Cates Park and to the east on the foreshore. PAH and metals contamination appears to extend/co-mingle with sediments to the south. The Filled area is proposed to be remediated by excavation for offsite disposal.

Hydrocarbon contamination in soil and groundwater east of the Noble Towing building (ZOC1-3) will require remediation through excavation and off-site disposal to remediate high risk conditions caused by naphthalene concentrations in groundwater at NBH22M and adjacent to Roche Point Creek at NBH28M.

12.3 Sediment Remedial Plan (ZOC2)

Surface sediments (ZOC2) south of the Site are contaminated with metals and PAH. Sediment delineation work extended a great distance from the Site. The remediation plan for sediments will be determined based on toxicity tests currently in progress.

Based on our experience, contaminant concentrations up to five times the applicable standards are highly likely to pass toxicity testing, while higher concentrations are in doubt. Concentrations up to roughly ten times the standard have been identified, but this is generally restricted to a small fraction of the area identified as exceeding applicable standards. Conceptually we plan to identify a toxicity threshold, and target soils exceeding that threshold for management. Soils below the threshold would be managed in place. Soils above the threshold could be capped, an option that is available based on the information that this area is subject to sediment deposition. Another alternative that could be considered if capping is not feasible for any reason would be dredging. Special management options will be developed for high value habitat that cannot reasonably be capped or dredged, if any.

12.4 Hydrocarbon Contaminated Soils in the Former UST Tank Nest (ZOC14)

Contaminated soil surrounding the former UST was assessed during tank removal and found to be contaminated, but localized. The hydrocarbon impacted soils will be removed from the Site during development related construction in the area of ZOC14.

12.5 Groundwater Arsenic (ZOC1-2)

Groundwater arsenic concentrations exceeding the drinking water standard will likely be risk assessed based on removing the drinking water pathway by placing a covenant on the titles for the Site, or by obtaining an exemption from drinking water standards at the Site.

12.6 Groundwater Tributyltin (TBT) (ZOC17)

The groundwater TBT concentration exceeding the applicable aquatic life standards will be delineated and risk assessed. It is likely that complete exposure pathways between TBT in groundwater and potential human and/or ecological receptors will not identified. Further work is required to delineate the extent of contamination laterally and vertically during Site decommissioning.

12.7 Feasibility of Risk Assessment

PGL has reviewed the viability of risk assessment to address risks on the Site and in Cates Park and PMV foreshore and water lots south of the Site. The information is contained in the separate document Preliminary Problem Formulation

13.0 CONCLUSIONS

PGL completed a Stage 2 PSI and DSI to assess the risks of contamination related to the identified areas of potential environmental concern at the Site. Investigation of both onsite and offsite APECs identified contaminated soil, groundwater and sediments at the Site. The identified contamination is associated with the long term operation of shipyards and the use of contaminated fill material at the Site. All contaminated media has been at least coarsely delineated both vertically and horizontally. Delineation is incomplete in areas where access is limited by site improvements that are still in use.

PGL's investigation identified the following:

- Surface soils at the Site are widely contaminated with metals (ZOC1, ZOC3, ZOC4, ZOC5, ZOC16, ZOC17, ZOC18, and ZOC19). The contamination appears to be sporadic but is a Site-wide issue and extends offsite into portions of Cates Park. Many of these shallow soils are also sporadically impacted with pockets of hydrocarbon contamination associated with surface spills;
- Deeper metals contamination is present in soils in the filled intertidal areas (ZOC3, ZOC4, and ZOC5);
- Despite widespread soil contamination, groundwater at the Site generally meets standards except for two areas where hydrocarbons are present (ZOC1-3 and ZOC5). Soil metals are not leachable and have not impacted groundwater. This was expected as most of the metals are low environmental availability because they are related to blasting grit;
- The entire offsite filled intertidal area southeast of the Site (ZOC5) contains impacted soil (metals and hydrocarbons) and groundwater (hydrocarbons), including hazardous waste concentrations of PAH in soil;
- Sediment contamination (metals and PAH) is widespread south of the Site (ZOC2);
- Soil contamination is present in the area surrounding the former UST tank nest at the Site (ZOC14);
- TBT contamination is present in groundwater beneath the painting shelter and northeast boneyard (ZOC17); and
- Dissolved arsenic contamination is present in groundwater exceeding the drinking water standard beneath the Noble Towing building (ZOC1-2).

14.0 RECOMMENDATIONS

We recommend that this report be submitted in support of an application for a Release of Development Permit under Administrative Guidance 6 that the Site has been delineated and has remediation plan in place suitable to remediate the Site to numerical and risk-based standards for soil, sediment, and groundwater.

15.0 PROFESSIONAL STATEMENT

Pursuant to the requirements of Part 16 of the Contaminated Sites Regulation, PGL affirms that:

- This documentation has been prepared in accordance with all requirements of the *Waste Management Act* and Regulations; and
- The persons signing this report have demonstrable experience with this type of investigation and the Site conditions.

16.0 STANDARD LIMITATIONS

PGL prepared this report for Polygon Development 270 Ltd. and its agents exclusively. It may be relied upon by these parties, Port Metro Vancouver, District of North Vancouver and the BC Ministry of Environment and the Contaminated Sites Approved Professionals Society exclusively. PGL accepts no responsibility for any damages that may be suffered by third parties as a result of decisions or actions based on this report.

The report's purpose is to provide the client with an assessment of contamination on the Site. The investigation consisted of a screening for potential contamination and, as is true for all environmental investigations, potential remains for the presence of unknown, unidentified, or unforeseen surface or subsurface contamination. More or different investigation may be required if other risks are identified. The data presented in this report is valid for the date of sampling, but Site conditions may change with time.

The findings and conclusions are Site-specific and were developed in a manner consistent with that level of care and skill normally exercised by environmental professionals currently practicing under similar conditions in the area. Changing assessment techniques, regulations, and Site conditions means that environmental investigations and their conclusions can quickly become dated, so this report is for use now. The report should not be used after that without PGL review/approval.

The project has been conducted according to our instructions and work program. Additional conditions and limitations on our liability are set forth in our work program/contract. This report is neither an endorsement nor a condemnation of the subject property. No warranty, expressed or implied, is made.

Respectfully submitted,

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.

Per:

D Bell

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President

DWB/CDC/WDG/mtl
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Preliminary Problem Formulation

SCANNED
Doc # 2205701

3829 to 3919 Dollarton Highway
North Vancouver, BC

Prepared for:
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Prepared by:
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PGL File: 1543-09.03
MOE Site ID#: 3412 / 14456

October 2013

Executive Summary

Pottinger Gaherty Environmental Consultants Ltd. (PGL) was retained by Polygon Development 270 Ltd. (Polygon) to complete the Preliminary Problem Formulation phase of a Detailed Quantitative Human Health and Ecological Risk Assessment (HHERA) for 3919 and 3829 Dollarton Highway and adjacent leased Port Metro Vancouver lands to the south in North Vancouver, BC (the Site, Figure 1). This Preliminary Problem Formulation considers Polygon's proposed future land use scenario only and is part of PGL's overall submission to secure a Release of municipal permits under BC Ministry of Environment Administrative Guidance 6.

Currently, the Site is occupied by two industrial shipyard operators: Noble Towing to the west at 3829 Dollarton and McKenzie Barge and Marine Ways to the east at 3919 Dollarton. The Site contains a terrestrial area of roughly 1.9ha, and extends north from the historical foreshore of Burrard Inlet to the south side of Dollarton Highway in North Vancouver. Partially filled water lots leased from Port Metro Vancouver are attached to the Site to the south.

Future development plans for the Site include eight multi-tenant residential buildings containing 99 residential units. The development plan also includes redeveloping the filled portions of water lot leased from Port Metro Vancouver as a foreshore park.

The major objective of this Preliminary Problem Formulation is to evaluate the adequacy of the available data and determine the assessment endpoints for measurement of risk to human and ecological health at the Site. Completion of this Preliminary Problem Formulation is intended to assist in the development of a remedial action plan for the Site.

Human Health Problem Formulation

Human receptors selected for assessment include; residents, construction/excavation workers and utility/trench workers. Contaminant of Potential Concern (COPC) screening was completed for all receptor types and numerous COPCs were identified for each media including; extractable petroleum hydrocarbons (EPHs), monocyclic aromatic hydrocarbons (MAHs), polycyclic aromatic hydrocarbons (PAHs), metals and volatile organic compounds (VOCs).

Complete and significant exposure pathways between COPCs in environmental media and human receptors that warrant quantitative assessments in the HHERA were identified as follows:

- Residents – incidental soil/sediment ingestion, dermal absorption with soil/sediment, soil particulate inhalation, soil vapour inhalation and ingestion of marine food items;
- Construction/Excavation Worker – incidental soil ingestion, dermal absorption with soil, soil particulate inhalation and soil vapour inhalation; and
- Utility/Trench Worker – incidental soil ingestion, dermal absorption with soil, soil particulate inhalation, soil vapour inhalation and groundwater dermal absorption.

The assessment endpoints for measurement of risk to human health chosen for the HHERA are represented by hazard quotients (HQs) and Incremental Lifetime Cancer Risks (ILCRs). Classification of "acceptable" risk for this risk assessment is congruent with BC MOE policy as defined especially within the BC Environmental Management Act and shown in Table ES-1.

Table ES-1: Measurement Endpoint Classification

Assessment Endpoint	Measurement Endpoint	BC MOE Acceptable Risk Level
Non-Carcinogenic Health Effects	HQ	HQ/HI ≤ 1.0
Probability of Developing Cancer	ILCR	ULCR ≤ of $1X10^{-5}$

Ecological Problem Formulation

Ecological receptors chosen for quantification of risk were based on those likely to be present in the area of the Site and that prefer habitat types that will present at the Site following re-development. Terrestrial and marine wildlife (birds and mammals of various feeding guilds), soil invertebrates and plants, and aquatic life (marine and freshwater) were identified as potential ecological receptors which warranted assessment in the HHERA.

Similar to the human health problem formulation, numerous COPCs were identified for each ecological receptor. Ecological COPCs for the various receptors include; EPHs, MAHs, PAHs, metals, VOCs, tributyltin and total polycyclic biphenyl (PCB). Complete and significant exposure pathways between media containing these COPCs and ecological receptors are:

- Soil Invertebrates and plants – contact with soil;
- Terrestrial/ Aquatic Wildlife – incidental soil/sediment ingestion, surface water ingestion, food item ingestion; and
- Marine and Freshwater Aquatic Benthos – Contact with freshwater/marine sediment and porewater.

The ecological assessment and measurement endpoints that were chosen for the HHERA are listed in Table ES-2.

Table ES-2: Assessment and Measurement Endpoints and Effects Levels

Measurement Receptor	Assessment Endpoint	Measurement Endpoint and Effect Level
Terrestrial Soil Invertebrate and Plant Community	Richness and Abundance	Compare calculated hazard quotients (HQs) to threshold values and quantify effect level as follows: • HQ≤1 indicates negligible effects • HQ≥1 indicates potential effects
Terrestrial and Aquatic Birds and Mammals	Health of Wildlife	Compare calculated HQs to threshold values and quantify effect level as follows: • HQ≤1 indicates negligible effects • HQ≥1 indicates potential effects
Freshwater and Marine Benthic Communities	Richness and Abundance	Compare calculated HQs to threshold values and quantify effect level as follows: • HQ≤1 indicates negligible effects • HQ≥1 indicates potential effects
	Larval Development, Growth and Survival	Compare toxicity testing results to thresholds where: • ≤20% reduction in growth or survival relative to uncontaminated conditions indicates negligible effects. • ≥20% reduction in growth or survival relative to uncontaminated conditions indicates potential effects

Recommendations to Support the HHERA Completion

A number of data gaps were identified through completion of the Preliminary Problem Formulation. Additionally, work to reduce the number of COPCs that will require assessment in the HHERA (if possible) is recommended. The following is a list of recommendations for additional work:

1. Collect additional surface water samples from Roche Point Creek;
2. Re-assess marine porewater data with groundwater samples collected from monitoring wells located immediately up-gradient of the marine shoreline and within areas of environmental concern (AECs) that have identified human health and/or ecological COPCs, or collect marine porewater samples and re-evaluate for the presence of COPCs;
3. Collect total metals data for Roche Point Creek and marine porewater data sets;
4. Collected terrestrial and marine invertebrate and/or plant samples. Collection of some tissues is recommended only if ingestion of modelled food items (tissues) contributes significantly to the overall EEC for humans and wildlife;
5. Refinement of human health and ecological COPCs by:
    a. Acquiring the developmental excavation plan and determining which soils will be excavated and removed from the Site in order to facilitate Site construction;
    b. Focusing on groups of COPCs rather than individuals (i.e., light and heavy weight PAHs);
    c. Focusing on substances with the greatest relative toxicity and have the largest spatial distribution on the Site;
    d. Assessing only bioaccumulative substances (Ecological RA only); and/or
    e. Further researching the requirement to carry tributyl tin forward as a COPC.

Risk Management Recommendations

Completion of this Preliminary Problem Formulation has indicated that with the exception of marine sediments, most of the risk management measures that are required can be identified without detailed evaluation. Risk management measures include:

- Removal of soil where groundwater effects are not bounded;
- Removal of hazardous waste fill;
- Hard capping of contamination managed in place with building slabs, concrete or asphalt and soft capping with at least 1m of clean fill where hard capping is absent.

With respect to marine sediments, it is recommended that risk management be focused on sediments that contain contaminant concentrations in excess of Risk Based Remediation Goals (RBRGs) which can be established using the HHERA results. RBRGs are the maximum contaminant concentration a receptor may be exposed to without posing unacceptable risk, and they can be developed using the most stringent value estimated from both sediment toxicity testing and HQs results. It is recommended that sediments containing contaminant concentrations in excess of these developed RBRGs be risk managed through capping, dredging or if required, special management options developed for high value habitat that cannot reasonably be capped or dredged.

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List of Acronyms

AEC	-	areas of environmental concern
APEC	-	area of potential environmental concern
AST	-	aboveground fuel storage tank
bgs	-	below ground surface
COPC	-	Contaminants of Potential Concern
CSM	-	Conceptual Site Model
CSR	-	Contaminated Sites Regulation
DSI	-	Detailed Site Investigation
EPA	-	Environmental Protection Agency
EPH	-	extractable petroleum hydrocarbons
HEPH	-	heavy extractable petroleum hydrocarbons
HHERA	-	Human Health and Ecological Risk Assessment
HQ	-	hazard quotient
LEPH	-	light extractable petroleum hydrocarbons
MAH	-	monocyclic aromatic hydrocarbons
MOE	-	BC Ministry of Environment
PAH	-	polycyclic aromatic hydrocarbons
PCBs	-	polychlorinated biphenyls
PGL	-	Pottinger Gaherty Environmental Consultants Ltd.
PSI	-	Preliminary Site Investigation
RBRG	-	Risk Based Remedial Goals
TBT	-	tributyltin
UST	-	underground fuel storage tank
VOC	-	volatile organic compounds
ZOC	-	Zones of Contamination

1.0 INTRODUCTION

Pottinger Gaherty Environmental Consultants Ltd. (PGL) was retained by Polygon Development 270 Ltd. (Polygon) to complete the Preliminary Problem Formulation phase of a Detailed Quantitative Human Health and Ecological Risk Assessment (HHERA) for 3919 and 3829 Dollarton Highway and adjacent Port Metro Vancouver lands to the south in North Vancouver, BC (the Site, Figure 1).

This Preliminary Problem Formulation considers Polygon's proposed future land use scenario only and is part of PGL's overall submission to secure a Release of municipal development permits under BC Ministry of Environment (MOE) Administrative Guidance 6.

1.1 Objectives and Scope of Work

The major objective of this Preliminary Problem Formulation is to evaluate the adequacy of the available data and determine the assessment endpoints for measurement of risk to human and ecological health at the Site. Further, completion of this Preliminary Problem Formulation is intended to assist in the development of a remedial action plan for the Site. Although risk is not being assessed, potential outcomes for each assessment and measurement endpoint have been detailed and risk management strategies have been provided for scenarios where unacceptable risk is a potential result.

It should also be noted that removal with offsite disposal of some Site soils will be required for Site development, and remediation of some impacted soil and groundwater through excavation and offsite disposal is proposed for the Site. To be conservative, this preliminary problem formulation does not consider these works. A final problem formulation will rely on detailed plans for the development that describe final excavation limits for development, and therefore what contaminants will be removed as an inevitable side effect of the development process. This is further discussed in Section 6.0.

Major tasks completed as part of the Preliminary Problem Formulation include:

- Review of historical documentation;
- Documentation of the Site exposure settings;
- Identification of Contaminants of Potential Concern (COPCs) in various environmental media;
- Identification of operable and inoperable exposure pathways;
- Identification of receptors of potential concern;
- Development of a set of Conceptual Site Models (CSMs);
- Nomination of an appropriate set of assessment and measurement endpoints for assessing toxicological exposure and effects; and
- Development of strategies for managing potentially unacceptable risk results.

1.2 Regulatory Framework and Approach

This report has been prepared under the regulatory regime of the Province of BC's Environmental Management Act, specifically the BC Contaminated Sites Regulation (BC CSR). This Preliminary Problem Formulation is based largely on the methods and guidance recommended by BC MOE and Health Canada in the following protocol and guidance documents:

- BC MOE (1998). Guidance and Checklist for Tier 1 Ecological Risk Assessment of Contaminated Sites in British Columbia (CSR Protocol 1);
- BC MOE (2009). Technical Guidance 4 on Contaminated Sites – Vapour investigation and Remediation, Draft, July 2009;
- BC MOE (2005a). CSR Technical Guidance 17 Soil Quality Database;
- BC MOE (2005b). CSR Technical Guidance 12 Statistics for Contaminated Sites;
- BC MOE (2007). CSR Technical Guidance 7 Supplemental Guidance for Risk Assessments;
- BC MOE (2008). CSR Protocol 13 Screening Level Risk Assessment;
- BC MOE (2010). CSR Technical Guidance 6 Determination of Water Use;
- CSAP Society (2012). CSAP Technical Guidance for Risk Assessment COPC Screening. February 2012;
- Environment Canada (2010). FCSAP Ecological Risk Assessment Guidance;
- Golder / Science Advisory Board (2008). Detailed Ecological Risk Assessment (DERA) in British Columbia – Technical Guidance;
- Health Canada (2009a). Federal Contaminated Site Risk Assessment in Canada Part V: Guidance on Complex Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRAchem); and
- Health Canada (2009b). Federal Contaminated Sites Risk Assessment in Canada Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA).

1.3 Report Structure

The major components of the Preliminary Problem Formulation are documented herein as follows:

- **Section 2:** Site Description. Includes current Site details such as physical site description, topography, geology, hydrogeology, groundwater use and discussions about site biota and species at risk for the area;
- **Section 3**: Background Information. Includes a discussion of Site history, a summary of findings from previous investigations, and details of Site contamination;
- **Section 3:** Human Health Preliminary Problem Formulation. Includes COPC screening, exposure pathway analysis, receptor selection, conceptual Site models and nomination of appropriate assessment and measurement endpoints for assessing human health at the Site;
- **Section 4:** Ecological Preliminary Problem Formulation. Includes COPC screening, exposure pathway analysis, receptor selection, conceptual Site models and nomination of appropriate assessment and measurement endpoints for assessing ecological risks at the Site; and
- **Section 5:** Conclusions and recommendations. Includes a list of potential outcomes for each assessment and measurement endpoint that will be later be measured in a full Human Health and Ecological Risk Assessment (HHERA), as well as risk management options for each potential outcome.

1.4 Professional Statement

Pursuant to Section 63 of the BC CSR, PGL confirms that this report has been prepared in accordance with all applicable requirements of the Environmental Management Act and the CSR. Michelle Ashley, B. Sc., R.P. Bio. and Will Gaherty, M.S., P. Eng. have demonstrable experience in Human Health and Ecological Risk Assessment for contaminated sites. Marc Cameron, M. Sc., R.P. Bio and CSAP was the roster reviewer.

2.0 SITE DESCRIPTION

2.1 Current Site Description

The Site contains a terrestrial area of roughly 2.85ha, and extends north from the historical foreshore of Burrard Inlet to the south side of Dollarton Highway in North Vancouver (Figure 1). Partially filled water lots leased from Port Metro Vancouver are attached to the Site to the south. The terrestrial portion of the Site is comprised of four freehold fee simple lots. The freehold land at the 3829 Property comprises one legal lot, while the freehold land at the 3919 Property consists of three legal lots.

The Site is occupied by two industrial shipyard operators: Noble Towing to the west (3829 Dollarton Highway) and McKenzie Barge and Marine Ways to the east (3919 Dollarton Highway). The Site is bounded by Dollarton Highway to the north, Burrard Inlet to the south, residential properties to the west, and Cates Park to the east. Roche Point Creek currently flows across the Noble Towing property near the boundary with the McKenzie Barge properties. Figure 2 illustrates the current Site use and land title information for the Site is provided in Table A, below.

Table A: Site Identification Information

Civic Address	3829 to 3919 Dollarton Highway, North Vancouver, BC
PID	008-965-358 008-965-404 015-994-937 015-994-902
Legal Descriptions**	LOT 1, Blocks A and D, District Lot 230, Plan 12037; LOT 2, Blocks A and D, District Lot 230, Plan 12037; The East 66 feet of the West 1/3 of Lot A (Reference Plan 757) District Lot 230 Group 1, New Westminster Land District; and The Centre 1/3 of Lot A (Reference Plan 757) District Lot 230 Group 1, New Westminster Land District.
Owner	M.A.N. Estates Ltd. (3829 Dollarton Hwy); McKenzie Enterprises Ltd. (3919 Dollarton Hwy)
Land Use	Industrial
Zoning	I-1 (Waterfront Industrial)
Proposed Land Use	Residential
Latitude*	49° 18' 13" North*
Longitude*	122° 57' 51" West*
Site Areas	Terrestrial Fee Simple Area = 19,236m^2 Total (4 legal lots)

	In-filled Port Metro Vancouver Water Lot Leases = 5426 m^2 Total (Parcel A south of 3919 Dollarton is 5,196m^2 and Parcel C south of 3829 Dollarton is 230m^2) Port Metro Vancouver Water Lots = 31,960m^2 Total (Parcel B south of 3919 Dollarton is 13,015m^2; Parcels A, B, D, and E south of 3829 Dollarton are 18,945m^2).
MOE Site #	3412/14456

* *Source: Google Earth*

** Port Metro Vancouver properties are not filed with the Land Title Office, therefore, there are no official legal descriptions or parcel identifier numbers.

The Noble Towing property to the west contains one large warehouse building enclosing one active marine way. The building occupies about 50% of the Noble Towing property and about 20% of the entire Site area. A two-storey residential-style building used as an office occupies the northeast corner of the Noble Towing property. There is one paved parking area north of the warehouse building and a gravel parking and storage area in the southwest corner of the Site near the beach.

The McKenzie Barge property contains:

- An office building/maintenance shop along Dollarton Highway;
- A large, centrally located steel-frame building where large-scale welding takes place;
- Two uncovered marine ways for servicing barges/boats in the southeast corner; and
- Several additional storage buildings.

A large portion of the McKenzie Barge property is unpaved ground used for active and inactive storage. Prior to 1974, the southern portion of this property was extended by filling about 50m south into Burrard Inlet. This in-filled area has since been used as a sandblasting and painting area and is herein referred to as the "in-filled sandblasting and painting area."

Roche Point Creek flows across the Noble Towing site near the eastern boundary with Mackenzie. Upstream of the Site, the creek has been highly modified by residential development and the placement of Dollarton Highway. Roche Point Creek passes through a large concrete culvert underneath Dollarton Highway and then flows onto the Site through a small waterfall that exists due to the raised outfall from the concrete culvert. The Roche Point Creek riparian area is a narrow vegetated corridor which is highly confined by the adjacent developments (i.e., pavement and buildings); a small section of the creek flows directly under the northeast corner of the main shipyard building at 3829 Dollarton.

The marine area of the Site features two timber pile supported wharfs/piers extending 70 and 100m out from the shore. The shoreline is relatively steep with coarse gravel, cobble and occasional boulders, with the exception of a localized sand and gravel beach at the west end of the Site. In general, the banks of the foreshore are armoured with boulders, angular rock riprap, treated timbers, waste concrete slab, concrete lock blocks or cast concrete foundations.

2.2 Adjacent Properties and Features

The area immediately surrounding the Site is residential to the west and across Dollarton Highway to the north and undeveloped parkland to the east (Figure 2). The specific surrounding property uses include:

- North (upgradient) – Dollarton Highway followed by single family residential properties;
- East (cross-gradient) – Cates Park;
- South (downgradient) – Burrard Inlet; and
- West (cross-gradient) – Residential properties.

2.3 Topography

The topography of the Site slopes very steeply up to the north from Burrard Inlet towards Dollarton Highway. Roche Point Creek crosses the Site from north to south.

2.4 Geology and Stratigraphy

Geology maps indicate the surficial geology consists of Vashon Drift and Capilano Sediments. The stratigraphy consists of glacial drift including lodgement and minor flow till, lenses and interbeds of substratified glaciofluvial sand to gravel and lenses and interbeds of glacial lake laminated stony silt. These units are up to 25m thick but in most places less than 8m thick and overlain by glaciomarine and marine deposits normally less than 3m but in places up to 10m thick. (Surficial Geology, Vancouver, British Columbia, Geological Survey of Canada, Map 1486A).

The stratigraphy of the Site varies in conjunction with two main areas as follows:

1. The terrestrial uplands area which is the portion of the Site that is north of the current high water mark. The stratigraphy for this zone generally consists of fill (usually less than 1m) overlaying native glacial till soils (sand and silt). This zone also consists of three discrete filled intertidal zones which were historically filled with imported or dredged material consisting primarily of sand. Fill in these areas exists at depths between 1.4m bgs to 5.8m bgs. This filling was completed to extend the shoreline south into Burrard Inlet and was conducted in the following areas:
    - Noble Point west of the mouth of Roche Point Creek;
    - Sandblasting area east of the mouth of Roche Point Creek; and
    - Offsite filled Port Metro Vancouver foreshore area east of the Site and south of Cates Park.
2. The marine area which consists of the intertidal and sub-tidal areas of the Site. These areas consist of marine sediments.

2.5 Hydrology and Hydrogeology

Hydrology and hydrogeology at the Site are typical in what would be expected in relatively steep terrain adjacent to Burrard Inlet. The onsite Creek (Roche Point Creek) is present near the center of the Site and is the only natural watercourse within 1km of the site. It originates roughly 200m north of Dollarton Highway, in Roche Point Park. It also receives storm water from Dollarton Highway and the residential area to the west across Dollarton.

A storm sewer servicing the residential areas to the east and north of the Site discharges about 80 meters east of the Site, in Cates Park.

The water table depth in the area varies with Site topography and distance from Burrard Inlet. It is approximately 15m below ground surface (bgs) near the northern property boundary and about 2m bgs in the south portion of the Site. Groundwater levels near Burrard Inlet fluctuate with the tides.

Groundwater flow direction is south, following the local topography. Additional hydrogeological information including groundwater flow direction contour maps, discussions pertaining to hydraulic conductivity and discussions related to onsite and offsite preferred pathways for groundwater flow are available in PGL's Stage 2 Preliminary Site Investigation and Detailed Site Investigation Report, dated October 2013 (PGL, 2013a).

2.6 Groundwater Use

A search of the BC Water Resource Atlas was conducted on September 22, 2013. Results of this search indicate that there is no groundwater wells located within 1 kilometre of the Site. Based on this and the knowledge that a community water supply is provided to the area of the Site (Capilano Reservoir), Site groundwater is not currently used and is not likely to be used as a drinking water source in the future. Appendix A presents the results of the BC Water Resource Atlas search.

2.7 Climate and Biogeoclimatic Zone

The Site is within the Coastal Western Hemlock Bioclimatic subzone (CWHvm1). This zone is the most extensive biogeoclimatic unit in the Vancouver Forest Region. In the region of the Site, the CWHvm1 occurs along the windward slopes of the Coast Mountains, from the Fraser River to the northern boundary of the Vancouver Forest Region. The elevation limits range from sea level to approximately 650 m above sea level. The CWHvm1 has a wet, humid climate with cool summers and mild winters featuring relatively little snow. The climate normals gathered by Environment Canada (1971 to 2000) for the "North Vancouver Second Narrows" meteorological station (station closest to the Site with an elevation of 4m) are summarized in Table B.

Table B: Climate Data

<table>
<tr><th colspan="12">Temperature Data</th></tr>
<tr><td colspan="6">Average daily mean temperature (C°):</td><td colspan="6">10</td></tr>
<tr><td colspan="6">Average daily maximum temperature (C°):</td><td colspan="6">13.5</td></tr>
<tr><td colspan="6">Average daily minimum temperature (C°):</td><td colspan="6">6.5</td></tr>
<tr><th colspan="12">Precipitation Data</th></tr>
<tr><th colspan="12">Monthly Precipitation (mm)</th></tr>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>237.9</td><td>201.7</td><td>170.7</td><td>128.5</td><td>103</td><td>83.4</td><td>58.1</td><td>57.6</td><td>82.9</td><td>175.5</td><td>289.5</td><td>266.5</td></tr>
<tr><td colspan="6">Average annual precipitation (mm):</td><td colspan="6">1855.2</td></tr>
<tr><td colspan="6">Average annual rainfall (mm):</td><td colspan="6">1817.1</td></tr>
<tr><td colspan="6">Average annual snowfall (cm)</td><td colspan="6">38</td></tr>
</table>

Source: Environment Canada, 2013

2.8 General Site Biota

2.8.1 Flora

As detailed above, the Site is within the Coastal Western Hemlock Biogeoclimatic subzone. Since the Site has been highly modified by existing land uses (i.e., Noble Towing and McKenzie Barge operations), onsite vegetation conditions do not reflect those of naturally occurring forest ecosystems within the biogeoclimatic zone.

Most Site flora is present within the Roche Creek riparian corridor. The southern portion of the riparian corridor exhibits some characteristics of a mixed forest community with tree species including western red cedar (Thuja plicata) and red alder (Alnus rubra). A large Douglas fir (Pseudotsuga menziesii) was also noted within this corridor. The most common native shrub species is salmonberry (Rubus spectabilis) but non-native invasive Himalayan blackberry (Rubus armeniacus) is also very prominent. Additionally, ground-level vegetation is dominated by English ivy (Hedera helix).

Outside of the riparian corridor, a small stand of deciduous trees was observed in the western portion of the Site. This stand is dominated by red alder with lesser amounts of bigleaf maple (Acer macrophyllum) and western red cedar. Understorey plant communities observed were dominated by invasive plants including the Himalayan blackberry with lesser amounts of periwinkle (Littorina littorea), English ivy (Hedera helix), and several clusters of Japanese knotweed (Fallopia japonica). Scotch broom (Cytisus scoparius), another invasive species, is also present on the Site, adjacent to Dollarton Highway.

2.8.2 Terrestrial Fauna

Terrestrial species that are likely to occur on the Site include those that prefer forest and/or riparian habitat types given the presence of these habitats on and adjacent to the Site. Further, since the area of the Site has industrial and residential developments, wildlife species typical of urban areas would be expected. Common wildlife species that have distribution ranges which include the area of the Site include those listed below. For mammals, amphibians and invertebrates, this information was captured from Hinterland Who's Who - Urban Wildlife, Canadian Wildlife Federation - Discover Wildlife and Sierra Club BC's - Animals of the coast and mountain webpages in September 2013. For information regarding bird species that are commonly present in this area of North Vancouver, the BC Wildlife Watches - Maple Wood Flats Bird species checklist was used (included in Appendix B). Bird species listed as abundant, common, or frequent for three seasons or more are listed below. Given that Maple Wood flats is a conservation area that is located approximately 2km northeast of the Site and includes both terrestrial and marine habitats along the north side of Burrard inlet, bird species listed here are likely common to the area of the Site.

- Terrestrial Birds: Bald Eagle (*Haliaeetus leucocephalus*), American Crow (*Corvus brachyrhynchos*), Killdeer (*Charadrius vociferous*), Pigeons, Northern Flicker (*Colaptes auratus*), Barn swallow (*Hirundo rustica*), Black-capped Chickadee (*Poecile atricapillus*), American Bushtit (*Psaltriparus minimus*), Winter Wren (*Troglodytes hiemalis*), Varied Trush (*Ixoreus naevius*), European Starling (*Sturnus vulgaris*), Cedar Waxwing (*Bombycilla cedrorum*), Wilson's Warbler (*Wilsonia pusilla*), Western Tanger (*Piranga ludoviciana*), Spotted Towhee (*Pipilo maculates)*, Sparrows, Finches, and the Red-winged blackbird (*Agelaius phoeniceus*).

- Aquatic Birds: Common Loon (*Gavia immer*), Grebes, Cormorants, Great Blue Heron *(Ardea herodias*), Canada Goose (*Branta canadensis*), various species of ducks, Greater Yellow Legs (*Tringa melanoleuca*), Dunlin (*Calidris alpine*) and gulls
- Mammals: Bats, Columbian black-tailed deer (*Odocoileus hemionus*), coyote (*Canis latrans*), Eastern grey squirrel (*Sciurus carolinensis*), opossom, racoon (*Procyon lotor*), rats, rabbits, and striped skunk (*Mephitis mephitis*).
- Amphibians and Reptiles: Northern Pacific tree frog (*Pseudacris regilla*), Northwestern salamander (*Ambystoma gracile*), Western garter snake.
- Invertebrates: Ants, banana slug, bumble bee, dragonflies, European black slug (*Arion ater*), ladybug, Monarch butterfly (*Danaus plexippus*), and mosquito.

2.8.3 Marine Fauna

Given the presence of water bodies (Burrard Inlet and Roche Point Creek) at the Site, aquatic species that may utilize the Site include both freshwater and marine species.

The marine biota identified as species likely to utilize the Site area has been based on a Marine Subtidal Biophysical Survey of Benthos that was completed for the adjacent property west of the Site at 3785 Dollarton Highway (Seacology, 2005 (Appendix C)). The marine area at 3785 Dollarton has not been impacted by Site contamination. Given the close proximity to the Site, the general good health of the marine ecosystem, and the similar marine substrates (sand with silt and the occasional cobble) observed at the adjacent property it is reasonable to assume that biota observed at 3785 Dollarton Highway would be expected for the marine area of the Site.

The Seacology survey employed three transects. Two were perpendicular to the shore line, were 90 and 70m long and began above the high water mark. The third transect was parallel to the shore and was 95m long. Biota observed during the survey were as follows:

- 11 species of marine plants including; diatoms, 2 species of green algae, 3 species of brown algae, 5 species of red algae (including eel grass) and 1 vascular plant;
- 22 species of invertebrates including; 4 species of cnidarians, 5 species of mollusca, 8 species of arthropods, 4 species of echinoderms and 1 bryozoan species; and
- 5 species of vertebrates including 4 fish species and 1 marine mammal (seal).

Freshwater species that are likely to exist in the onsite freshwater habitat (Roche Point Creek) include various types of fish and aquatic invertebrates. The Dollarton Highway culvert configuration prevents fish travel across Dollarton Highway. Fish species that have been documented in Roche Point Creek include cutthroat trout (Oncorhynchus clarkia) and small runs of Coho Salmon (Oncorhynchus kisutch) were observed spawning at the mouth of Roche Point Creek on an annual basis prior to 1995 (Cook, 2002). The Habitat Conservation and Stewardship Program's North Vancouver Watershed Profile shows that fish species that exist in other District of North Vancouver Streams include; coho (Oncorhynchus kisutch), cutthroat (Oncorhynchus clarkia), dolly vardin (Salvelinus malma malma), sculpin and steelhead (Oncorhynchus mykiss) (HCAP, 2013). Although existence in Roche Point Creek is not documented, these fish types could inhabit the creek if appropriate improvements to the aquatic habitat are completed at the Site.

2.9 Listed Species Information

Information concerning endangered or threatened species that may be present on or near the Site was obtained from the following sources:

- BC Conservation Data Centre (CDC); and
- Federal Species at Risk Act (SARA).

Appendix B provides a list of potentially occurring species-at-risk (red or blue listed) that might use the terrestrial and marine areas of the Site. 57 species were identified for the Metro Vancouver Regional District in total, however only 29 of these were ranked as "plausible" for likelihood of occurrence on the Site. Species rated as "plausible" were those which had a Metro Vancouver or District of North Vancouver (if available) occurrence status of "confident or certain" and were detailed to frequently use forest, riparian, or marine habitats. These habitats were chosen based on the current habitat available on the Site as well as habitat that may be available following Site redevelopment (see Section 3.5). Table C lists the species at risk identified to have a plausible likelihood of occurrence on the Site.

Table C: Species at Risk Ranked as Plausible Potential Occurrence Site

Class	Species
Fish	Green Sturgeon (*Acipenser medirostris*)
Mammals	Townsend's Big-eared Bat (*Corynorhinus townsendii*)
	Southern Red-backed Vole (*Myodes gapperi*)
	Pacific Water Shrew (*Sorex bendirii*)
Birds	Band-tailed Pigeon (*Patagioenas fasciata*)
	Double-crested Cormorant (*Phalacrocorax auritus*)
	Sooty Grouse (*Dendragapus fuliginosus*)
	Great Blue Heron (*Ardea Herodias*)
	Olive-sided Flycatcher (*Contopus cooperi*)
	Caspian Tern (*Hydroprogne caspia*)
	Western Screech-Owl (*Megascops kennicottii*)
Terrestrial Invertebrates	Emma's Dancer (*Argia emma*)
	Western Thorn *(Carychium occidentale)*
	Oregon Forestsnail (*Allogona townsendiana*)
	Silver-spotted Skipper (*Epargyreus clarus)*
	Grappletail (*Octogomphus specularis*)
	Blue Dasher (*Pachydiplax longipennis*)
	Zerene Fritillary (*Speyeria zerene*)
Amphibians	Northern Red-legged Frog (*Rana aurora*)

3.0 BACKGROUND INFORMATION

3.1 Site History

Table D details the chronology of key events related to Site ownership and use since being granted from the crown in 1883.

Table D: Chronology of Key Site Events

Date(s)	Event
October 1883	Grants From Crown
1920s or 1930s	Western portion of Site (currently 3829 Dollarton) developed as a brickyard.
1931	McKenzie family purchased east portions of 3919 Dollarton Highway and began McKenzie Barge and Marine Ways shipyard operations.
1940s	3829 Dollarton Highway developed as a shipyard.
1950s	I.M. Matsumoto purchased 3829 Dollarton Highway and expanded the property building for Matsumoto Shipyards operation.
1960s	McKenzie Barge began filling activities in the foreshore to extend the Site further south into Burrard Inlet.
1965	The westernmost lot currently comprising 3919 Dollarton Highway was purchased and subdivided from the Matsumoto property at 3829 Dollarton Highway.
1974	Filling of the foreshore south of 3919 Dollarton Highway extended the western half of the Site approximately 50m south into Burrard Inlet.
1980s	Fill was imported to 3829 Dollarton Highway and placed at the east side of the property between the shipyard building and Roche Point Creek.
1989	M.A.N. Estates purchased the Matsumoto property at (3829 Dollarton Highway) and began operating Noble Towing.
1950s-1995	Offsite foreshore area adjacent to the Site to the southeast was filled in the 1950s and used for boat building, material storage, dumping and burning. The exact use and responsible parties are not clear.

Except brickyard activities in the 1920s/30s at 3829 Dollarton Highway, both Site properties have primarily been operating as shipyards since being developed. Additionally, as discussed in Section 2.4 above, filling activities has occurred on both properties and in the offsite area to the southeast. Filling at 3919 Dollarton and the offsite property occurred along the foreshore area, and filling at 3289 Dollarton occurred on the east side of the property, near Roche Point Creek. Figure 2 illustrates the areas of filling activities for both properties.

Further detail on the Site's history as well as the current status is provided in PGL's Stage 1 PSI, dated October 2013 (PGL, 2013b).

3.2 Previous Investigations

Environmental investigations have been conducted on the Site since 1992 by various environmental consultants. Prior to 2013, investigations were focused on the individual properties that make up the Site. These investigations include:

- April 15, 1992. Norecol Environmental Management Ltd. *Phase 1 Environmental Site Investigation - 3829 and 3919 Dollarton Highway, North Vancouver, British Columbia.* File 5-202-01.01;
- July 8, 1993, Norecol, Dames & Moore. *Preliminary Environmental Investigation Report, 3828 and 3919 Dollarton Highway. North Vancouver, British Columbia.* Job. No. 26674-002-313;
- December 9, 2005. Hemmera Envirochem Inc. *Final Report, Phase 1 Environmental Site Assessment and Sediment Investigation, Waterlots Adjacent to 3785 and 3829 Dollarton Highway, North Vancouver, BC.* File: 302-015.01;
- January 24, 2006. Hemmera Envirochem Inc. *Addendum Report – Supplemental Coring Investigation, VPA Waterlots Adjacent to 3785 and 3829 Dollarton Highway, North Vancouver, BC.* File: 302-015.02;
- January 2010. *Limited Stage 1 and 2 Environmental Site Investigation. McKenzie Barge and Marine Ways Ltd., 3919 Dollarton Highway, North Vancouver, BC*; and
- February 2010. *Limited Stage 1 and Stage 2 Preliminary Site Investigation. Noble Towing, 3829 Dollarton Highway, North Vancouver, BC.*

In 2013, PGL prepared a series of Site investigation reports for the Site. Work completed as part of these investigations included a review of the above listed historical reports. Relevant information and data from the previous reports was incorporated into PGL's 2013 Site Investigation reports. Given this, reliance on information and data required for completing this Preliminary Problem Formulation is weighted on these recent reports, as listed below:

- PGL, October 2013, *Stage 1 Preliminary Site Investigation, 3919 and 3829 Dollarton Highway, North Vancouver, BC.* (Stage 1 PSI report); and
- PGL, October 2013. *Stage 2 Preliminary Site Investigation and Detailed Site Investigation, 3919 and 3829 Dollarton Highway, North Vancouver, BC.* (Stage 2 PSI and DSI report).

3.3 Site Contamination

PGL's 2013 environmental investigations indicate that Site soil, groundwater, and sediment exhibit contamination (i.e., contain concentrations of various contaminants in excess of applicable British Columbia CSR numerical standards). Specifically, 12 AECs have been identified for the Site. These AECs and COCs were delineated as part of PGL's Stage 2 PSI and DSI report to identify Zones of Contamination (ZOCs) which are defined as the spatial area within an AEC caused by a single contaminant source. These ZOCs represent Zones of Soil, Groundwater and Soil Vapour Contaminant Plumes.

Table E lists these AECs and details the associated contaminants of concern (COCs) and provides information regarding the ZOCs.

Table E: AECs and associated COCs/ZOCs

AEC*	COCs	ZOC
AEC 1 General Shipbuilding and Brickyard Activities (3829 Dollarton)	AEC1-1: Soil: Metals (antimony, copper, tin, zinc); AEC 1-2: Groundwater: Dissolved Arsenic AEC 1-3: Soil: PAH (naphthalene and phenanthrene); MAH (benzene, ethylbenzene); VPH; and LEPH Groundwater: PAH, LEPH	ZOC 1-1: Soil: Depth: to 1.1m bgs Area: 300m^2 ZOC 1-2: Groundwater: Est. Area: 900m^2 ZOC 1-3: Soil: Depth: to 3.4m bgs Area: 400m^2 Groundwater: Est. Area: 400 m^2
AEC 2 Sediments - Foreshore and Marine Ways – General Shipyard Activities	Soil/Sediment: Metals (arsenic, chromium, copper, lead, mercury, and zinc); PAH; and PCB (AEC 2-2 only)	ZOC 2-1: Sediment : Depth: to 1.5m bgs Area: 34,500m^2 ZOC 2-2: Sediment : Depth: to 1.0m bgs Area: 2,250m^2 ZOC 2-3: Sediment : Depth: to 1.0m bgs Area: 3,100m^2
AEC 3 Imported Fill East of Shipyard Building (3829 Dollarton)	Soil: Metals (arsenic, copper, zinc); and PAH	ZOC 3: Soil: Depth: 0.2 to 4.6m bgs Area: 775m^2
AEC 4 In-filled Sandblasting and Painting Area with Accumulated Sandblast Grit (3919 Dollarton)	Soil: Metals (antimony, arsenic, cadmium, chromium, copper, miolybdenum, nickel, zinc); and PAH	ZOC 4: Soil: Depth: grade to a maximum of 3.5m bgs Area: 2,220m^2
AEC 5 Offsite Filled Foreshore and Former Materials storage/ Burning Area East of Site	Soil: Metals (antimony, arsenic, chromium, copper, lead, mercury, miolybdenum, nickel, tin, zinc); PAH; LEPH; and MAH. Groundwater: PAH and LEPH	ZOC 5: Soil: Depth: grade to a maximum of 4.0m bgs Area: 2,300m^2 Groundwater: Est. Area: 900m^2
AEC 12 Historical Solvent and Paint Storage Area (3829 Dollarton)	Soil: Metals (copper, zinc); HEPH; and PAH	ZOC 12: Soil: Depth: to 1.1m bgs Area: 125m^2
AEC 14 Former Gasoline Underground Storage Tank and Outdoor Battery Storage Area (3919 Dollarton)	Soil: Metals (lead and cadmium); PAH (benzo(a)fluoranthene); LEPH/HEPH; and VPH	ZOC 14-1: Soil: Depth: to 4.0m bgs Area: 75m^2 ZOC 14-2: Soil: Depth: to 2.2m bgs Area: 15m^2

AEC*	COCs	ZOC
AEC 15 Former Drum Rack (3919 Dollarton)	Soil: MAH (ethylbenzene, xylene);	ZOC 15: <u>Soil:</u> Depth: to 1.5m bgs Area: 4m^2
AEC 16 Northwest Bone Yard (3919 Dollarton)	Soil: Metals (arsenic, chromiuim, copper, nickel, and zinc); PAH (benzo(b)fluoranthene); HEPH, and MAH (benzene).	ZOC 16: <u>Soil:</u> Depth: to 1.0m bgs Area: 1,340m^2
AEC 17 Northeast Bone Yard (3919 Dollarton)	Soil: Metals (antimony, arsenic, barium, chromium, copper, lead, molybdenum, tin, and zinc) Groundwater: TBT	ZOC 17: <u>Soil:</u> Depth: to 2.5m bgs onsite, to 0.6m bgs offsite in Cates Park Area: 360m^2 Groundwater: Est. Area: 75m^2
AEC 18 Staining and Stressed Vegetation in Area of Former Office/Bunkhouse/Cookhouse (3919 Dollarton)	Soil: Metals (barium, copper, molybdenum, tin and zinc)	ZOC 18: <u>Soil:</u> Depth: to 1.0m bgs Area: 550m^2
AEC 19 Winch Shed/Area Beneath Decking North of Marine Ways (3919 Dollarton)	Soil: Metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, vanadium, and zinc)	ZOC 19: <u>Soil:</u> Depth: to 1.0m bgs Area: 650m^2

* AEC numbers in the table are not consecutive as they have been carried forward using their original APEC numbers.

In addition to the 12 AECs listed above, two Areas of Potential Environmental Concern (APECs) remain at the Site. These remain as APECs as they were not accessible at the time of the Site investigations and include; APEC 8- Machine Shop (3919 Dollarton) and APEC 21 – Regulated Building Materials. Investigation pertaining to these APECs will be completed following Site decommissioning work.

Figure 3 illustrates the locations and estimated lateral extents of each AEC. Additional information is available in PGL's Stage 2 PSI and DSI report (PGL, 2013b).

3.4 Sediment Quality in Burrard Inlet

Sediment quality trends in Burrard Inlet have been assessed by various studies, as monitoring has taken place since the 1970s. Metro Vancouver (formerly the Greater Vancouver Regional District) has an ongoing monitoring program that tests sediment at seven sites that have been evaluated periodically since at least 1985. The most recent report Burrard Inlet Ambient Monitoring Program – 2011 Sediment Sampling (June 2012) includes data up to 2011. Since only seven locations are tested, the data is of more value for observing trends than for observing the range of contaminant concentrations. It nonetheless provides some context for Site data. The nearest sampling location is at Roche Point (referred to as "Central Harbour"), about 1km to the east.

Copper is one of the key indicator parameters assessed by the program as well as being of interest at this site. Concentrations at most stations modestly exceed the 100mg/kg objective for copper. In 2011, the results at Site 4 were roughly 80-85mg/kg. The highest concentrations found in the Port Moody Inlet (at 110-135mg/kg). Site concentrations are generally higher but of the same order of magnitude. Copper concentrations at most locations show a modest declining trend.

Roche Point shows the highest PAH concentrations of the seven stations, with this attributed to the nearby oil refineries. Phenanthrene and pyrene, the PAHs that most frequently exceeded the applicable standard at the Site, are around 120-200µg/kg, so background concentrations in the harbour are 10 times lower or more than that found at the Site. Temporal trends are harder to identify given the relatively small data set for PAHs.

3.5 Proposed Future Site Development

Future development plans for the Site involve the construction of a multi-family residential community which will include a public walkway and habitat bank with barrier plantings to limit human access. Along with construction of the residential community, the development will involve improvements to the Roche Point Creek riparian corridor and the adjacent marine shoreline.

Information regarding the proposed development plans is detailed in the following sections. For simplicity, the Site has been divided into two main areas including; 1) the uplands area which includes all areas north of the current high tide mark and 2) the marine area, which includes the intertidal and sub-tidal areas. Figure 2 illustrates the boundaries of each of these areas. Conceptual Site development plans are provided in Appendix C.

3.5.1 Uplands Area

The uplands area includes all areas between Dollarton Highway and the current high water mark. The redevelopment plan for the uplands area includes eight multi-tenant residential buildings containing 99 residential units and a waterfront walkway. Proposed combined quantitative areas for these buildings as well as various other Site features include:

- Total building area – 4915m^2
- Landscape / Roche Creek area – 10942m^2
- Hardscape area – 388m^2
- Road / driveway area – 2785m^2

Two areas of infilling will be required to support the proposed development. As shown in Appendix C, these include one small area (62.3 m2) along the southwest boundary of the uplands area and a larger area (699.4 m2) in the area of the current marine ways at 3919 Dollarton. It is proposed that the required fill material be imported from the in-filled sandblasting and painting area which is currently present on the southwest portion of the McKenzie Barge and Marine Ways property (see Section 2.1). As discussed in Section 7.0, material imported into these areas will be capped with asphalt / concrete or a minimum of 1m of clean fill.

The re-development of the uplands area will also incorporate improvements to the Roche Point Creek riparian corridor. It is understood that a remediation program will be implemented which will rehabilitate the habitat conditions of Roche Point Creek and will increase the riparian buffer zone on either side to 15m.

3.5.2 Marine Area

The marine area includes the Site area south of the current high water mark. The general development plan for the Marine Area involves removal of all currently present infrastructure and redevelopment as a foreshore passive park. One private dock for the use of Site residents will sit roughly on the current footprint of the Noble Towing pier.

Planned redevelopment of the eastern portion of the marine area involves the creation of an estuarine marsh and an intertidal channel. To construct these features, excavation of soils from the infilled sandblasting and painting area is required. The excavated soils will be moved to the uplands portion of the Site and used as fill material (see Section 3.5.1, above). Any impacted soils that remain within the marine area, will be capped with a minimum of 1m of clean fill, as discussed in Section 7.0.

The development plan also includes reconfiguring the shoreline banks with angular rock riprap and ecopockets to naturalize it. Recommendations are presented in Northwest Hydraulic Consultant's Coastal/Foreshore Hazard Assessment (NHC, 2013).

The figures included in Appendix C illustrate the redevelopment plans for the Marine Area.

4.0 HUMAN HEALTH PRELIMINARY PROBLEM FORMULATION

The following sections present the Human Health component of a Preliminary Problem Formulation for the Site. This Preliminary Problem formulation has been completed using the future land use scenario detailed in Section 3.5 above.

4.1 Receptor Selection

Selection of human health receptors involved considering all potential receptors that may utilize the Site under the future land use scenario. Table F lists potential human receptors identified for the Site.

Table F: Human Receptors for Uplands and Marine Areas

Receptor Class	Receptor Category	Age Class	Assess as Receptor?
	Uplands Area		
Resident	Onsite residents living in the proposed development. Also considers recreational use of the Site for activities such as exercising, swimming, sun bathing and/or harvesting of marine food items such as clams, mussels, fish and crab.	Infant, Toddler, Child, Teenager, Adult	Yes
Site Workers	Maintenance Worker - Maintains landscaped grounds and/or buildings.	Adult	No
	Construction/Excavation Workers – Involved with construction and/or excavation activities associated with Site redevelopment or other future works.	Adult	Yes
	Utility/Trench Worker – Involved with construction and maintenance of utilities.	Adult	Yes
	Residential guests – Individuals that may visit residents of the Site.	Infant, Toddler, Child, Teenager, Adult	No
	Recreational User – Utilizes the Site for outdoor activities such as exercising, swimming, sun bathing and/or harvesting of marine food items such as clams, mussels, fish and crab.		

Residents, construction/excavation workers, and utility workers will be carried forward for assessment in the HHERA. Since many of the receptor groups listed in Table F have similar and overlapping exposure scenarios, the receptor groups being carried forward are considered conservative surrogate receptors for those which are not. Residents are considered a reasonable surrogate for maintenance workers, commercial workers, and visitors because they have similar exposure scenarios, have the greatest potential for exposure since they spend the most amount of time onsite and include all age classes. With respect to construction/excavation, and utility/trench workers, they will be retained for assessment due to their different exposure scenarios relative to residential receptors (see Section 4.3).

4.2 Contaminants of Potential Concern

Contaminants at the Site will be refined to a list of COPCs by comparing the maximum constituent concentrations to media specific screening criteria. Constituents with concentrations exceeding the project screening criteria and background levels (where applicable) will be carried forward as COPCs. The screening criteria consist of human health toxicity based standards, guidelines, or alternative values. This approach is consistent with the recommendations of BC MOE CSR Protocol 13, Contaminated Sites Approved Professionals (2012) COPC screening guidance and Health Canada (2009a, and 2010).

Table G summarizes the screening criteria applied for each media assessed, and the source of media specific standards, guidelines, and background values used for COPC screening. Where possible, pathway specific standards were selected as screening criteria over generic standards. Additionally, Table G defines the chemistry datasets that were used to determine COPCs for each receptor group/exposure media combination. Data sets were selected based on best representation of conditions which the specific receptors will be exposed to.

Note that marine surface waters have not been included as a media for COPC screening. Site contamination is unlikely to be measureable in marine surface water given the area is tidal and continuously mixing and flushing.

Table G: Summary of Human Health Screening Criteria

Media	Receptor	Data Set Screened	Standards/guidelines applied in Order of Priority
Soil	Resident	All soil samples collected throughout the uplands area except soil located south of the proposed waterfront walkway in the Filled Intertidal area.	1. Protocol 4 and BC CSR Technical Guidance 17 2. BC CSR Schedule 5 – Human Intake of Contaminated Soil PL/RL 3. BC CSR Schedule 4/10 – PL/RL generic standards
	Construction/ Excavation Worker	All soil samples collected throughout the Uplands Area. Unlike residents, soils south of the proposed waterfront walkway (Filled Intertidal area) have been included in this data set given this receptor group could be exposed to deeper soil.	1. Protocol 4 and BC CSR Technical Guidance 17 2. BC CSR Schedule 5 – Human Intake of Contaminated Soil CL 3. BC CSR Schedule 4/10 – CL generic standards
	Utility/Trench Worker		
Soil Vapour	Resident	All vapour samples collected from the Uplands Area with the indoor attenuation factor of $2.0*10^{-2}$ applied. These samples are in areas of proposed residential buildings.	BC CSR Schedule 11 generic vapour standards for residential sites.
	Construction/ Excavation Worker	All vapour samples collected from the Uplands Area with the outdoor attenuation factor of $1.0*10^{-4}$ applied. These samples are in areas of landscaping, pathways, parking, or roadways.	BC CSR Schedule 11 generic vapour standards for commercial sites.
	Utility/Trench Worker	Vapour samples collected from within the Uplands Area with the trench air attenuation factor of 0.09 applied.	
Groundwater	Utility/Trench Worker	All groundwater samples collected from beneath the Site.	US EPA Region 9 Adjusted Regional Screening Levels (RSLs) for tap water, dermal exposure with modification.[4]

Media	Receptor	Data Set Screened	Standards/guidelines applied in Order of Priority
Roche Point Creek Surface Water	Resident	Modelled surface water concentrations using maximum groundwater concentrations with a dilution factor of 10.	US EPA Region 9 Adjusted Regional Screening Levels (RSLs) for tap water, dermal exposure with modification.[4]
Roche Point Creek Sediment	Resident	All sediment samples collected from Roche Point Creek.	1. Protocol 4 and BC CSR Technical Guidance 17 2. BC CSR Schedule 5 – Human Intake of Contaminated Soil PL/RL 3. BC CSR Schedule 4/10 – PL/RL generic standards
Marine Sediment	Marine Area Recreational User	All sediment samples collected from the intertidal zone of the Marine Area between the high and low water marks.	1. Protocol 4 and BC CSR Technical Guidance 17 2. BC CSR Schedule 5 – Human Intake of Contaminated Soil PL/RL 3. BC CSR Schedule 4/10 – PL/RL generic standards
Marine Food items	Marine Area Recreational User	No tissue sampling results are available. Parameters were identified as COPCs if identified as a COPC in marine sediment.	Identified as a COPC in marine sediments.

Notes:
1) An RSL representing ILCR – 1 x 10^{-5}

With respect to soil COPC screening for residents, all soils have conservatively been screened as opposed to surface soils only1 because soil movement during Site development may change the depths of impacted soil. Additionally, soil south of the proposed waterfront walkway was not included in the dataset as it is understood that any impacted soils moved from this area and all impacted surficial soils (0 and 1.0 mbgs) remaining in this area will be capped.

With respect to vapour COPC screening, since excavation surface levels following Site redevelopment are unknown, COPC screening for all receptor types was completed using the most conservative attenuation factor for each exposure scenario. One exception is related to indoor air where the attenuation factor for buildings with unlined crawlspaces, earthen or wooden basements was not applied as it is understood that future buildings at the Site will have concrete bases.

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[1] Typically, COPC screening for residents/recreational users is completed using surface soils only (0-1.0 m below ground surface)

COPC screening for surface water in Roche Point Creek was completed using a data set where the concentrations of surface water in the creek were modeled[2] by applying a dilution factor of 10 to all Site groundwater data. This dilution factor was applied because the BC MOE has adopted such dilution/attenuation in the derivation of the BC CSR schedule 6 standards. Further dilution of this groundwater when it reaches the creek is likely, however has not been assumed in our conservative approach.

It is also important to note that the data used to predict the concentrations of metals in surface water is for dissolved metals, but the guidelines used for COPC screening are for total metals. Since total (unfiltered) metals measurements are generally higher, it is likely metals concentrations in surface water are underestimated in our assessment, suggesting that some COPCs may have been incorrectly screened out. This is considered a data gap for the HHERA (see Section 6.0).

The list of human health COPCs at the Site is summarized in Table H. COPCs were identified in all media except freshwater sediments and surface water in Roche Point Creek. The complete results of the COPC screening process are presented in Appendix D.

Table H: Summary of Human Health COPCs

Parameter	Soil		Ground water	Soil Vapour			Marine Sediments	Marine Food Items
	Resident	All Workers	Utility Worker	Resident	Construction/ Excavation Workers	Utility/ Trench Workers	Residents	Residents
Extractable Petroleum Hydrocarbons (EPHs)								
EPH10-19	X	X						
EPH19-32	X	X					X	X
LEPH	X	X						
HEPH	X	X					X	X
Monocyclic Aromatic Hydrocarbons (MAHs)								
Benzene				X		X		
Xylenes				X		X		
VPH (C6-C10)	X	X		X		X		
Polycyclic Aromatic Hydrocarbons (PAHs)								
Benzo(a)anthracene	X	X					X	X
Benzo(a)pyrene	X	X					X	X
Benzo(b)fluoranthene	X	X					X	X
Benzo(k)fluoranthene	X	X					X	X
Dibenz(a,h)anthracene	X	X					X	X
Indeno(1,2,3-c,d)pyrene	X	X					X	X
Naphthalene	X	X	X	X	X	X		
Phenanthrene	X	X					X	X
Pyrene	X	X					X	X

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[2] Some data is available for surface water in the creek, however the data is limited (only one sample for PAHs).

Parameter	**Soil**		**Ground water**	**Soil Vapour**			**Marine Sediments**	**Marine Food Items**
	Resident	**All Workers**	**Utility Worker**	**Resident**	**Construction/ Excavation Workers**	**Utility/ Trench Workers**	**Residents**	**Residents**
Metals								
Antimony	X	X					X	X
Arsenic	X	X					X	X
Cadmium	X	X						X
Chromium	X	X						
Lead	X	X						
Manganese			X					
Mercury	X							
Molybdenum	X	X					X	X
Nickel	X							
Tin	X							
Vanadium	X						X	X
Volatile Organic Compounds (VOCs)								
Acetone						X		
Hexane				X		X		
Trichloroethene				X		X		
1,2,4-trimethylbenzene				X		X		
1,3,5-trimethylbenzene				X		X		
Vinyl chloride				X		X		

Given the extensive number of COPCs identified for humans at the Site, further work to reduce the number that will be quantitatively assessed may be completed as part of the HHERA. Various options for completing this include focusing on groups of COPCs rather than individuals (e.g. low molecular weight and high molecular weight PAHs), assessing only bioaccumulative substances and/or selecting COPCs that have the greatest relative toxicity and show the largest spatial distribution. Further information pertaining to refinement of COPCs is discussed in Section 6.1.2.

4.2.1 Carcinogenic COPCs

Carcinogens are defined by BC's CSR as substances with an International Agency for Research on Cancer (IARC) classification of 1 or 2A, or a US Environmental Protection Agency (EPA) classification of A or B1. Table I details substances which are considered carcinogenic COPCs for the Site.

Table I: Carcinogenic COPCs

COPC	IARC Classification	US EPA Classification
Benzene	1	A
Benzo(a)pyrene	1	B2
Arsenic	1	A
Cadmium	1	B1
Chromium	1	A (inhalation route only)
Nickel	1	B2 (Nickel carbonyl) A (nickel subsulphides)
Trichloroethene	1	A
Vinyl chloride	1	A

4.3 Human Exposure Pathway Analysis and Conceptual Site Model

As detailed in Section 4.1, potential human receptors carried forward for assessment include: residents, construction/excavation workers, and utility/trench workers. Table J presents a qualitative analysis of all potential exposure pathways associated with each of these receptors. Exposure pathways have been ranked as:

- Complete and significant;
- Partially complete but insignificant; or
- Inoperable.

Pathways ranked as complete and significant will be carried forward for quantitative assessment of risk in the HHRA.

Several exposure pathways have not been considered in this assessment because:

- Roche Creek surface water and sediment has not been considered because COPCs were not identified for these media and exposure is not expected because of the proposed barrier plantings to protect the habitat, that will also have the effect of substantially limiting exposure;
- Marine surface water has not been considered because measurable contamination is not expected for this media because of tidal flushing and water movement; and
- Ingestion of plants has not been considered as it is assumed that edible plants will not be planted as part of Site redevelopment and any garden plots that may be constructed will be raised beds filled with imported clean soil and located in areas where a minimum 1m of clean soil will be present under the garden bed. As well, medicinal plants that may be harvested by local First Nations groups will not be available on the Site.

Table J: Qualitative Exposure Pathway Assessment

Receptor	Media	Exposure Pathway Analysis	Pathway Ranking
Resident (Infant, Toddler, Child, Teenager, Adult)	Soil	Incidental Soil Ingestion	●
		Soil Dermal Absorption	●
		Soil Particulate Inhalation	●
	Groundwater	Groundwater Ingestion	X
		Groundwater Dermal Absorption	X
	Soil Vapour	Soil Vapour Inhalation	●
	Marine Sediments	Incidental Sediment Ingestion	●
		Sediment Dermal Absorption	●
		Sediment Particulate Inhalation	○
	Marine Food Items	Ingestion of Marine Food Item	●
Construction/Excavation Worker (Adult)	Soil	Incidental Soil Ingestion	●
		Soil Dermal Absorption	●
		Soil Particulate Inhalation	●
	Groundwater	Groundwater Ingestion	X
		Groundwater Dermal Absorption	X
	Soil Vapour	Soil Vapour Inhalation	●
	Marine Sediments	Incidental Sediment Ingestion	X
		Sediment Dermal Absorption	X
		Sediment Particulate Inhalation	X
	Marine Food Items	Ingestion of Marine Food Item	X
Utility/Trench Worker (Adult)	Soil	Incidental Soil Ingestion	●
		Soil Dermal Absorption	●
		Soil Particulate Inhalation	●
	Groundwater	Groundwater Ingestion	○
		Groundwater Dermal Absorption	●
	Soil Vapour	Soil Vapour Inhalation	●
	Marine Sediments	Incidental Sediment Ingestion	X
		Sediment Dermal Absorption	X
		Sediment Particulate Inhalation	X
	Marine Food Items	Ingestion of Marine Food Item	X

Notes:
● Complete and Significant
○ Partially Complete but Insignificant
X Inoperable

Exposure pathways considered to be partially complete but insignificant, or inoperable will not be carried forward for quantitative assessment in the HHRA based on the rationale discussed below.

4.3.1 Resident

- Exposure to groundwater was considered inoperable as groundwater wells do not exist in the area and none will be installed in association with Site redevelopment (see Section 2.6, above); and
- Inhalation of airborne marine sediments is considered partially complete but insignificant. It is possible that sediments may dry during low tide events such that they may be distributed as particulate matter during high wind events; however it is anticipated that these events will be infrequent and exposure to contaminants through this pathway would be insignificant when compared to exposure through incidental ingestion and dermal absorption.

4.3.2 Construction/Excavation Worker

- While it is conceptually possible that exposure to groundwater would occur in trenches, Section 20.95 of the BC OHS Regulation prohibits accumulation of water in excavations if it "...might endanger workers." Because of the much lower structural stability of "wet" excavations, it is universal practice in BC not to allow workers to enter wet excavations. As such, this exposure can be discounted; and
- Exposure to marine sediments and food items was considered inoperable because construction and/or excavation work is not planned for the marine area. It is possible that a worker could harvest marine food items while at the Site; however assessment of this exposure pathway using residential receptors is a reasonable surrogate.

4.3.3 Utility/Trench Worker

- Exposure to groundwater through ingestion was considered partially complete but insignificant for trench workers. As discussed above, contaminated groundwater is be pumped out of trenches to facilitate work thereby limiting exposure; and
- Exposure to marine sediments and food items was considered inoperable for the same reasons discussed for construction/excavation workers.

A Conceptual Site model (CSM) summarizing potential exposure pathways for human receptors and Site contamination is presented in Figure 4.

4.4 Assessment and Measurement Endpoints

The assessment endpoints for measurement of risk to human health are measurements of an individual's likelihood of experiencing non-carcinogenic adverse health effects or probability of developing cancer as a result of potential future chronic exposure to Site contamination. The respective measurements of these endpoints are represented by hazard quotients (HQs) and Incremental Lifetime Cancer Risks (ILCRs).

Classification of "acceptable" risk for this risk assessment is congruent with BC MOE policy as defined in the Environmental Management Act and shown in Table .

Table K: Measurement Endpoint Classification

Assessment Endpoint	Measurement Endpoint	BC MOE Acceptable Risk Level
Non-Carcinogenic Health Effects	HQ	HQ/HI ≤ 1.0
Probability of Developing Cancer	ILCR	ULCR ≤ of $1X10^{-5}$

5.0 ECOLOGICAL PRELIMINARY PROBLEM FORMULATION

The Ecological component of a Preliminary Problem Formulation for the Site has been completed using the future land use scenario that is detailed in Section 3.5 above.

5.1 Potential Ecological Receptors

Based on the type of habitats expected to be present at the Site following re-development, as well as the general biota expected for the Site and surrounding area (See Section 2.8), potential ecological receptors at the Site will include both terrestrial and aquatic (freshwater and marine) biota.

The following list details general types of biota that are identified as candidates requiring consideration. Additionally, the levels of ecological organization that should be assessed are presented. It should be noted that BC MOE guidance (BC MOE, 1998) required the evaluation of the same receptor groups.

- Soil Invertebrates (community);
- Terrestrial plants (community);
- Wildlife
  - Terrestrial and aquatic birds (populations);
  - Terrestrial and aquatic mammals (populations);
  - Reptiles and amphibians (populations);
- Freshwater and marine aquatic life;
  - fish (communities);
  - invertebrates (communities); and
- Threatened, endangered and sensitive species (individuals, if present).

Where necessary, we have refined these groups of receptors into more specific biota following the identification of COPCs in Site media (Section 5.4) and whether there are complete exposure pathways associated with the media where COPCs have been identified (Section 5.3).

5.2 Contaminants of Potential Concern for Various Ecological Receptors

Screening for ecological COPCs has been conducted using the same approach as for human health. The list of Site contaminants was narrowed by comparing maximum concentrations of constituents for samples in different media to toxicity based screening criteria.

Table L provides a summary of the applicable environmental quality standards and guidelines, as well as background concentrations (where applicable), that were used as screening criteria. Detailed results of the COPC screening process are presented in Appendix E.

Table L: Summary of Ecological COPC Screening

Receptor	Media	Data Set Screened	Standards/guidelines applied in Order of Priority
Terrestrial Receptors			
Terrestrial Soil Invertebrate and Plants Communities	Soil	All soil samples collected throughout the uplands area except soil south of the proposed waterfront walkway in the Filled Intertidal area.	1. Protocol 4 and BC CSR Technical Guidance 17 2. BC CSR Schedule 5 – Toxicity to soil invertebrates and plants PL/RL standards 3. BC CSR Schedule 4/10 – PL/RL generic standards
Wildlife	Soil and Roche Point Creek Sediment	All soil samples collected throughout the uplands area as well as sediment samples collected within Roche Point Creek.	
	Roche Point Creek Surface Water	Modelled surface water concentrations using maximum groundwater concentrations with a dilution factor of 10.	1. BC Approved and Working Water Quality Guidelines (BCWQG) Wildlife Water Supply (WWS) 2. BC CSR Schedule 6 and Schedule 10 DW Standards 3. US EPA Region 9 Regional Screening Levels, Tap Water – non cancer
	Wildlife Food Items (plant and soil Invertebrate Tissue)	No tissue sampling results were available thus parameters were identified as COPCs if identified as a soil COPC.	Identified as a COPC in soil.
Freshwater Aquatic Receptors			
Roche Point Creek Benthic Aquatic Community	Roche Point Creek Sediment	All sediment samples collected from Roche Point Creek.	1. BC CSR Schedule 9 standards for typical freshwater Sites
Roche Point Creek Aquatic Community	Roche Point Creek Surface Water	Modelled surface water concentrations using maximum groundwater concentrations with a dilution factor of 10.	1. BCWQG FAL (Freshwater Aquatic Life)
Marine Aquatic Receptors			
Marine Benthic Aquatic Community	Marine Sediment	All sediment samples collected from the Marine Area (intertidal and sub-tidal).	1. BC CSR Schedule 9 standards for typical marine and estuarine Sites.

Receptor	Media	Data Set Screened	Standards/guidelines applied in Order of Priority
	Marine Pore Water[1]	Modelled pore water concentrations using maximum groundwater concentrations with a dilution factor of 10.	1. BC Approved and Working Water Quality Guidelines Marine Aquatic
Wildlife	Marine Sediment	All sediment samples collected from the intertidal zone of the Marine Area.	1. Protocol 4 and BC CSR Technical Guidance 17 2. BC CSR Schedule 5 – Toxicity to soil invertebrates and plants PL/RL standards 3. BC CSR Schedule 4/10 – PL/RL generic standards
	Food Item - Marine Aquatic Invertebrates	No tissue sampling results were available thus parameters were identified as COPCs if identified as a soil COPC.	Identified as a COPC in sediments.
	Food Item- Marine Aquatic Plants	No tissue sampling results were available thus parameters were identified as COPCs if identified as a soil COPC.	Identified as a COPC in sediments.

Notes: 1. Marine pore water has been assessed given the importance of the benthic community to general marine ecological health. Surface water has

Similar to Human Health COPC screening, the data set used to complete COPC screening for terrestrial soil invertebrates and plants and terrestrial wildlife included Site soils north of the proposed waterfront walkway only. Soil from south of the walkway was not included as it will be capped with a minimum of 1 meter of clean fill (whether used as fill in the uplands area or left as part of the Marine area). Additionally, the data set used to complete soil COPC screening for wildlife included sediment data from Roche Point Creek given that wildlife may be exposed to these sediments during creek crossings, or when creek levels are low.

COPC screening for surface water in Roche Point Creek and pore water in Burrard Inlet was completed using a data set where concentrations of surface water were modeled by applying a dilution factor of 10 to all Site groundwater data. This dilution factor was applied because the BC MOE has adopted such dilution/attenuation in the derivation of the BC CSR schedule 6 Standards. Further dilution for this groundwater when it reaches the creek and Inlet is likely, but not assumed, to be conservative.

The use of groundwater data to predict surface and marine pore water contaminant concentrations is a reasonable approach given that it is expected to be conservative. If a hazard is identified, with the concentrations from modelling, then additional data will be collected to increase confidence that appropriate parameters are being assessed. Section 6.0 further discusses this data gap.

With respect to food items for terrestrial and marine wildlife, parameters have been carried forward as COPCs if they were identified as COPCs in soil and sediment, respectively. No tissue data is available thus it is not possible to determine if these contaminants are truly present at measurable concentrations in food items in the Site area. This is considered a data gap for the HHERA (See Section 6.0). Further, wildlife food items that may be present in Roche Point Creek have not been considered as an exposure pathway. Sediments in Roche Point creek are not impacted and only one COPC was identified (ethylbenzene) for wildlife in surface water (see Table). Since ethylbenzene has a low bioaccumulation potential[3], it is unlikely to be present at measurable levels in Roche Point Creek wildlife food items (plants, benthic organisms or fish).

A summary of ecological COPCs is provided in Table M.

Table M: Summary of Preliminary Ecological COPCs

Parameter	Soil		Terrestrial Food Items	Roche Point Creek Surface Water		Marine Sediments		Marine Pore Water	Marine Food Items
	Soil Inverts and Plants	Terrestrial Wildlife	Terrestrial Wildlife	Aquatic Life	Terrestrial Wildlife	Benthic Aquatic Life	Wildlife	Benthic Aquatic Life	Wildlife
Extractable Petroleum Hydrocarbons (EPHs)									
EPH10-19	X	X	X						
EPH19-32	X	X	X				X		X
LEPH	X	X	X						
HEPH	X	X	X				X		X
Monocyclic Aromatic Hydrocarbons (MAHs)									
Ethylbenzene	X	X	X		X				
Xylenes	X	X	X						
VPH (C6-C10)	X	X	X						
Polycyclic Aromatic Hydrocarbons (PAHs)									
2-Methylnaphthalene						X			X
Acenaphthene				X		X		X	X
Acenaphthylene						X			X
Anthracene						X			X
Benzo(a)anthracene	X	X	X			X	X		X
Benzo(a)pyrene	X	X	X			X	X		X
Benzo(b)fluoranthene	X	X	X				X		X
Benzo(k)fluoranthene	X	X	X				X		X
Chrysene						X			
Dibenz(a,h)anthracene	X	X	X			X	X		X
Fluoranthene						X			
Fluorene						X			
Indeno(1,2,3-c,d)pyrene	X	X	X				X		X
Naphthalene	X	X	X	X		X		X	X
Phenanthrene	X	X	X			X	X		X
Pyrene	X	X	X			X	X		X
Metals									

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[3] US EPA Technical Fact Sheet on Ethylbenzene.
http://www.epa.gov/ogwdw/pdfs/factsheets/voc/tech/ethylben.pdf

Parameter	**Soil**		**Terrestrial Food Items**	**Roche Point Creek Surface Water**		**Marine Sediments**		**Marine Pore Water**	**Marine Food Items**
	Soil Inverts and Plants	**Terrestrial Wildlife**	**Terrestrial Wildlife**	**Aquatic Life**	**Terrestrial Wildlife**	**Benthic Aquatic Life**	**Wildlife**	**Benthic Aquatic Life**	**Wildlife**
Antimony	X	X	X				X		X
Arsenic	X	X	X			X	X		X
Cadmium	X	X	X	X		X	X	X	X
Calcium				X					
Chromium	X	X	X			X			
Copper				X		X	X	X	X
Iron				X					
Lead	X	X	X			X			
Mercury						X			
Molybdenum	X	X	X				X		X
Nickel	X	X	X						
Sodium	X	X	X				X		X
Tin	X	X	X						
Vanadium	X	X	X				X		X
Zinc	X	X	X			X	X		X
Organotins									
Tributyltin						X			
Volatile Organic Compounds (VOCs)									
Chloroform				X					
PCBs									
PCBs (Sum of total)						X			

Tributyltin (TBT) did not exceed any of the standards or guidelines used for marine sediment COPC screening, but has been carried forward as a COPC for marine benthos as it is a known toxicant and is highly bioaccumulative. However, we understand that TBT is a regional issue for Burrard Inlet and further research into the requirement to carry this contaminant forward as a COPC is warranted for the HHERA. Section 6.1.2 provides further information on the recommended approach for this issue.

In contrast, although sodium has been identified as a COPC, it is will not be carried forward for assessment in the HHERA. High levels of sodium are expected for this Site given its proximity to a marine aquatic environment, thus it is reasonable to assume that high levels of sodium are present in Site media as background and not as a result of historical activities.

Further refinement of ecological COPCs will likely be completed as part of the HHERA. Similar to the Human Health Preliminary Problem Formulation, an extensive number of COPCs have been identified at the Site and refining the number that will be quantitatively assessed in the HHERA will simplify and streamline the HHERA. The approach for COPC refinement will be conservative and ensure adequate protection of ecological receptors from all Site contaminants. It is further discussed in Section 6.1.2.

5.3 Ecological Receptor Exposure Pathway Analysis and Conceptual Site Model

As discussed above, potential ecological receptors for the Site include:

- Soil invertebrates and terrestrial plants;
- Birds (terrestrial and aquatic);
- Mammals (terrestrial and aquatic);
- Reptiles and amphibians;
- Freshwater and marine aquatic community groups; and
- Threatened, endangered and sensitive species (if present).

Table provides a qualitative analysis of all potential exposure pathways associated with each of the receptors listed above. Exposure pathways have been ranked as complete and significant, partially complete but insignificant or inoperable. Pathways ranked as complete and significant will be carried forward for assessment in the HHERA. Additionally as detailed in Table , some receptor groups will not be carried forward because there is considerable overlap with other groups, or they show limited Site use.

With respect to wildlife exposure pathways, the BC MOE Tier 1 Eco RA Policy Decision (BC MOE 2001) advises against quantifying soil and sediment risks to wildlife for dermal or inhalation exposures, therefore these pathways have not been considered as potential exposure pathways. Further, similar to the Human Health Preliminary Problem Formulation, exposure to marine surface water has not been considered as a potential exposure pathway given that contaminants in marine surface water are unlikely due to the amount of dilution and continuous flushing due to tidal action.

A CSM presenting potential exposure pathways between ecological receptors and soils, sediments, Roche Point Creek surface water, marine pore water and food items is presented in Figure 4.

Table N: Qualitative Ecological Receptors Exposure Pathway Analysis

Receptor Type	Receptor Category	Feeding Guild	Exposure Pathway		Carried Forward for Assessment?	Rationale
Terrestrial Soil Invertebrate and Plant Community	Soil Invertebrates and Plants	NA	Contact with soil	●	**Yes**	Contaminants in surface soil may accumulate in soil invertebrates and plants and cause adverse effects
			Contact with groundwater	X		
			Contact with surface water	X		
	Deep Rooting Plants	NA	Contact with soil	●	No	Contamination from all depths is being assessed with respect to soil invertebrates and plants. Site groundwater contamination limited to discrete areas
			Contact with groundwater	●		
			Contact with surface water	X		
Terrestrial Wildlife	Birds	Invertivore	Incidental soil ingestion	●	**Yes**	Soil contamination may accumulate in soil invertebrates which may cause adverse effects to this feeding guild.
			Groundwater ingestion	X		
			Surface water ingestion	●		
			Food item ingestion (soil invertebrates)	●		
		Grainivore	Incidental soil ingestion	●	**Yes**	Soil contamination may accumulate in plants which may cause adverse effects to this feeding guild.
			Groundwater ingestion	X		
			Surface water ingestion	●		
			Food item ingestion (plants)	●		
		Omnivore	Incidental soil ingestion	●	No	This feeding guild has considerable overlap with other feeding guilds. Invertivore and grainivore feeding guilds are likely protective of this group.
			Groundwater ingestion	X		
			Surface water ingestion	●		
			Food item ingestion (invertebrates & plants)	●		
		Carnivore	Incidental soil ingestion	●	No	Raptors generally have large home ranges, thus Site specific ingestion rate will be low given the limited size of the Site.
			Groundwater ingestion	X		
			Surface water ingestion	●		
			Food item ingestion (small prey)	●		

Receptor Type	Receptor Category	Feeding Guild	Exposure Pathway		Carried Forward for Assessment?	Rationale
Terrestrial Wildlife	Small Mammals	Invertivore	Incidental soil ingestion	•	**Yes**	Soil contamination may accumulate in soil invertebrates which may cause adverse effects to this feeding guild.
			Groundwater ingestion	X		
			Surface water ingestion	•		
			Food item ingestion (soil invertebrates)	•		
		Grainivore	Incidental soil ingestion	•	**Yes**	Soil contamination may accumulate in plants which may cause adverse effects to this feeding guild.
			Groundwater ingestion	X		
			Surface water ingestion	•		
			Food item ingestion (plants)	•		
		Omnivore	Incidental soil ingestion	•	No	This feeding guild has considerable overlap with other feeding guilds. Assessment of invertivore and grainivore feeding guilds is protective of this group.
			Groundwater ingestion	X		
			Surface water ingestion	•		
			Food item ingestion (invertebrates & plants)	•		
		Carnivore	Incidental soil ingestion	•	No	Carnivorous small mammals assessed as invertivores as invertebrates are more likely to be impacted compared to more mobile food sources eaten by larger carnivores.
			Groundwater ingestion	X		
			Surface water ingestion	•		
			Food item ingestion (small prey)	•		
	Large Mammals	Herbivore	Incidental soil ingestion	•	No	Site use by large mammals will be low given the urban setting. Additionally, they generally have large home ranges thus will source a large portion of their food items from areas other than the Site. Assessment of small mammals is a therefore protective of this group.
			Groundwater ingestion	X		
			Surface water ingestion	•		
			Food item ingestion (plants)	•		
		Carnivore	Incidental soil ingestion	•	No	
			Groundwater ingestion	X		
			Surface water ingestion	•		
			Food item ingestion (plants)	•		

Receptor Type	Receptor Category	Feeding Guild	Exposure Pathway		Carried Forward for Assessment?	Rationale
Terrestrial Wildlife	Amphibians and Reptiles	Herbivore/ Invertivore	Incidental soil ingestion	●	No	Receptor group has considerable overlap with mammals; therefore assessing mammals is a suitable surrogate.
			Groundwater ingestion	X		
			Surface water ingestion	●		
			Food item ingestion (plants)	●		
Freshwater Aquatic Groups	Roche Point Freshwater Benthos		Contact with Roche Point Creek Sediment	●	**Yes**	Based on modelled surface water concentrations, pore water in Roche Point creek may be impacted.
			Contact with Roche Point Creek Pore water	●		
	Freshwater Aquatic Life		Contact with surface water	●	No	Impacted surface water due to Site contamination is unlikely given dilution and continuous flushing.
			Ingestion of food items	●		
Marine Aquatic Groups	Marine Benthos		Contact with Marine Sediment	●	**Yes**	Marine sediments show considerable impacts and based on modelled pore water concentrations,
			Contact with Marine Pore water	●		
	Marine Aquatic Life		Contact with marine surface water	●	No	Impacts in surface water due to Site contamination are unlikely given dilution and continuous flushing.
			Food item ingestion	●		
Marine Aquatic Wildlife	Shore and Waterfowl	Herbivore	Incidental sediment ingestion	●	No	Assessment of omnivore is a suitable surrogate for both feeding guilds.
			Ingestion of food items (aquatic plants)	●		
			Ingestion of surface water	●		
		Invertivore	Incidental sediment ingestion	●	No	
			Ingestion of food items (benthos)	●		
			Ingestion of surface water	●		
		Omnivore	Incidental sediment ingestion	●	**Yes**	Sediment contamination may accumulate in marine bethos and plants which may cause adverse effects to this feeding guild.
			Ingestion of food items (benthos and plants)	●		
			Ingestion of surface water	●		
		Piscivore	Incidental sediment ingestion	□	No	Fish are unlikely to show impacts due to Site contamination and incidental sediment ingestion rate for this group is low. Omnivores are a conservative surrogate.
			Ingestion of food items (fish)	●		
			Ingestion of surface water	●		

Receptor Type	Receptor Category	Feeding Guild	Exposure Pathway		Carried Forward for Assessment?	Rationale
Marine Aquatic Wildlife	Small Aquatic Mammals	Invertivore	Incidental sediment ingestion	●	**Yes**	May be impacted due to ingestion of Site benthos.
			Ingestion of food items (benthos)	●		
			Ingestion of surface water	●		
		Herbivore	Incidental sediment ingestion	●	No	Very few aquatic mammals are herbivorous. They are unlikely to be present in the area of the Site.
			Ingestion of food items (benthos and plants)	●		
			Ingestion of surface water	●		
		Piscivore	Incidental sediment ingestion	○	No	Fish are unlikely to show impacts due to Site contamination therefore assessment and incidental sediment ingestion rate is low. Invertivores are a conservative surrogate.
			Ingestion of food items (fish)	●		
			Ingestion of surface water	●		
	Large Aquatic Mammals	Herbivores, Carnivores and Omnivores	Incidental sediment ingestion	●	N o	Generally have large home ranges and may feed outside the area of the Site. Assessment of small mammals considered a conservative surrogate.
			Ingestion of food items (fish)	●		
			Ingestion of surface water	●		

Notes:

- ● Complete and Significant
- ○ Partially Complete but Insignificant
- X Inoperable

Exposure pathways considered to be partially complete but insignificant, or inoperable will not be quantitatively assessed in the HHERA for reasons discussed below.

5.3.1 Soil Invertebrates and Plants

- Exposure to groundwater and surface water is considered inoperable as these organisms do not live within surface water bodies or at depths where groundwater exists.

5.3.2 Deep Rooting Plants

- Exposure to surface water is considered inoperable as these organisms do not live within surface water bodies.

5.3.3 Terrestrial Wildlife

- Exposure to groundwater is considered inoperable as it is below ground surface. No daylighting of groundwater has been observed on the Site and burrowing animals are unlikely to burrow to depths below the groundwater table.

5.3.4 Piscivorous Aquatic Wildlife

- Exposure to sediments is considered partially complete but insignificant. Since their prey generally exists within the water column, incidental ingestion of sediments during feeding is minimal.

5.4 Ecological Receptor Refinement

Based on the qualitative exposure pathway analysis, the HHERA will address:

- Soil invertebrates and plants;
- Aquatic groups;
- Terrestrial and aquatic wildlife.

Since it is difficult to evaluate risk to every ecological receptor that may encounter the Site, receptor refinement has been conducted. Refinement has only been conducted for wildlife receptors, as soil invertebrates and plants and aquatic groups will be assessed as a community in the HHERA.

Receptor refinement involves selecting surrogate species for evaluation. Surrogates were chosen to represent reasonable worst-case exposure scenarios (i.e. have the greatest amount of exposure), to ensure that risk is not underestimated, to represent a range of body sizes, and based on likelihood of presence at the Site. For further protectiveness, species at risk identified for the area (see Section 2.9) were chosen where appropriate. Table details the wildlife surrogate species chosen for assessment in the HHERA.

Table O: Wildlife Surrogate Species Chosen for Quantitative Assessment of Risk

Wildlife Surrogate Species	Receptor Category	Feeding Guild	Reason for Inclusion
American Robin (Turdus migratorius)	Terrestrial Bird	Invertivore /Omnivore	• Ground foraging species, therefore potential exposure to COPCs is high • Good species to assess invertivore diet feeding guild as invertebrates compose high portion of diet • Some individuals may not migrate, meaning potential exposure to COPCs is high • Reliable reference for species characteristics available
Band-tailed Pigeon (*Patagioenas fasciata*)	Terrestrial Bird	Grainivore	• Blue listed species • May not migrate, meaning potential for exposure to COPCs is high • Observation records indicate presence at nearby Maplewood Conservation Area[4] • Diet is 98% vegetarian (buds, flowers, nuts, seeds, grain and berries) thus good species to assess grainivore feeding guild
Pacific Water Shrew (*Sorex bendirii*)	Terrestrial Small Mammal	Invertivore	• Red-listed species • Reasonable potential for presence on the Site once riparian area habitat is enhanced • Reliable reference for species characteristics available • Small home range meaning potential for exposure to COPCs is high
Southern Red-backed Vole (*Myodes gapperi*)	Terrestrial Small Mammal	Grainivore	• Yellow listed species • Reasonable potential for presence on the Site once riparian area habitat is enhanced • Small home range meaning potential for exposure to COPCs is high • Feeds chiefly on vegetation, seeds, nuts, fungi thus good species to asses grainivore diet
Mallard (*Anas platyrhynchos*)	Aquatic Bird	Omnivore	• Feeds on both aquatic plants and invertebrates • Reliable reference for species characteristics available • May not migrate, meaning potential for exposure to COPCs is high
Mink (*Mustala vison*)	Aquatic Small Mammal	Piscivore/ Invertivore	• Medium sized home range meaning potential for exposure to COPCs is moderate • Significant portion of diet comprised of benthic invertebrates • Incidental sediment ingestion rate is high • Active year round

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[4] E-Fauna BC: Electronic Atlas of the Wildlife of British Columbia

5.5 Assessment and Measurement Endpoints and Effect Levels

Assessment endpoints are biological aspects of receptors of concern such as population abundance, community diversity, or health of individual specimens. Measurement endpoints are more specific quantifiable biological aspects that are relevant to the assessment endpoints. Ecological risk assessments evaluate whether or not such assessment endpoints are being adversely affected by Site COPCs using measurement endpoints.

The assessment and measurement endpoints that will be utilized in the HHERA are listed in Table .

Table P: Assessment and Measurement Endpoints and Effects Levels

Measurement Receptor	Assessment Endpoint	Measurement Endpoint	Effect Level
Terrestrial Soil Invertebrate and Plant Community	Richness and Abundance	Concentrations in soil relative to published effects threshold values.	Compare calculated hazard quotients (HQs) to threshold values and quantify effect level as follows: • HQ≤1 indicates negligible effects • HQ≥1 indicates potential effects
Terrestrial and Aquatic Birds and Mammals	Health of Wildlife	Estimated exposure dose (EED) for maximally exposed individuals relative to published or derived toxicity reference values (TRVs). EED is cumulative dose from all applicable exposure pathways.	Compare calculated HQs to threshold values and quantify effect level as follows: • HQ≤1 indicates negligible effects • HQ≥1 indicates potential effects
Freshwater and Marine Benthic Communities	Richness and Abundance	Concentrations in sediment relative to published effects threshold values.	Compare calculated HQs to threshold values and quantify effect level as follows: • HQ≤1 indicates negligible effects • HQ≥1 indicates potential effects
	Larval Development, Growth and Survival	Toxicity testing results (marine benthos only) where larval development of *Mytilus galloprovincialis*, grow and survival of *Neanthes arenaceodentata*and, survival of *Eohaustrorius estuaries* are determined after exposure to marine sediments.	Compare toxicity testing results to thresholds where: • ≤20% reduction in growth or survival relative to uncontaminated conditions indicates negligible effects. • ≥20% reduction in growth or survival relative to uncontaminated conditions indicates potential effects

With respect to marine benthos, the three toxicity tests selected were chosen as they reflect suitable taxonomic groups and consider both lethal and sub-lethal endpoints. The tests organisms are considered suitable as they that are readily in contact with sediment, are tolerant to a broad range of sediment physic-chemical characteristics (i.e. grain size) are ecologically important and are indigenous to the Site and surrounding area. The endpoints assessed are important as all three are critical to long-term sustainability of populations. Since chemicals can act directly or indirectly on reproductive endpoints (e.g., endocrine disrupting compounds) comprehensive reproductive toxicity tests are critical. Sub-lethal endpoints in sediment tests have also been shown to provide better estimates of responses of benthic communities to contaminants in the field (Hayward 2002).

Results of toxicity testing will be weighted more heavily compared to HQ results when evaluating potential risks for this receptor group (if individual toxicity test results are considered acceptable[5]). The process for calculating HQs is conservative and does not consider the influence that Site specific characteristics may have on contaminant toxicity (i.e. metals solubility), thus in general it overestimates true risk. Toxicity testing results are a better representation of actual toxicity as Site specific characteristics are represented in each of the tests.

6.0 RECOMMENDATIONS TO SUPPORT COMPLETION OF THE HHERA

6.1.1 Summary of Data Gaps

Various data gaps have been identified throughout the Preliminary Problem Formulation. Table summarizes the identified data gaps and details management strategies to address them.

Table Q: Summary of Data Gaps and Options for Management

Data Gap #		Potential Effect on Risk Assessment Results	Management Strategy
#	**Description**		
1	Inadequate Roche Point Creek Surface Water Data.	Creek / porewater conditions not accurately represented by modelled data. Modelled data overestimates actual contaminant concentrations given the conservative dilution that was assumed. This will likely result in an overestimation of true risk.	If hazard is identified with conservative screening using 10 times dilution, collect a surface water sample from the Creek. Location chosen should be adjacent to or slightly down stream of areas where impacted groundwater may be reaching the creek at low tide to minimize dilution.
2	Inadequate Burrard Inlet porewater data.		Re-assessment of pore-water COPCs using dataset modelled from most down-gradient wells on the Site only (current modelled data set considers all Site wells). Groundwater from these wells best represents conditions that may be reaching the marine area.
			Collection of porewater samples from intertidal zone at locations where impacted groundwater may be reaching the marine environment. Analyze porewater for parameters that were considered COPCs through use of modelled groundwater in screening process (PAHs and metals).

---

[5] Results of individual toxicity test will only be considered acceptable for use in assessing risk to benthic organisms if the responses in the negative control group are within acceptable limits and adequate environmental conditions are maintained in the test chambers during the testing.

Data Gap #		Potential Effect on Risk Assessment Results	Management Strategy
#	**Description**		
3	Lack of analytical data for total metals in surface and/or groundwater.	Affects COPC screening for Roche Point Creek surface water and Burrard Inlet porewater where various metal COPCs may be overlooked.	Collection of total metals data from Roche Point Creek (See Data Gap #1). Collection of total metals data from most down-gradient wells onsite that are also down-gradient of AECs which show exceedences of marine aquatic life CSR standards for dissolved metals. Re-assess potential pore water COPCs using this data only.
4	Lack of tissue data for terrestrial and marine invertebrate and plant food items	COPC screening for food items based on presence of contaminant in soil or sediment resulting in an over estimation of true food item COPCs. Also, modelled tissue concentrations are conservative thus overestimated which impacts EECs.	Collection and analysis of terrestrial and marine invertebrate and/or plant samples. Tissue samples can be modelled, however collection of some tissues may be recommended if ingestion of food item tissues is contributing significantly to the overall EEC for humans and wildlife.

6.1.2 Further Work to Support Completion of HHERA

Preliminary COPC screening has identified numerous human health and ecological COPCs at the Site. Work to reduce the number of COPCs that will require quantitative assessment of risk (if possible) is recommended to simplify and streamline the HHERA. Various options for COPC refinement include:

- Completing the COPC screening using a datasets that represents onsite conditions following Site development and completion of any planned remedial works. As indicated in Section 1.1, this problem formulation did not consider removal of soils, sediments and/or groundwater that is required for Site development or removal that may occur through planned remedial activities[6]. COPC screening using an updated and representative dataset is imperative as the developmental and remedial activities may eliminate various COPCs, changes the depths of COPCs and/or result in the ability to use less stringent attenuation factors for vapours on the Site;
- Focusing on groups of COPCs rather than individuals;
- Focusing on substances that have the greatest relative toxicity and the largest spatial distribution on the Site; and/or
- Assessing only bioaccumulative substances (Ecological RA only).

---

[6] A preliminary remedial plan has been developed for the Site (see PGL's DSI report). This plan recommends removal of soils that show the greatest environmental risks including:

- All hazardous waste soils;
- Soils in the fill zone southeast of the Site (AEC 5) where groundwater PAHs exceed applicable standards; and
- Soils east of the Noble Towing building where groundwater concentrations of PAH exceed applicable standards (AEC 1-3).

Further, although TBT has been carried forward for assessment given it is a known toxicant to marine benthos and it is highly bioaccumulative, we understand that TBT contamination is a regional issue for Burrard Inlet. Since its presence is likely not isolated to the Site, research into the requirement to carry this contaminant forward as a COPC is warranted for the HHERA. Research could involve collecting and analyzing offsite reference samples and/or seeking advice from regulatory agencies such as the Vancouver Port Authority or Fisheries and Oceans Canada.

7.0 RISK MANAGEMENT RECOMMENDATIONS

Conceptually, given the fact that groundwater is largely unaffected at the Site, most of the risk management measures that are required can be identified without detailed evaluation. Measures include removing impacted media or ensuring that exposure pathways are incomplete by:

- Removal of soil where groundwater effects are not bounded (i.e., the fill area south of Cates Park);
- Removal of hazardous waste from the fill zone on the Noble Towing site;
- Capping of contamination managed in place with hard surfaces or at least 1m of clean fill; and/or
- For unacceptable risks identified for utility/trenchworkers only, provide recommendations related to the use of appropriate personal protective equipment (PPE) while working on the Site.

Intertidal and subtidal sediments that exceed the applicable standard for that media will however rely substantially on Risk Based Remedial Goals (RBRGs). RBRGs are the maximum contaminant concentration a receptor may be exposed to without showing unacceptable risk. RBRGs for sediment will be estimated based on the two lines of evidence which are sediment toxicity testing and HQs (the measurement endpoints for sediment discussed in Section 5.5)Any sediments that contain contaminant concentrations in excess of the established RBRGs will be risk managed as discussed in Section 7.1.1, below.

7.1.1 Establishment of Sediment Risk Based Remediation Goals

Although humans and ecological receptors may be exposed to contaminants in marine sediments, risk management of this media will likely focus on ecological receptors given they have much higher exposure rates and are therefore more likely to be adversely effected. This will be confirmed by establishing RBRGs for both receptor types. Management will be focused on the most stringent of the established human health and ecological RBRGs.

To establish human health based RBRGs, the equation used to calculate HQs will be used where the HQ/HI will be set as 1.0 or the ILCR will be set at 1X10-5 (highest value where risk is still acceptable). Then by inputting the receptor information and TRV used to assess human risks the maximum contaminant concentration where acceptable risks is the result (RBRG) will be determined.

Ecological RBRGs will be based on toxicity testing results. As indicated above in Section 5.5, although HQs will be established for sediment benthos, toxicity testing results will be weighted more heavily with respect to assessing toxicity as they better represent Site conditions (i.e., more Site specific). Ecological RBRGs will be the highest contaminant concentration in sediment that meets the measurement endpoints of ≤20% reduction in reproduction, growth and survival (i.e., the highest contaminant concentration where all toxicity testing results meet the acceptable effects level).

7.1.2 Risk Management Options for Sediments

Risk management of sediment with contaminant levels in excess of the established RBRGs will be completed through capping (an option that is available based on the information that this area is subject to sediment deposition) or dredging. Additionally, special management options will be developed for high value habitat that cannot reasonably be capped or dredged.

8.0 CONCLUSIONS

The Conceptual Site Model indicates that in the absence of volatiles exceeding applicable standards and removal of any unbounded groundwater effects by excavation, that the risk for the Site can be addressed by:

- Capping by hard surfaces or at least 1m of clean fill for terrestrial residual contaminated areas; and
- Removal or capping of exposed intertidal or subtidal sediments based on RBRGs founded in toxicity testing and other available information to eliminate this exposure pathway.

Based on available information, remediation of the Site to meet applicable standards is conceptually reasonable.

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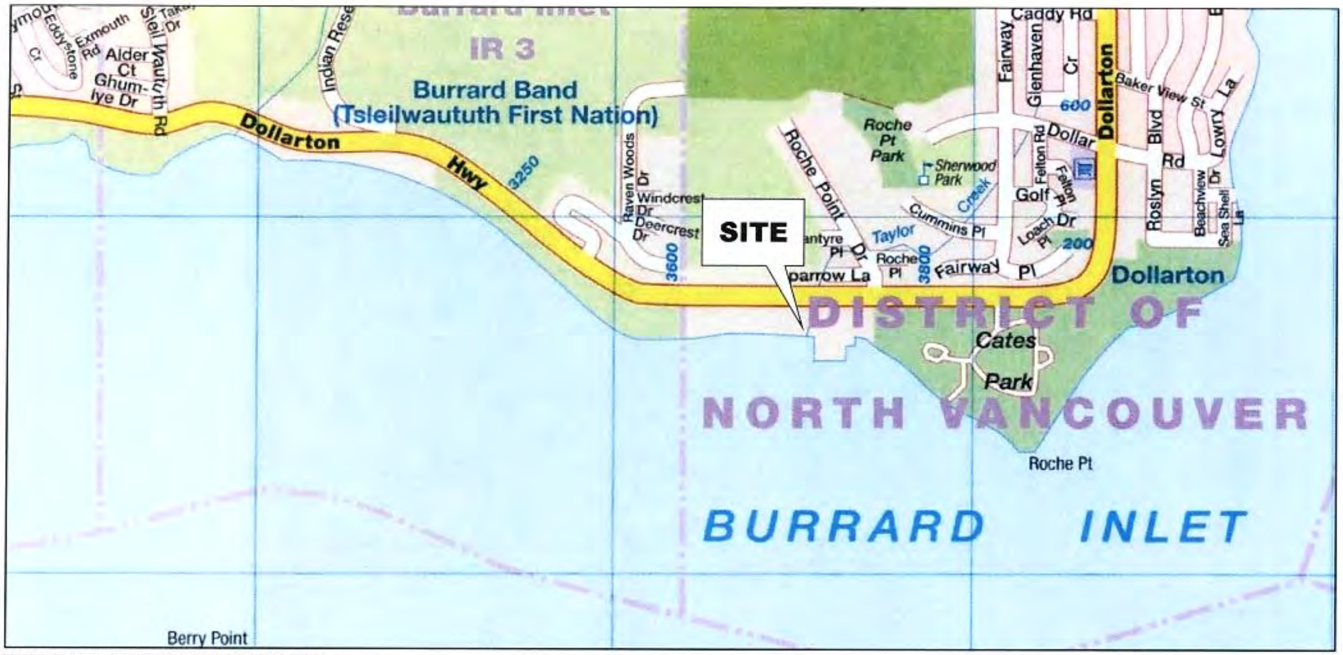

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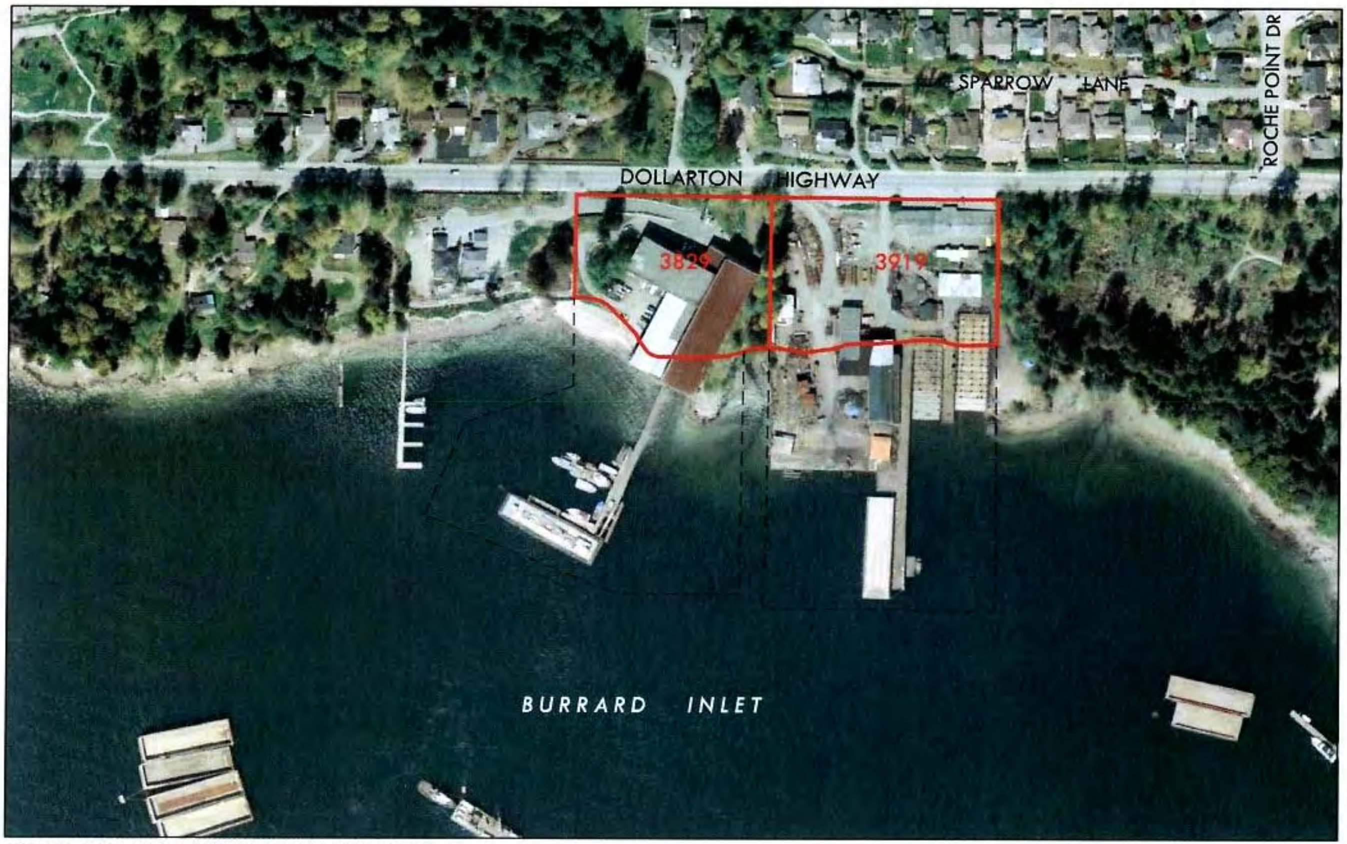

2009 image obtained through the District of Vancouver's open data catalogue.

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ENVIRONMENTAL CONSULTANTS

SITE LOCATION

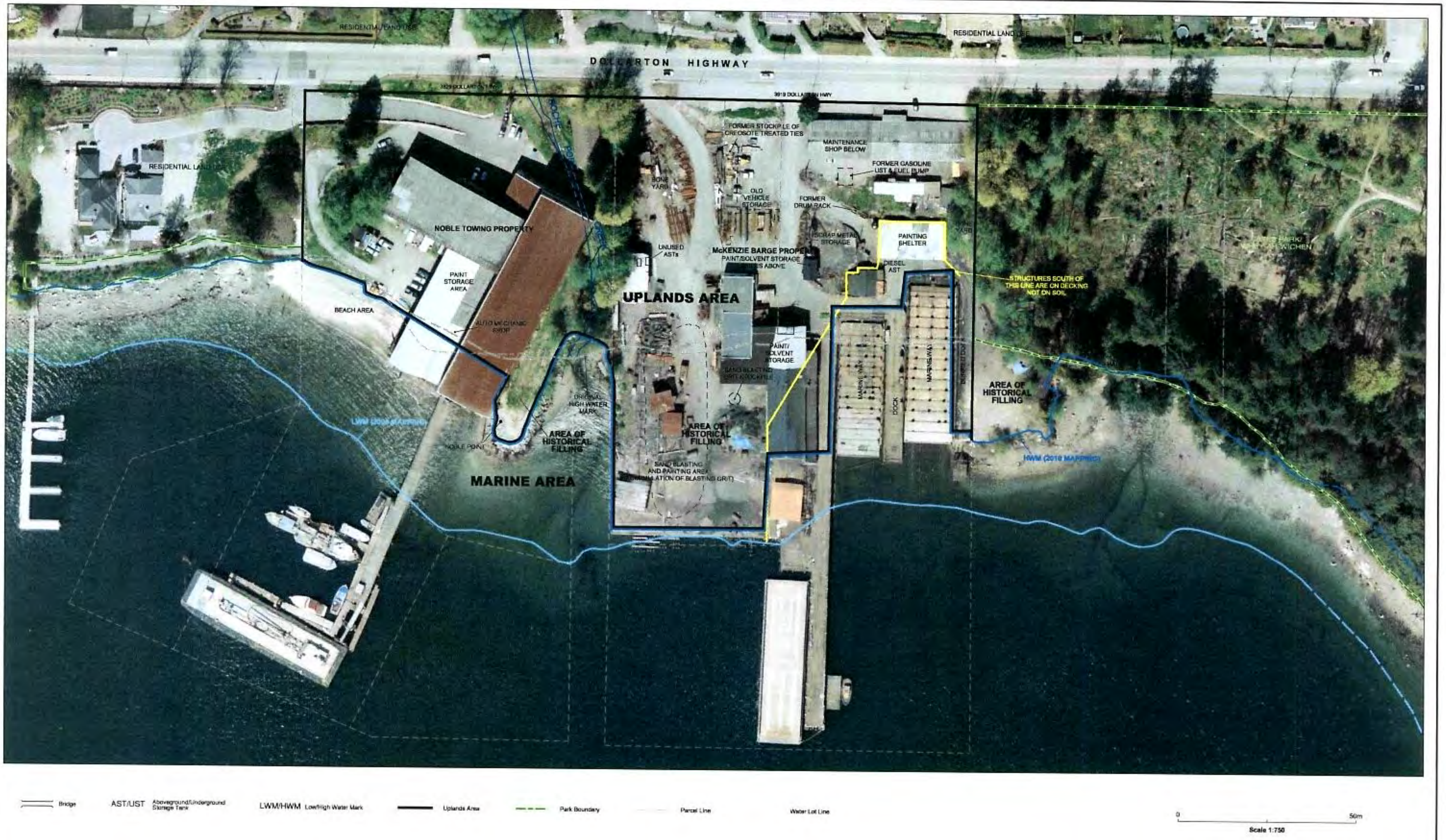
3829 & 3919 Dollarton Highway, District of North Vancouver, BC

File No.: 1543-09.03
Date: OCT 2013
Dwg No.: RA_F1.1
Drawn by.: IRB

N

FIGURE 1

ORIGINAL IN COLOUR



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3829 & 3919 Dollarton Highway, District of North Vancouver, BC

Polygon Development 270 Ltd.

File No.: 1543-09.03
Date: OCT 2013
Dwg No.: RA_2.1
Drawn by: IRB

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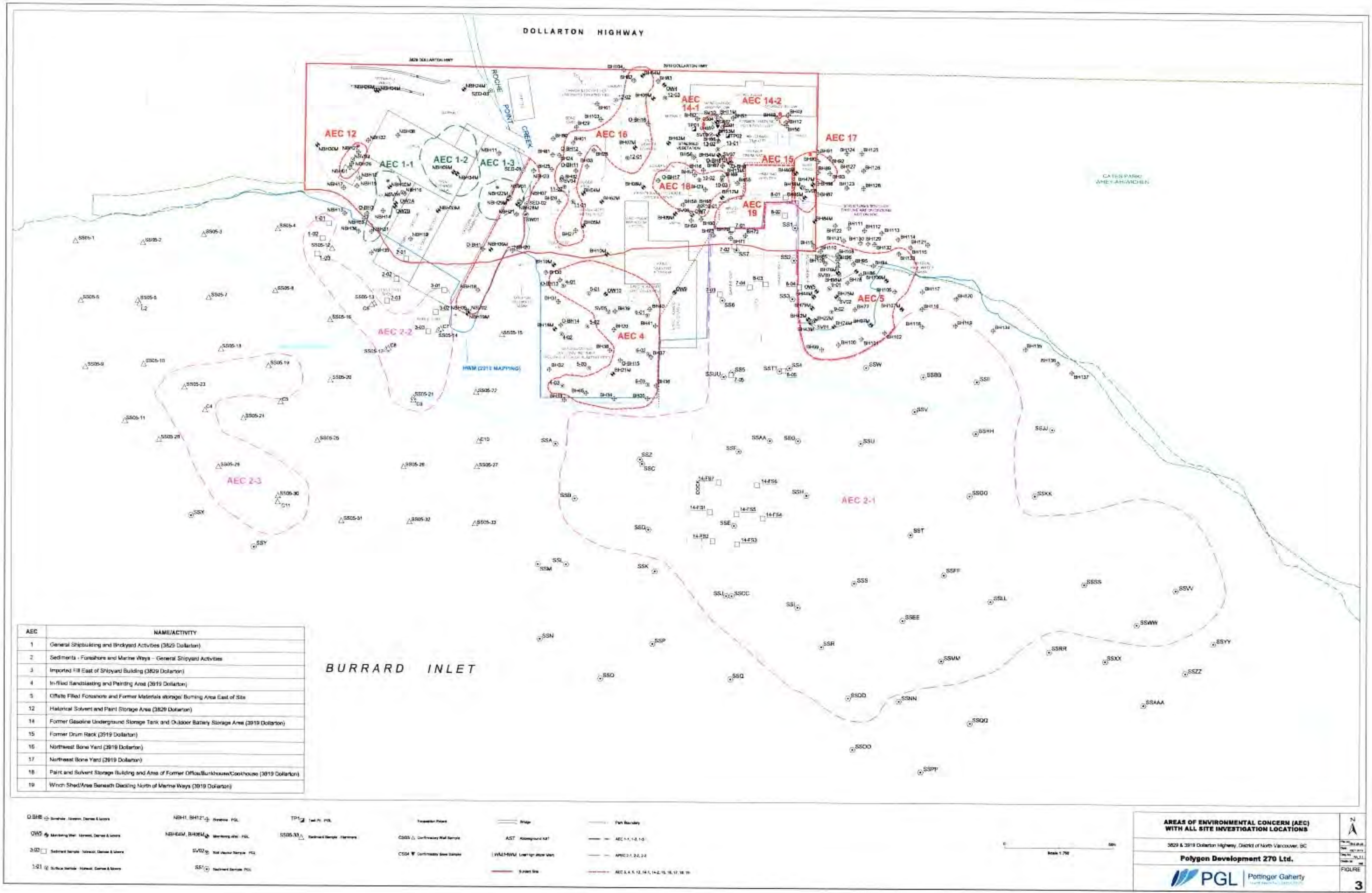
SITE PLAN

FIGURE 2

ORIGINAL IN COLOUR



AEC	NAME/ACTIVITY
1	General Shipbuilding and Brickyard Activities (3829 Dollarton)
2	Sediments - Foreshore and Marine Ways – General Shipyard Activities
3	Imported Fill East of Shipyard Building (3829 Dollarton)
4	In-filled Sandblasting and Painting Area (3919 Dollarton)
5	Offsite Filled Foreshore and Former Materials storage/ Burning Area East of Site
12	Historical Solvent and Paint Storage Area (3829 Dollarton)
14	Former Gasoline Underground Storage Tank and Outdoor Battery Storage Area (3919 Dollarton)
15	Former Drum Rack (3919 Dollarton)
16	Northwest Bone Yard (3919 Dollarton)
17	Northeast Bone Yard (3919 Dollarton)
18	Paint and Solvent Storage Building and Area of Former Office/Bunkhouse/Cookhouse (3919 Dollarton)
19	Winch Shed/Area Beneath Decking North of Marine Ways (3919 Dollarton)

AREAS OF ENVIRONMENTAL CONCERN (AEC)
WITH ALL SITE INVESTIGATION LOCATIONS

3829 & 3919 Dollarton Highway, District of North Vancouver, BC

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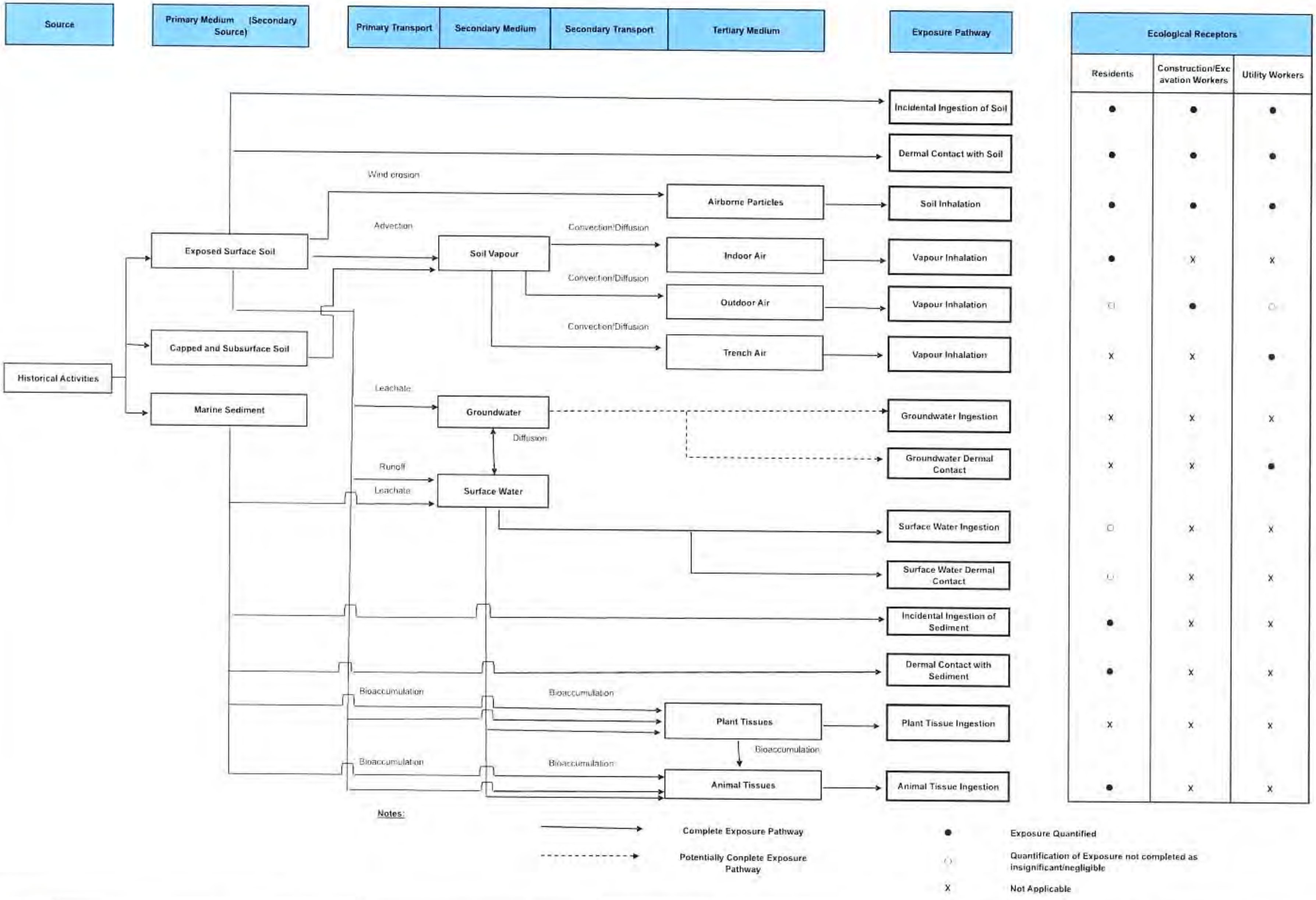
FIGURE
3



Exposure Pathway	Ecological Receptors		
	Residents	Construction/Excavation Workers	Utility Workers
Incidental Ingestion of Soil	●	●	●
Dermal Contact with Soil	●	●	●
Soil Inhalation	●	●	●
Vapour Inhalation	●	X	X
Vapour Inhalation	○	●	○
Vapour Inhalation	X	X	●
Groundwater Ingestion	X	X	X
Groundwater Dermal Contact	X	X	●
Surface Water Ingestion	○	X	X
Surface Water Dermal Contact	○	X	X
Incidental Ingestion of Sediment	●	X	X
Dermal Contact with Sediment	●	X	X
Plant Tissue Ingestion	X	X	X
Animal Tissue Ingestion	●	X	X

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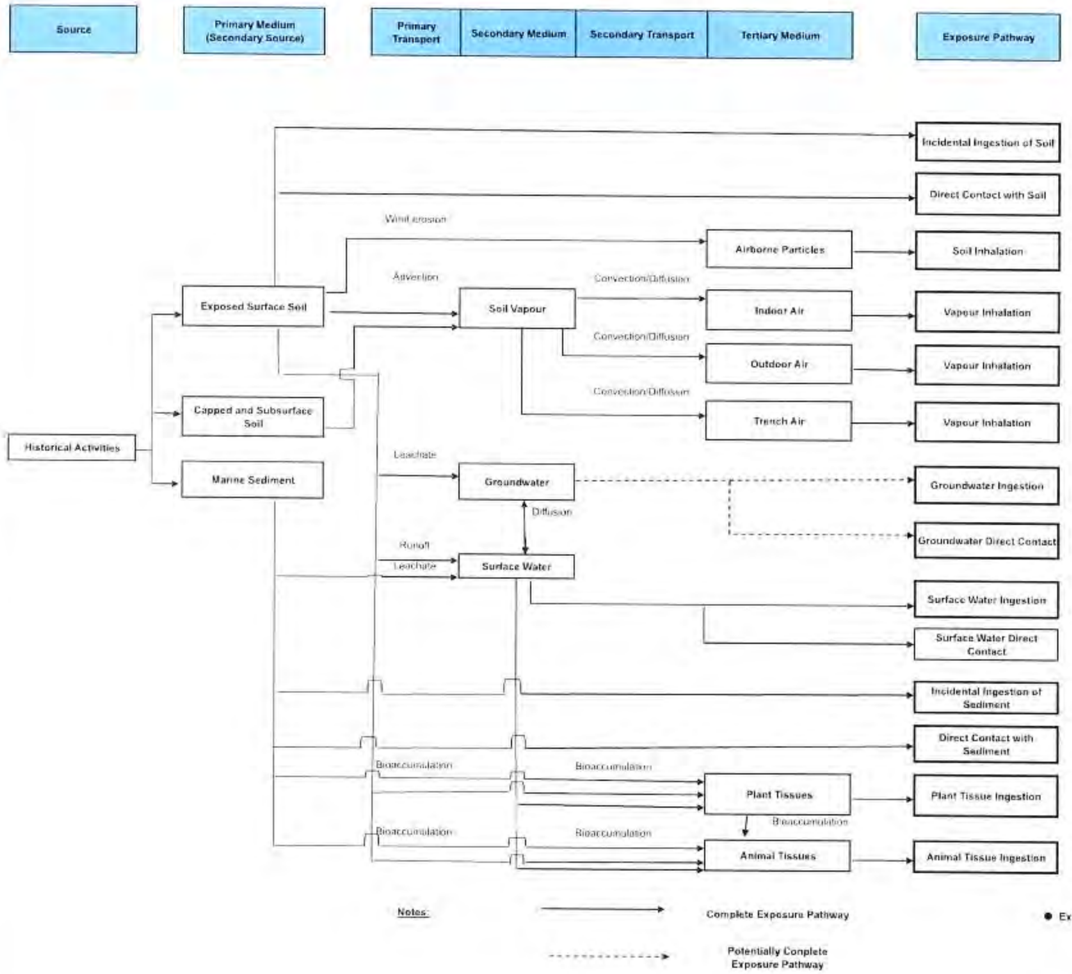
CONCEPTUAL SITE MODEL - HUMAN HEALTH

3829 & 3919 Dollarton Highway, District of North Vancouver, BC

File No.: 1543-09.03
Date: OCT 2013
Dwg.: 15430903_F4.1
Drawn by: IRB

FIGURE
4



Exposure Pathway	Ecological Receptors								
	Soil Invertebrates and plants	Roche Point Creek Benthos	Marine Benthos	Terrestrial Bird		Terrestrial Mammal		Marine Bird	Marine Mammal
				Invertevore	Grainivore	Invertevore	Grainivore	Omnivore	Invertivore
Incidental Ingestion of Soil	x	x	x	●	●	●	●	□	□
Direct Contact with Soil	●	x	x	x	x	x	x	x	x
Soil Inhalation	x	x	x	□	□	□	□	□	□
Vapour Inhalation	x	x	x	x	x	x	x	x	x
Vapour Inhalation	x	x	x	x	x	x	x	x	x
Vapour Inhalation	x	x	x	x	x	x	x	x	x
Groundwater Ingestion	x	x	x	x	x	x	x	x	x
Groundwater Direct Contact	□	x	x	x	x	x	x	x	x
Surface Water Ingestion	x	x	x	●	●	●	●	●	●
Surface Water Direct Contact	x	□	□	x	x	x	x	x	x
Incidental Ingestion of Sediment	x	x	x	□	□	□	□	●	●
Direct Contact with Sediment	x	●	●	x	x	x	x	x	x
Plant Tissue Ingestion	x	x	x	x	●	x	●	●	●
Animal Tissue Ingestion	x	x	x	●	x	●	x	●	●

● Exposure Quantified

□ Quantification of exposure not completed as insignificantinegligible

x Not Applicable

Polygon Development 270 Ltd.

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CONCEPTUAL SITE MODEL - ECOLOGICAL

3829 & 3919 Dollarton Highway, District of North Vancouver, BC

File No.:	1543-09.03
Date:	OCT 2013
Dwg:	15430903_F5.1
Drawn by:	IRB

FIGURE

5

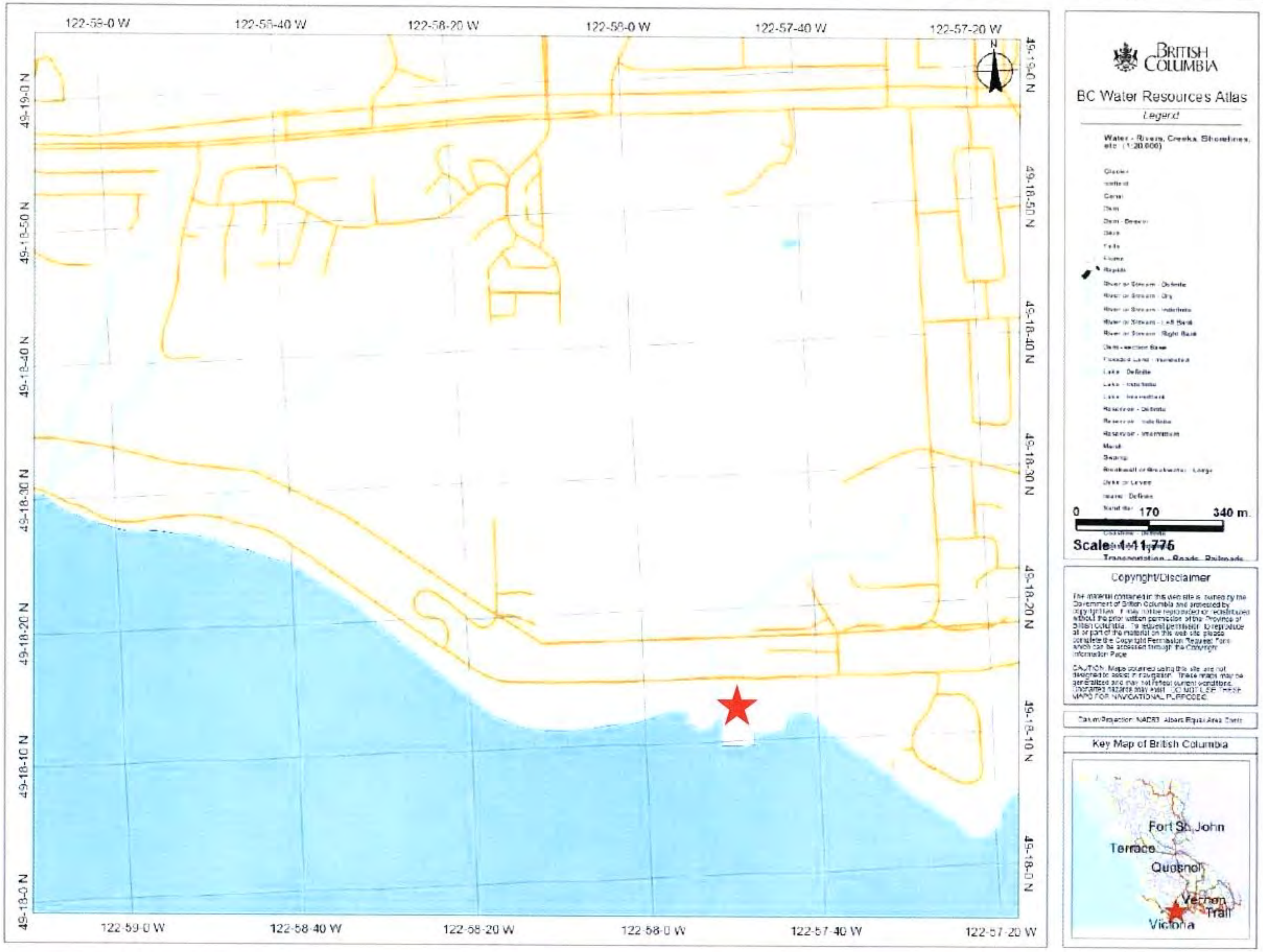
Appendix 1

Water Resource Atlas

PGL

BC Water Resources Atlas
Water Well Search Results

★ = the Site



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Datum/Projection: NAD83, Albers Equal Area Conic

Appendix 2

Ecosystem Explorer

BC Species and Ecosytem Explorer Search Results for Metro Vancouver District

English Name	Scientific Name	BC List	SARA	Potential for Occurrence on the Site
Northern Gohawk	*Accipiter gentilis laingi*	Red	1-T (2003)	**Low**. Prefer extensive forests with large stands of mature trees and dense canopies, but with an open understory. Site does not currently and will not have large stand of mature trees following redevelopment.
Green Sturgeon	*Acipenser medirostris*	Red	1-SC	**Plausible**. Habitat types include eelgrass beds, intertidal marine and subtidal marine and the occurrence status for North Vancouver District is detailed as "confident or certain".
Western Pond Turtle	*Actinemys marmorata*	Red	1-X	**Low**. The occurrence status for the Coastal Western Hemlock bioclimatic zone is detailed as "presumed extirpated".
Oregon Forestsnail	*Allogona townsendiana*	Red	1-E	**Plausible**. Habitat preference is mixed wood and deciduous forests and the occurrence status for Metro Vancouver is detailed as "confident or certain".
Western Toad	*Anaxyrus boreas*	Blue	1-SC	**Low**. Occurs in a wide variety of habitats including various upland habitats.
Mountain Beaver	*Aplodontia rufa rainieri*	Blue	1-SC	**Plausible**. Occurs in a wide variety of habitats including riparian/riparian forests and the occurrence status for Metro Vancouver is detailed as "confident or certain".
Great Blue Heron	*Ardea herodias fannini*	Blue	1-SC	**Plausible**. May nest in park north of Site (prefers isolation from disturbance) and feed in aquatic area of Site. In general, feeding areas are within 5 kms of nesting site. The occurrence status for Metro Vancouver is detailed as "confident or certain".
Emma's Dancer	*Argia emma*	Blue		**Plausible**. Habitat preferences are; along rivers, creeks and sometimes wave-washed lake beaches and the occurrence status for Metro Vancouver is detailed as "confident or certain".
Coastal Tailed Frog	*Ascaphus truei*	Blue	1-SC	**Low**. Habitat preferences are clear, cold swift-moving mountain streams and primarily in older forest sites.
Short-eared Owl	*Asio flammeus*	Blue	1-SC	**Low**. Prefers broad expanses of open land with low vegetation for nesting and foraging.
American Bittern	*Botaurus lentiginosus*	Blue		**Low**. Prefers large freshwater and (less often) brackish marshes, including lake and pond edges.
Marbled Murrelet	*Brachyramphus marmoratus*	Blue	1-T	**Plausible**. Habitat preferences are coastal areas, mainly in salt water within 2 km of shore including bays and sounds and the occurrence status for Metro Vancouver is detailed as "confident or certain".

Rough-legged Hawk	*Buteo lagopus*	Blue		**Plausible**. Occurrence status for Metro Vancouver is detailed as "confident or certain".
Green Heron	*Butorides virescens*	Blue		**Plausible**. Habitat preference is swamps, mangroves, marshes, and margins of ponds, rivers, lakes, and lagoons and may nest a kilometer away from a foraging area. The occurrence status for Metro Vancouver is detailed as "confident or certain.
Western Pine Elfin	*Callophrys eryphon sheltonensis*	Blue		**Low**. Habitat preferences are alpine tundra, grass/shrub and wetland / bog.
Johnson's Hairstreak	*Callophrys johnsoni*	Blue		**Low**. Occurs mostly in old-growth coniferous forests.
Western Thorn	*Carychium occidentale*	Blue		**Plausible**. Prefers low elevation forests. The occurrence status for Metro Vancouver is detailed as "confident or certain".
Painted Turtle - Pacific Coast Population	*ysemys picta*	Red	1-E (2007)	**Low**. Occurrence status for North Vancouver District is "Possible".
Olive-sided Flycatcher	*Contopus cooperi*	Blue	1-T (2010)	**Plausible**. Detailed to frequently use forest/conifer forests, and riparian/riparian forest and occurrence status for Metro Vancouver is detailed as "confident or certain".
Townsend's Big-eared Bat	*Corynorhinus townsendii*	Blue		**Plausible**. Detailed that in the west coast they are found regularly in forested regions and buildings. The occurrence status for Metro Vancouver is detailed as "confident or certain".
Puget Oregonian	*Cryptomastix devia*	Red	1-X (2005)	**Low**. Occurrence status for Lower Mainland is "presumed extirpated".
Monarch	*Danaus plexippus*	Blue	1-SC (2003)	**Low**. Habitat preference is grass lands, fields/pastures.
Sooty Grouse	*Dendragapus fuliginosus*	Blue		**Plausible**. Habitat preference is forest and occurrence status for Metro Vancouver is detailed as "confident or certain".
Silver-spotted Skipper	*Epargyreus clarus*	Blue		**Plausible**. Detailed to use numerous types of habitats and occurrence status for Metro Vancouver is detailed as "confident or certain".
Beaverpond Baskettail	*Epitheca canis*	Blue		**Low**. Occurrence is detailed as "possible" for Vancouver.
Dun Skipper	*Euphyes vestris*	Red	1-T (2003)	**Low**. Grassland/Shrub / Meadow obligate.
Peregrine Falcon, *anatum* subspecies	*Falco peregrinus anatum*	Red	1-SC (2012)	**Low**. Occurrence status for Metro Vancouver is "Predicted or probable".
Wolverine, *luscus* subspecies	*Gulo gulo luscus*	Blue		**Low**. Occurrence status for Metro Vancouver is "Predicted or probable"

Northern Abalone	*Haliotis kamtschatkana*	Red	1-T (2003)	**Plausible**. Is noted as a year round resident and confirmed breeder with an occurrence status of "confident or certain" for Metro Vancouver.
Barn Swallow	*Hirundo rustica*	Blue		**Low**. Prefers open situations (fields).
Caspian Tern	*Hydroprogne caspia*	Blue		Plausible as a seasonal resident and nests on sandy or gravelly beaches and shell banks along coasts. Occurrence status for Metro Vancouver is detailed as "confident or certain".
Snowshoe Hare, *washingtonii* subspecies	*Lepus americanus washingtonii*	Red		**Low**. Occurrence status for North Vancouver district is "possible".
Western Screech-Owl, *kennicottii* subspecies	*Megascops kennicottii kennicottii*	Blue	1-SC (2005)	**Plausible**. Habitat preference not detailed, but occurrence status for Metro Vancouver is "confident or certain".
Pacific Sideband	*Monadenia fidelis*	Blue		**Low**. Occurrence status for District of North Vancouver is "predicted or probable".
Long-tailed weasel, *altifrontalis* subspecies	*Mustela frenata altifrontalis*	Red		**Low**. Occurrence status for Metro Vancouver is "possible".
Southern Red-backed Vole, *occidentalis* subspecies	*Myodes gapperi occidentalis*	Red		**Plausible**. Frequent use of forest and riparian habitat and occurrence status for Metro Vancouver is "confident or certain".
Keen's Myotis	*Myotis keenii*	Blue	3 (2005)	**Low**. Occurrence status for North Vancouver is "predicted or probable".
Black-crowned Night-heron	*Nycticorax nycticorax*	Red		**Plausible**. Frequent use of riparian habitats and occurrence status of "confident or certain" for Metro Vancouver.
Grappletail	*Octogomphus specularis*	Red		**Plausible**. Frequent use of riparian and riparian forest habitat and occurrence status of "confident or certain" for Metro Vancouver.
Blue Dasher	*Pachydiplax longipennis*	Blue		**Plausible**. Frequent use of riparian/riparian forest habitat and occurrence status of "confident or certain" for Metro Vancouver.
Band-tailed Pigeon	*Patagioenas fasciata*	Blue	1-SC (2011)	**Plausible**. Frequent use of riparian/riparian forest and forest/conifer forest habitat and occurrence status of "confident or certain" for Metro Vancouver.
Double-crested Cormorant	*Phalacrocorax auritus*	Blue		**Plausible**. Prefers coastal bays, marine islands, and seacoasts; usually within sight of land. Occurrence status of "confident or certain" for Metro Vancouver.
Purple Martin	*Progne subis*	Blue		**Low**. Prefers wetland habitat.
Scarletback Taildropper	*Prophysaon vanattae*	Blue		**Low.** Occurrence status for District of North Vancouver is "predicted or probable".

Northern Red-legged Frog	*Rana aurora*	Blue	1-SC (2005)	**Plausible**. Habitat includes the vicinity of permanent waters of stream pools. Occurrence status of "confident or certain" for Metro Vancouver.
Oregon Spotted Frog	*Rana pretiosa*	Red	1-E (2003)	**Plausible**. Occurs in vegetated shallows or grassy margins of streams and springs marshes. Occurrence status of "confident or certain" for Metro Vancouver.
Pacific Water Shrew	*Sorex bendirii*	Red	1-E (2003)	**Plausible**. Riparian habitat specialist. Occurrence status of "confident or certain" for District of North Vancouver".
Olympic Shrew	*Sorex rohweri*	Red		**Plausible**. Frequent use of riparian/riparian forest and forest/mixed forest habitat. Occurrence status of "confident or certain" for Metro Vancouver.
Trowbridge's Shrew	*Sorex trowbridgii*	Blue		**Low**. Occurrence use for North Vancouver is "possible".
Zerene Fritillary, *bremnerii* subspecies	*Speyeria zerene bremnerii*	Red		**Plausible**. Frequent use of forest habitat and occurrence status of "confident or certain" for Metro Vancouver.
Rocky Mountain Fingernailclam	*Sphaerium patella*	Red		**Plausible**. Obligate of streams/rivers and occurrence status of "confident or certain" for Metro Vancouver.
Spotted Owl	*Strix occidentalis*	Red	1-E (2003)	**Low**. Prefers dense forest and deep wooded canyons; generally in mature stands or old growth.
Autumn Meadowhawk	*Sympetrum vicinum*	Blue		**Low**. Prefers ponds, slow streams and lakes with dense, emergent vegetation.
Black Petaltail	*Tanypteryx hageni*	Blue		**Low**. Usually found in seepage areas and bogs, flat or on hillsides, often associated with streams and usually not under forest canopy in wet mountain ranges.
Barn Owl	*Tyto alba*	Blue	1-SC (2003)	**Low**. Prefers fields of dense grass. Open and partly open country (grassland, marsh, lightly grazed pasture, hayfields) in a wide variety of situations.
Grizzly Bear	*Ursus arctos*	Blue		**Low**. Occurrence status of "presumed extirpated" for District of North Vancouver.
Black Gloss	*Zonitoides nitidus*	Blue		**Low**. Occurrence status of "predicted or probable" for District of North Vancouver.

10.0 STANDARD LIMITATIONS

PGL prepared this report for Polygon Development 270 Ltd. and its agents exclusively. It may be relied upon by these parties, the BC Ministry of Environment and the Contaminated Sites Approved Professionals Society exclusively. PGL accepts no responsibility for any damages that may be suffered by third parties as a result of decisions or actions based on this report.

The report's purpose is to provide the client with an assessment of contamination on the Site. The investigation consisted of a screening for potential contamination and, as is true for all environmental investigations, potential remains for the presence of unknown, unidentified, or unforeseen surface or subsurface contamination. More or different investigation may be required if other risks are identified. The data presented in this report is valid for the date of sampling, but Site conditions may change with time.

The findings and conclusions are Site-specific and were developed in a manner consistent with that level of care and skill normally exercised by environmental professionals currently practicing under similar conditions in the area. Changing assessment techniques, regulations, and Site conditions means that environmental investigations and their conclusions can quickly become dated, so this report is for use now. The report should not be used after that without PGL review/approval.

The project has been conducted according to our instructions and work program. Additional conditions and limitations on our liability are set forth in our work program/contract. This report is neither an endorsement nor a condemnation of the subject property. No warranty, expressed or implied, is made.

Respectfully submitted,

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.

Per:

M Ashley

Michelle Ashley, B.Sc., R.P. Bio
Environmental Risk Assessor

20131023

William Gaherty, M.S., P.Eng.
President

MLA/WDG/mtl
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Figures

PGL

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Maplewood Flats
Bird Checklist

return to home page

208 species	compiled by Dick Beard	printed 09/95

- . . . other viewing opportunities at Maplewood Flats
- . . . more information on Maplewood Flats
- . . . list of available bird checklists

> May 2002 - The taxonomic order, common names and four-letter codes included in this web version of the *Maplewood Flats Bird Checklist* published in 1995 have been updated using the 7th edition of the American Ornithologists' Union (AOU) *Check-List of North American Birds* (AOU 1998) and its supplement (AOU 2000).

The following is a list of the bird species that have been observed at Maplewood Flats. The status of each species is indicated by an abundance level in each of four seasons. The standard four letter code is shown for each species.

Explanation of Symbols

Seasonal Occurrence

Sp = Spring (spring transient; generally March through early June)
S = Summer (summer resident; including spring arrival and fall departure)
F = Fall (fall transient; generally July through November)
W = Winter (winter resident; including fall arrival and spring departure)

Relative Abundance

a = abundant [generally 100 or more per day]
c = common [25 to 100 per day]
f = fairly common [5 to 25 per day]
u = uncommon [1 to 5 per day, with at least 10 records per year]
r = rare [1 to 10 records per year, but regularly seen singly or in small numbers]
ca = casual [3 to many documented records; seen on average less than once a year; somewhat out of normal range]
ac = accidental [only 1 or 2 documented records; usually far outside normal range]

Other Symbols

* = species has been documented breeding in the checklist area
[I] = introduced species [present more than 10 years]
# = erratic/irregular [numbers fluctuate yearly from abundant to absent]

Code	*	Species	Spring	Summer	Fall	Winter

RTLO		Red-throated Loon	u		u	u
PALO		Pacific Loon	r		r	r
COLO		Common Loon	f	u	f	f
PBGR		Pied-billed Grebe	r		r	u
HOGR		Horned Grebe	f		f	f
RNGR		Red-necked Grebe	f		f	f
WEGR		Western Grebe	f		f	f
AWPE		American White Pelican			ac	
DCCO		Double-crested Cormorant	f	u	f	f
BRCO		Brandt's Cormorant	r		r	r
PECO		Pelagic Cormorant	c	a	c	c
AMBI		American Bittern	ca		ca	
GBHE		Great Blue Heron	f	f	f	f
GRHE	*	Green Heron	r	r	r	
TUVU		Turkey Vulture	r	r		
CAGO	*	Canada Goose	a	c	a	a
BRAN		Brant	ca		ca	ca
TRUS		Trumpeter Swan	ca		ca	ca
TUSW		Tundra Swan	ca		ca	ca
WODU		Wood Duck	r			r
GADW	*	Gadwall	f	u	f	f
EUWI		Eurasian Wigeon	r		r	r
AMWI		American Wigeon	c	u	c	c
MALL	*	Mallard	a	c	a	a
BTWE		Blue-winged Teal	r	r		
CITE		Cinnamon Teal	r	r		

NOSL		Northern Shoveler	r	r	r	r
NOPI		Northern Pintail	u		u	u
GWTE		Green-winged Teal	c	r	c	c
CANV		Canvasback				ca
RNDU		Ring-necked Duck	ca			ca
TUDU		Tufted Duck			ac	ac
GRSC		Greater Scaup	c	u	c	c
LESC		Lesser Scaup	u	u	u	f
HADU		Harlequin Duck	c	f	c	c
SUSC		Surf Scoter	c	u	c	a
WWSC		White-winged Scoter	f	u	f	f
BLSC		Black Scoter	u	ca	u	u
LTDU		Long-tailed Duck	r		r	r
BUFF		Bufflehead	f		f	f
COGO		Common Goldeneye	c	r	c	c
BAGO		Barrow's Goldeneye	f	r	f	f
HOME		Hooded Merganser	u		u	u
COME		Common Merganser	f	f	f	f
RBME		Red-breasted Merganser	u		r	u
RUDU		Ruddy Duck				r
OSPR	*	Osprey	u	u	r	
BAEA		Bald Eagle	f	f	f	f
NOHA		Northern Harrier	r		r	r
SSHA		Sharp-shinned Hawk	u	r	u	u
COHA		Cooper's Hawk	u	u	u	u
RTHA		Red-tailed Hawk	u	u	u	u
RLHA		Rough-legged Hawk	ca		ca	ca
GOEA		Golden Eagle				ac
AMKE		American Kestrel	r		r	
MERL		Merlin	u	u	u	u

PEFA		Peregrine Falcon	r	r	r	r
RUGR		Ruffed Grouse	ca	ca	ca	ca
VIRA		Virginia Rail	r	r	r	r
SORA	*	Sora	r	r	r	
AMCO		American Coot	r		r	r
BBPL		Black-bellied Plover		u	u	
AGPL		American Golden-Plover			ac	
SEPL		Semipalmated Plover	r		r	
KILL	*	Killdeer	f	f	f	u
AMAV		American Avocet		ac	ac	
GRYE		Greater Yellowlegs	f	r	f	f
LEYE		Lesser Yellowlegs	u		u	
SOSA		Solitary Sandpiper	r		r	
WATA		Wandering Tattler				ac
SPSA	*	Spotted Sandpiper	f	f	u	ac
WHIM		Whimbrel	r		r	
RUTU		Ruddy Turnstone			r	ca
BLTU		Black Turnstone	u		u	u
SAND		Sanderling	r		r	r
SESA		Semipalmated Sandpiper			r	
WESA		Western Sandpiper	a		a	
LESA		Least Sandpiper	f		f	
BASA		Baird's Sandpiper	r		r	
PESA		Pectoral Sandpiper	r		r	
DUNL		Dunlin	a		a	a
STSA		Stilt Sandpiper			r	
SBDO		Short-billed Dowitcher	u		u	

LBDO		Long-billed Dowitcher	f		f	u
COSN	*	Common Snipe	f	u	f	r
WIPH		Wilson's Phalarope	r			
RNPL		Red-necked Phalarope	r	ca	r	
REPH		Red Phalarope			ca	
PAJA		Parasitic Jaeger			ca	
FRGU		Franklin's Gull			ca	
BOGU		Bonaparte's Gull		u	f	
MEGU		Mew Gull	c	r	c	c
RBGU		Ring-billed Gull	f	u	f	f
CAGU		California Gull	u	u	c	u
HEGU		Herring Gull	r		r	r
THGU		Thayer's Gull	u		u	u
GWGU		Glaucous-winged Gull	a	a	a	a
GLGU		Glaucous Gull				ca
CATE		Caspian Tern		f	r	
COTE		Common Tern	f		f	
COMU		Common Murre				r
PIGU		Pigeon Guillemot	r	u	r	r
MAMU		Marbled Murrelet	r	r	r	r
RODO		Rock Dove [I]	c	c	c	c
BTPI		Band-tailed Pigeon	f	f	f	f
MODO		Mourning Dove	u	r	u	
BNOW		Barn Owl	ac			
GHOW		Great Horned Owl	r	r	r	r
NPOW		Northern Pygmy-Owl	r	r	r	r
SEOW		Short-eared Owl	r		r	r

CONI		Common Nighthawk		u	r	
BLSW		Black Swift	u	f	f	
VASW		Vaux's Swift	u	f	f	
CAHU		Calliope Hummingbird	ca			
RUHU		Rufous Hummingbird	u	u	r	
BEKI		Belted Kingfisher	u	u	u	u
RBSA		Red-breasted Sapsucker	r		u	u
DOWO	*	Downy Woodpecker	u	u	u	u
HAWO		Hairy Woodpecker	r	r	r	r
NOFL	*	Northern Flicker	f	f	f	f
PIWO		Pileated Woodpecker	u	r	u	u
OSFL		Olive-sided Flycatcher	u		r	
WWPE		Western Wood-Pewee	r	r	r	
ALFL		Alder Flycatcher		ac		
WIFL	*	Willow Flycatcher	u	f	u	
HAFL		Hammond's Flycatcher	u	u	u	
PSFL		Pacific-slope Flycatcher	u	u	u	
SAPH		Say's Phoebe	ca			
ATFL		Ash-throated Flycatcher		ac		
WEKI		Western Kingbird	r	r		
EAKI		Eastern Kingbird	r	ca	r	
NOSH		Northern Shrike	r		r	r
CAVI		Cassin's Vireo	u	u	u	
HUVI		Hutton's Vireo	u	u	u	u

WAVI		Warbling Vireo	u	u	u	
REVI	*	Red-eyed Vireo		f		
STJA		Steller's Jay	u	u	u	u
NOCR		Northwestern Crow	a	a	a	a
CORA		Common Raven	u	u	u	u
PUMA	*	Purple Martin	f	f		
TRSW	*	Tree Swallow	f	f	u	
VGSW	*	Violet-green Swallow	c	c	u	
NRWS		Northern Rough-winged Swallow	f	f	u	
BKSW		Bank Swallow	r		r	
BASW	*	Barn Swallow	c	c	c	
CLSW	*	Cliff Swallow	u	u	u	
BCCH	*	Black-capped Chickadee	f	f	f	f
CBCH		Chestnut-backed Chickadee	r	r	r	r
BUSH		Bushtit	f	f	f	f
RBNU		Red-breasted Nuthatch	r	r	r	r
BRCR		Brown Creeper	r	r	r	r
BEWR		Bewick's Wren	r	r	r	r
HOWR		House Wren	ca		ca	
WIWR	*	Winter Wren	f	f	f	f
MAWR		Marsh Wren	ca		ca	ca
AMDI		American Dipper	ca		ca	ca
GCKI		Golden-crowned Kinglet	c	u	c	c

RCKI		Ruby-crowned Kinglet	c	u	f	f
MOBL		Mountain Bluebird	ca			
TOSO		Townsend's Solitaire	r	r	r	
SWTH	*	Swainson's Thrush	f	f	u	
HETH		Hermit Thrush	r		r	ca
AMRO	*	American Robin	c	f	c	f
VATH		Varied Thrush	f	r	f	f
EUST	*	European Starling [I]	c	c	c	c
AMPI		American Pipit	f		f	
BOWA		Bohemian Waxwing				r
CEWA		Cedar Waxwing	f	f	f	
OCWA		Orange-crowned Warbler	u	u	u	
NAWA		Nashville Warbler	ca		ca	
YEWA		Yellow Warbler	f	u	f	
YRWA		Yellow-rumped Warbler	f	u	f	
BTGW		Black-throated Gray Warbler	f	u	f	
TOWA		Townsend's Warbler	u	r	u	
MACW		MacGillivray's Warbler	u	u	u	
COYE		Common Yellowthroat	u	r	u	
WIWA		Wilson's Warbler	f	f	f	
WETA		Western Tanager	f	f	f	
SPTO	*	Spotted Towhee	f	f	f	f
ATSP		American Tree Sparrow				ca
CHSP		Chipping Sparrow	ac		ac	
SAVS	*	Savannah Sparrow	f	f	f	ca
FOSP		Fox Sparrow	u		u	u

SOSP	*	Song Sparrow	c	c	c	c
LISP		Lincoln's Sparrow	ca		ca	ca
WCSP	*	White-crowned Sparrow	f	f	f	u
GCSP		Golden-crowned Sparrow	f		f	r
DEJU		Dark-eyed Junco	f		f	c
LALO		Lapland Longspur	ca		ca	
CCLO		Chestnut-collared Longspur		ac		
SNBU		Snow Bunting				ca
BHGR	*	Black-headed Grosbeak	u	f	u	
LZBU		Lazuli Bunting		ca		
BOBO		Bobolink		ac		
RWBL	*	Red-winged Blackbird	f	f	f	c
WEME		Western Meadowlark	r		r	r
YHBL		Yellow-headed Blackbird	r	ca	r	
BRBL		Brewer's Blackbird	u	u	u	
BHCO	*	Brown-headed Cowbird	f	f	f	
BUOR		Bullock's Oriole		ca		
PUFI		Purple Finch	u	u	u	u
HOFI	*	House Finch	c	c	c	c
RECR		Red Crossbill #	u	u	f	u
PISI		Pine Siskin #	f	u	c	c
AMGO	*	American Goldfinch	f	f	f	r
EVGR		Evening Grosbeak #	u	u	u	u
HOSP		House Sparrow [I]	u	u	u	u

Appendix 3

Conceptual Development Plans

PGL

Rositch Hemphill Architects
120 Powell Street, Unit 10 Vancouver, BC Canada V6A 1G1
t 604.669.6002 f 604.669.1091 www.rharchitects.ca

P+A
Perry + Associates
Landscape Architecture
Site Planning

PROJECT:
NOBLE COVE
3829 & 3919 Dollarton Highway,
North Vancouver, BC

DRAWING TITLE:
SITE PLAN

POLYGON

DATABASE:	1033_1.0
PROJECT NO:	1033
DATE:	26 MAR, 2013
SCALE:	1"=30'-0"

STORMWATER MANAGEMENT PLAN

OBJECTIVE: REDUCE, TO THE EXTENT PRACTICAL, THE RATE AND VOLUME OF RUNOFF FROM THE PROPOSED DEVELOPMENT UP TO THE 60% OF MAR STORM EVENT

RAINFALL DATA: DNV MUNICIPAL HALL
50% OF MAR STORM EVENT = 60mm

STORMWATER MANAGEMENT PLAN – SUMMARY CALCULATION

OBJECTIVE: REDUCE, TO THE EXTENT PRACTICAL, THE RATE AND VOLUME OF STORMWATER RUNOFF FROM THE PROPOSED DEVELOPMENT UP TO THE MAR STORM EVENT

TOTAL LOT AREA = 1.9ha
MAR STORM EVENT = 60mm
RAINFALL VOLUME = 1141.8m³

POSTDEVELOPMENT CONDITION (SEE DETAILS AT LEFT)
PERVIOUS AREA = 10942m² (LANDSCAPE)
    CAPTURE VOLUME > 836.8m³
    RUNOFF VOLUME = 0.0m³
IMPERVIOUS AREA = 8088m² (BUILDINGS)
    CAPTURE VOLUME = 486.5m³ (FORESHORE POND)
    RUNOFF VOLUME = 0.0m³
POSTDEVELOPMENT RUNOFF VOLUME = 0.0m³

OBJECTIVE ACHIEVED (100% RAINFALL CAPTURED)
PROPOSED STORMWATER BMPS CAPTURE 100% OF SITE RUNOFF DURING THE 60% OF MAR STORM EVENT

▨	BUILDINGS (IMPERMEABLE)
☐	HARDSCAPE (PERMEABLE)
🟩	LANDSCAPE AREAS (PERMEABLE)

⇐	MAJOR STORM ROUTING
+EL 19.93	EXISTING ELEVATION
+(EL 17.80)	PROPOSED ELEVATION

NOTES:

1. SITE GRADES SHOWN FOR REFERENCE ONLY, DETAILED SITE GRADING BY OTHERS

2. SITE DRAINAGE SHOWN RELATES TO STORMWATER MANAGEMENT ONLY. CONTRACTOR TO ENSURE ADEQUATE DRAINAGE PROVIDED.

3. ALL WORKS TO CONFORM TO BCBC REQUIREMENTS.

4. RAIN GARDEN LOCATIONS AND EXTENTS TO BE COORDINATED IN FIELD WITH ENGINEER.

"I, FRED CIAMBRELLI, PROFESSIONAL ENGINEER, IN GOOD STANDING IN AND FOR THE PROVINCE OF BRITISH COLUMBIA, HEREBY CERTIFY THAT THE WORKS AS HEREIN SET OUT ON THE ATTACHED DRAWINGS HAVE BEEN DESIGNED TO GOOD ENGINEERING STANDARDS AND IN ACCORDANCE WITH THE DISTRICT OF NORTH VANCOUVER DESIGN CRITERIA MANUAL, DATED NOV 2006, THE MASTER MUNICIPAL CONSTRUCTION DOCUMENTS (MMCD), VERSION 2000 AND THE DISTRICT OF NORTH VANCOUVER SUPPLEMENTARY MASTER MUNICIPAL CONSTRUCTION DOCUMENTS (SUPPLEMENTARY SPECIFICATIONS AND SUPPLEMENTARY STANDARD DRAWINGS), ADOPTED BY THE DISTRICT OF NORTH VANCOUVER.

POLYGON DEVELOPMENT

DOLLARTON REZONING
NORTH VANCOUVER, BRITISH COLUMBIA

www.creus.ca

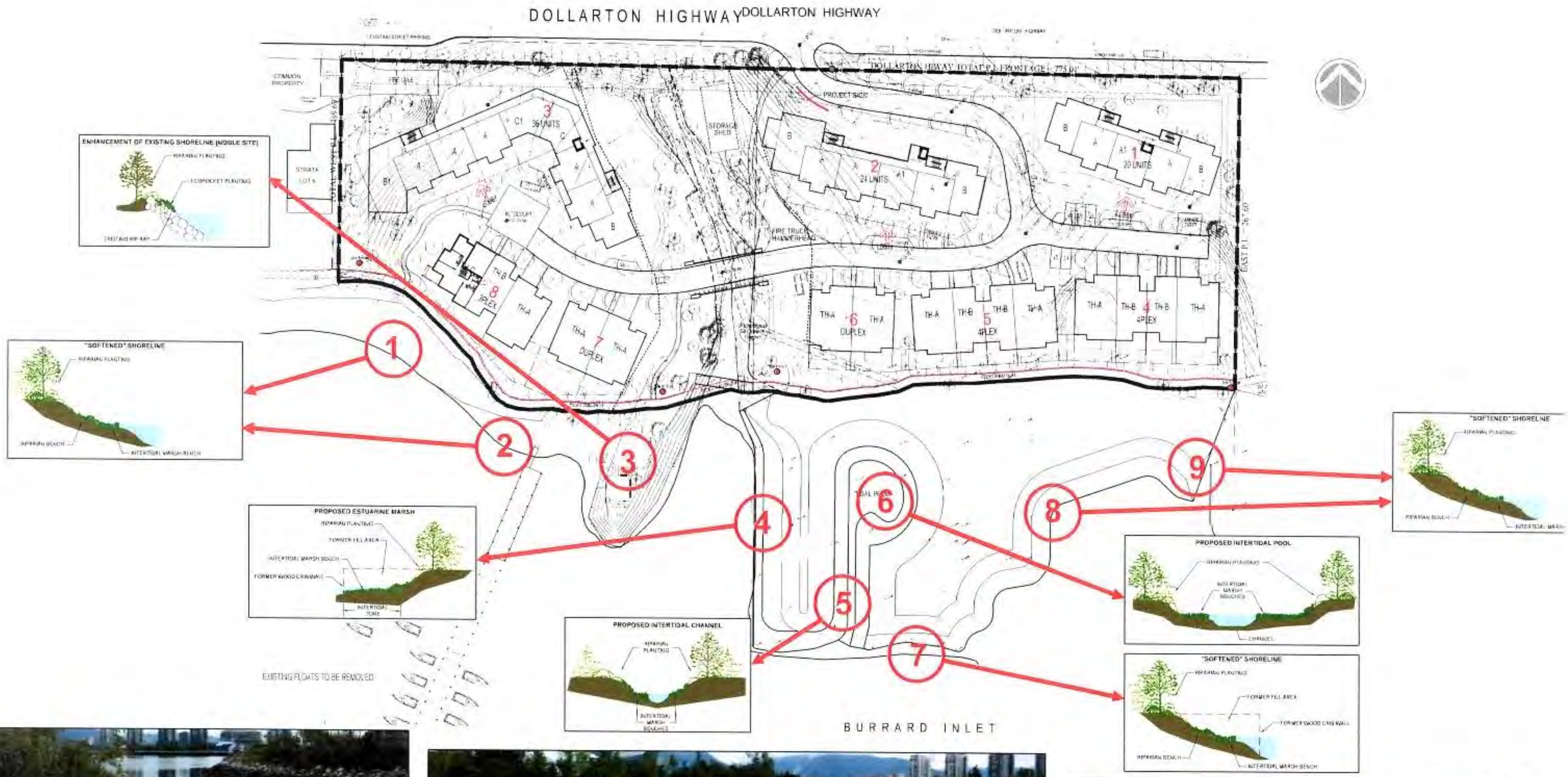
CREUS Engineering Ltd

Civil Engineers

designed by R.A.W.
drawn by D.X.R.
checked by F.M.C.
date FEB.28/13

STORMWATER MANAGEMENT PLAN

scale 1:500
job no. 12123
drawing SMP
rev. 1



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P+A
Perry + Associates
Landscape Architecture
Site Planning

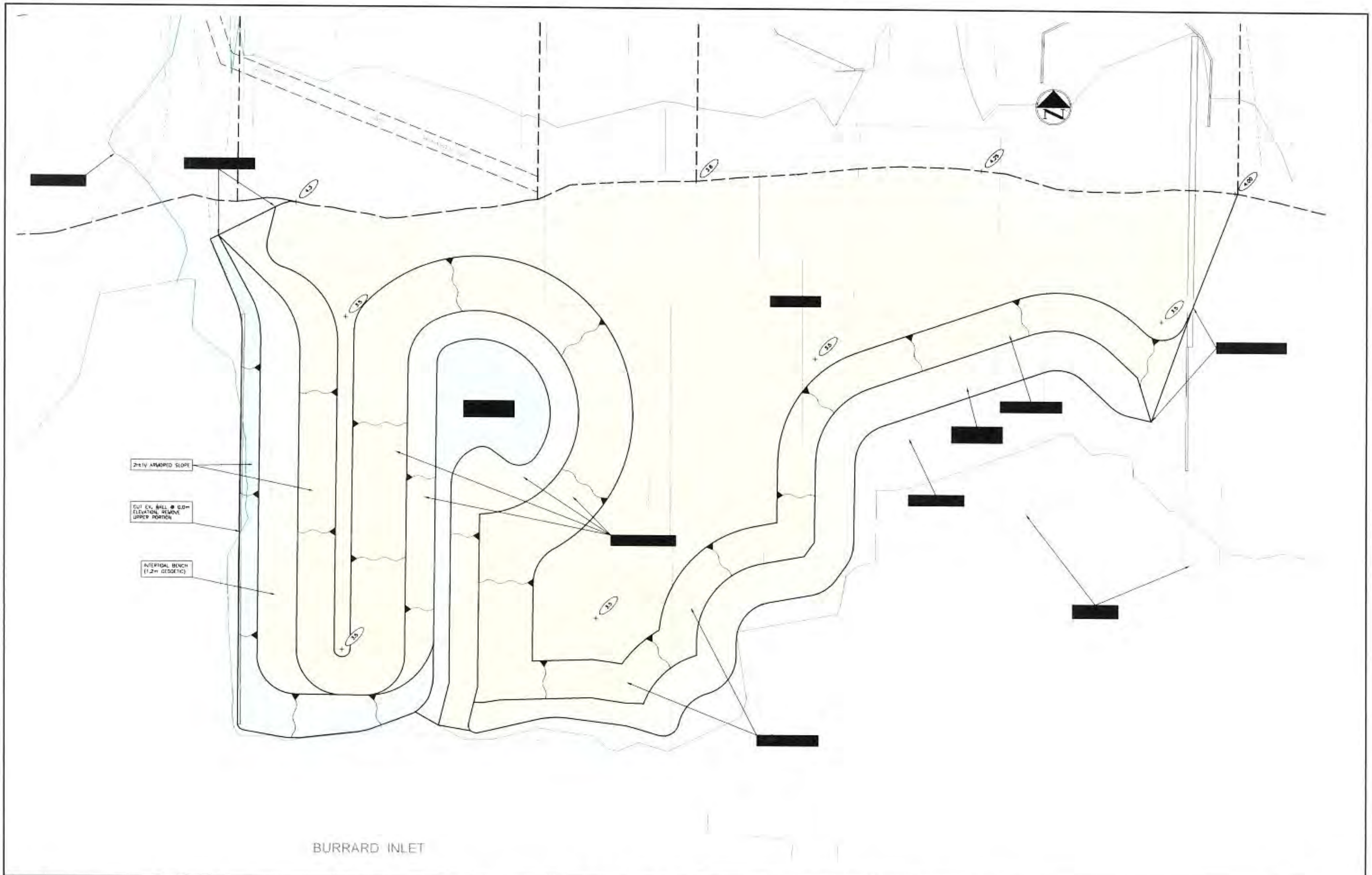
PROJECT:
NOBLE COVE
3829 & 3919 Dollarton Highway,
North Vancouver, BC

DRAWING TITLE :
HABITAT RESTORATION PLAN
WITH REFERENCE IMAGES

POLYGON
Suite 900 - 1333 West Broadway, Vancouver, BC
Canada V6H4C2 T (604)877-1131 F (604)871-4120

DATABASE: 1033.1.2
PROJECT NO: 1033
DATE: 25 FEB, 2013
SCALE:

12



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POLYGON DEVELOPMENT

DOLLARTON NOBLE COVE
NORTH VANCOUVER, BRITISH COLUMBIA

www.creus.ca

CREUS Engineering Ltd
Civil Engineers

designed by R.A.W.
drawn by D.K.D.
checked by F.M.C.
date FEB.25.13

PRELIMINARY FORESHORE GRADING PLAN

scales hor: 1:200 vert: -
job no. 12123
drawing no. FS-GR-1
rev. -

Appendix 4

Human Health COPC Screening Sheets

Table D1
Residents - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests										
pH	177	177	9.8	-	unknown	-	-	-	-	No
Total Petroleum Hydrocarbons										
Mineral Oil and Grease	13	8	41000	-	unknown	-	-	-	-	No
Total EH	1	1	12	-	unknown	-	-	-	-	No
Extractable Petroleum Hydrocarbons										
EPH10-19	73	12	6450	-	unknown	-	-	1000	1000	Yes
EPH19-32	73	21	14900	-	unknown	-	-	1000	1000	Yes
LEPH	53	6	6200	-	unknown	-	-	1000	1000	Yes
HEPH	53	13	13700	-	unknown	-	-	1000	1000	Yes
Monocyclic Aromatic Hydrocarbons (MAHs)										
Benzene	56	6	<0.4	-	unknown	1000	-	-	1000	No
Ethylbenzene	56	11	1.7	-	unknown	3500	-	-	3500	No
Toluene	56	6	0.9	-	unknown	40000	-	-	40000	No
Styrene	54	0	<0.2	-	unknown	-	-	5	5	No
Xylene Total	56	14	13.4	-	unknown	65000	-	-	65000	No
VH C6-C10	49	5	420	-	unknown	-	-	-	-	No
VPH (C6-C10)	49	5	410	-	unknown	-	-	200	200	Yes
MTBE	39	0	<0.25	-	unknown	-	320	-	320	No
Polycyclic Aromatic Hydrocarbons (PAHs)										
2-Methylnaphthalene	54	16	11.5	-	unknown	-	-	-	-	No
Acenaphthene	57	13	18.6	-	unknown	-	-	-	-	No
Acenaphthylene	57	9	15.4	-	unknown	-	-	-	-	No
Anthracene	57	18	103	-	unknown	-	-	-	-	No
Benzo(a)anthracene	57	23	159	-	unknown	-	-	1	1	Yes
Benzo(a)pyrene	57	22	197	-	unknown	5	-	-	5	Yes
Benzo(g,h,i)perylene	57	18	83.9	-	unknown	-	-	-	-	No
Benzo(b)fluoranthene	54	22	261	-	unknown	-	-	1	1	Yes
Benzo(k)fluoranthene	54	12	109	-	unknown	-	-	1	1	Yes
Chrysene	57	23	160	-	unknown	-	-	-	-	No
Dibenz(a,h)anthracene	57	12	18.9	-	unknown	-	-	1	1	Yes
Fluoranthene	57	27	383	-	unknown	-	-	-	-	No
Fluorene	57	13	31.2	-	unknown	-	-	-	-	No
Indeno(1,2,3-c,d)pyrene	57	19	106	-	unknown	-		1	1	Yes
Naphthalene	60	17	28.5	-	unknown	-	-	5	5	Yes
Phenanthrene	57	26	245	-	unknown	-	-	5	5	Yes
Pyrene	57	26	328	-	unknown	-	-	10	10	Yes
Metals										
Aluminum	53	53	50300	-	unknown	-	-	-	-	No
Antimony	152	101	121	4	yes	-	-	20	20	Yes
Arsenic	170	132	595	15	yes	100	-	-	100	Yes
Barium	169	169	969	150	yes	6500	-	-	6500	No

Table D1
Residents - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
Beryllium	150	51	2.95	1	yes	-	-	4	4	No
Boron	53	29	14	-	unknown	-	-	-	-	No
Cadmium	169	115	236	0.55	yes	35	-	-	35	Yes
Calcium	53	53	84500	-	unknown	-	-	-	-	No
Chromium	169	169	326	100	yes	100	-	-	100	Yes
Cobalt	169	168	37	15	yes	-	-	50	50	No
Copper	176	176	8130	100	yes	15000	-	-	15000	No
Iron	53	53	41600	-	yes	-	-	-	-	No
Lead	175	165	3550	300	yes	500	-	-	500	Yes
Magnesium	53	53	12000	-	unknown	-	-	-	-	No
Manganese	34	34	502	-	unknown	-	1800	-	1800	No
Mercury	169	115	39.5	0.4	yes	15	-	-	15	Yes
Molybdenum	169	77	37.5	6	yes	-	-	10	10	Yes
Nickel	169	169	142	75	yes	-	-	100	100	Yes
Phosphorus	53	53	930	-	unknown	-	-	-	-	No
Potassium	53	53	2700	-	unknown	-	-	-	-	No
Selenium	169	47	2	2	no	-	-	3	3	No
Silver	169	59	2	1	yes	-	-	20	20	No
Sodium	53	53	4050	-	unknown	1000000	-	-	1000000	No
Strontium	34	34	250	-	unknown	-	47000	-	47000	No
Thallium	96	39	0.365	-	unknown	-	-	-	-	No
Tin	171	58	83.7	4	yes	-	50	50	50	Yes
Titanium	53	53	864	-	unknown	-	-	-	-	No
Uranium	96	96	6.24	-	unknown	-	16	-	16	No
Vanadium	150	150	393	100	yes	-	-	200	200	Yes
Zinc	170	170	4300	90	yes	10000	-	-	10000	No
Zirconium	53	53	8	-	unknown	-	-	-	-	No
Organontins										
Tributyltin	6	5	937	-	unknown	-	-	-	-	No
Volatile Organic Compounds										
Bromodichloromethane	4	0	<0.03	-	unknown	-	8.2	-	8.2	No
Bromoform	4	0	<0.03	-	unknown	-	620	-	620	No
Bromomethane	4	0	<0.12	-	unknown	-	3.9	-	3.9	No
Carbon tetrachloride	7	0	<0.2	-	unknown	-	-	5	5	No
Chlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
Chlorodibromomethane	4	0	<0.03	-	unknown	-	11	-	11	No
Chloroethane	4	0	<0.06	-	unknown	-	30	-	30	No
Chloroform	7	0	<0.1	-	unknown	-	-	5	5	No
Chloromethane	4	0	<0.12	-	unknown	-	47	-	47	No
1,2-dibromoethane	4	0	<0.03	-	unknown	-	0.32	-	0.32	No
Dibromomethane	4	0	<0.03	-	unknown	-	67	-	67	No
1,2-dichlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No

Table D1
Residents - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
1,3-dichlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
1,4-dichlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
Dichlorodifluoromethane	4	0	<0.06	-	unknown	-	94	-	94	No
1,1-dichloroethane	7	0	<0.1	-	unknown	-	5	5	5	No
1,2-dichloroethane	7	0	<0.2	-	unknown	-	-	5	5	No
1,1-dichloroethene	7	0	<0.1	-	unknown	-	-	5	5	No
cis-1,2-dichloroethene	7	0	<0.1	-	unknown	-	5	-	5	No
trans-1,2-dichloroethene	7	0	<0.1	-	unknown	-	5	-	5	No
Dichloromethane	7	2	<0.9*	-	unknown	-	-	5	5	No
1,2-dichloropropane	7	0	<0.1	-	unknown	-	5	5	5	No
cis-1,3-dichloropropene	7	0	<0.1	-	unknown	-	-	5	5	No
trans-1,3-dichloropropene	7	0	<0.1	-	unknown	-	-	5	5	No
2-hexanone	4	0	<1.5	-	unknown	-	-	-	0	No
Methyl Ethyl Ketone	4	0	<1.5	-	unknown	-	22000	-	22000	No
4-Methyl-2-pentanone	4	0	<0.06	-	unknown	-	5300	-	5300	No
1,1,2,2-tetrachloroethane	7	0	<0.2	-	unknown	-	4.1	-	4.1	No
Tetrachloroethene	7	0	<0.1	-	unknown	1000	-	-	1000	No
1,1,1-trichloroethane	7	0	<0.2	-	unknown	-	5	5	5	No
1,1,2-trichloroethane	7	0	<0.1	-	unknown	-	5	5	5	No
Trichloroethene	7	0	<0.1	-	unknown	200	-	-	200	No
Trichlorofluoromethane	4	0	<0.03	-	unknown	-	390	-	390	No
1,3,5-trimethylbenzene	3	0	<0.1	-	unknown	-	-	-	-	No
Vinyl chloride	4	0	<0.06	-	unknown	-	0.79	-	0.79	No
Polychlorinated Biphenlys										
Arochlor 1242	2	0	<0.1	-	unknown	-	-	-	-	No
Arochlor 1248	2	0	<0.1	-	unknown	-	-	-	-	No
Arochlor 1254	2	2	0.37	-	unknown	-	-	-	-	No
Arochlor 1260	2	0	<0.1	-	unknown	-	-	-	-	No
PCBs (Sum of total)	10	5	1.4	-	unknown	5	-	-	5	No

Notes:

*Although detections were measured, detection limit that exceeded the highest value detected was used for COPC screening for conservativeness.

Table D2
Workers - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil CL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards CL/IL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards CL Land Use (mg/kg)	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests										
pH	266	266	9.8	-	unknown	-	-	-	-	No
Total Petroleum Hydrocarbons										
Mineral Oil and Grease	21	15	41000	-	unknown	-	-	-	-	No
Total EH	2	2	15000	-	unknown	-	-	-	-	No
Extractable Petroleum Hydrocarbons										
EPH10-19	129	26	8180	-	unknown	-	-	2000	2000	Yes
EPH19-32	129	42	14900	-	unknown	-	-	5000	5000	Yes
LEPH	108	20	8090	-	unknown	-	-	2000	2000	Yes
HEPH	108	33	13700	-	unknown	-	-	5000	5000	Yes
Monocyclic Aromatic Hydrocarbons (MAHs)										
Benzene	82	5	<0.4	-	unknown	4000	-	-	4000	No
Ethylbenzene	82	12	33.6	-	unknown	10000	-	-	10000	No
Toluene	82	10	<2	-	unknown	100000	-	-	100000	No
Styrene	79	0	<2	-	unknown	-	-	50	50	No
Xylene Total	82	19	262	-	unknown	200000	-	-	200000	No
VH C6-C10	70	10	480	-	unknown	-	-	-	-	No
VPH (C6-C10)	70	9	480	-	unknown	-	-	200	200	Yes
MTBE	58	0	<8	-	unknown	-	700	-	700	No
Polyclyclic Aromatic Hydrocarbons (PAHs)										
2-Methylnaphthalene	124	48	81.3	-	unknown	-	-	-	-	No
Acenaphthene	133	54	196	-	unknown	-	-	-	-	No
Acenaphthylene	133	31	15.4	-	unknown	-	-	-	-	No
Anthracene	133	61	769	-	unknown	-	-	-	-	No
Benzo(a)anthracene	133	75	812	-	unknown	-	-	10	10	Yes
Benzo(a)pyrene	133	73	672	-	unknown	15	-	-	15	Yes
Benzo(g,h,i)perylene	133	69	227	-	unknown	-	-	-	-	No
Benzo(b)fluoranthene	124	72	941	-	unknown	-	-	10	10	Yes
Benzo(k)fluoranthene	124	54	263	-	unknown	-	-	10	10	Yes
Chrysene	133	77	740	-	unknown	-	-	-	-	No
Dibenz(a,h)anthracene	133	43	67.9	-	unknown	-	-	10	10	Yes
Fluoranthene	133	85	1950	-	unknown	-	-	-	-	No
Fluorene	133	56	444	-	unknown	-	-	-	-	No
Indeno(1,2,3-c,d)pyrene	133	70	292	-	unknown	-		10	10	Yes
Naphthalene	137	58	190	-	unknown	-	-	50	50	Yes
Phenanthrene	133	79	2500	-	unknown	-	-	50	50	Yes
Pyrene	133	82	1480	-	unknown	-	-	100	100	Yes
Metals										
Aluminum	63	63	50300	-	unknown	-	-	-	-	No
Antimony	229	155	121	4	yes	-	-	40	40	Yes
Arsenic	250	206	595	15	yes	300	-	-	300	Yes
Barium	242	242	969	150	yes	20000	-	-	20000	No
Beryllium	223	67	2.95	1	yes	-	-	8	8	No
Boron	63	37	18	-	unknown	-	-	-	-	No

Table D2
Workers - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil CL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards CL/IL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards CL Land Use (mg/kg)	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests										
Cadmium	247	175	236	0.55	yes	100	-	-	100	Yes
Calcium	63	63	103000	-	unknown	-	-	-	-	No
Chromium	242	242	839	100	yes	300	-	-	300	Yes
Cobalt	242	241	37	15	yes	-	-	300	300	No
Copper	257	257	8130	100	yes	50000	-	-	50000	No
Iron	64	64	92400	-	unknown	-	-	-	-	No
Lead	253	241	3550	300	yes	1000	-	-	1000	Yes
Magnesium	63	63	17200	-	unknown	-	-	-	-	No
Manganese	39	39	502	-	unknown	-	19000	-	19000	No
Mercury	242	174	39.5	0.4	yes	40	-	-	40	No
Molybdenum	242	120	45.5	6	yes	-	-	40	40	Yes
Nickel	242	242	290	75	yes	-	-	500	500	No
Phosphorus	63	63	1210	-	unknown	-	-	-	-	No
Potassium	63	63	3480	-	unknown	-	-	-	-	No
Selenium	242	58	2	2	no	-	-	10	10	No
Silver	242	89	5.83	1	yes	-	-	40	40	No
Sodium	63	63	4050	-	unknown	1000000	-	-	1000000	No
Strontium	39	39	629	-	unknown	-	100000	-	100000	No
Thallium	146	62	0.365	-	unknown	-	-	-	-	No
Tin	242	90	133	4	yes	-	300	300	300	No
Titanium	63	63	864	-	unknown	-	-	-	-	No
Uranium	146	146	6.24	-	unknown	-	200	-	200	No
Vanadium	223	223	393	100	yes	-	-	-	-	No
Zinc	252	252	5520	90	yes	30000	-	-	30000	No
Zirconium	63	63	14	-	unknown	-	-	-	-	No
Organontins										
Tributyltin	11	6	1.71	-	unknown	-	-	-	-	No
Volatile Organic Compounds										
Bromodichloromethane	6	0	<0.03	-	unknown	-	18	-	18	No
Bromoform	6	0	<0.03	-	unknown	-	2200	-	2200	No
Bromomethane	6	0	<0.12	-	unknown	-	13	-	13	No
Carbon tetrachloride	13	0	<0.8	-	unknown	-	-	50	50	No
Chlorobenzene	13	0	<0.4	-	unknown	-	-	10	10	No
Chlorodibromomethane	6	0	<0.03	-	unknown	-	26	-	26	No
Chloroethane	6	0	<0.06	-	unknown	-	65	-	65	No
Chloroform	13	2	2.5	-	unknown	-	-	50	50	No
Chloromethane	6	0	<0.12	-	unknown	-	160	-	160	No
1,2-dibromoethane	6	0	<0.03	-	unknown	-	0.73	-	0.73	No
Dibromomethane	6	0	<0.03	-	unknown	-	230	-	230	No
1,2-dichlorobenzene	13	0	<0.4	-	unknown	-	-	10	10	No
1,3-dichlorobenzene	13	0	<0.4	-	unknown	-	-	10	10	No
1,4-dichlorobenzene	13	0	<0.4	-	unknown	-	-	10	10	No
Dichlorodifluoromethane	6	0	<0.06	-	unknown	-	310	-	310	No

Table D2
Workers - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil CL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards CL/IL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards CL Land Use (mg/kg)	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests										
1,1-dichloroethane	13	0	<0.4	-	unknown	-	50	50	50	No
1,2-dichloroethane	13	0	<0.8	-	unknown	-	-	50	50	No
1,1-dichloroethene	13	0	<0.4	-	unknown	-	-	50	50	No
cis-1,2-dichloroethene	13	0	<0.4	-	unknown	-	50	-	50	No
trans-1,2-dichloroethene	13	0	<0.4	-	unknown	-	50	-	50	No
Dichloromethane	13	6	2.9	-	unknown	-	-	50	50	No
1,2-dichloropropane	13	0	<0.4	-	unknown	-	50	50	50	No
cis-1,3-dichloropropene	13	0	<0.4	-	unknown	-	-	50	50	No
trans-1,3-dichloropropene	13	0	<0.4	-	unknown	-	-	50	50	No
2-hexanone	6	0	<1.5	-	unknown	-	-	-	0	No
Methyl Ethyl Ketone	6	0	<1.5	-	unknown	-	110000	-	110000	No
4-Methyl-2-pentanone	6	0	<0.06	-	unknown	-	47000	-	47000	No
1,1,2,2-tetrachloroethane	13	0	<0.8	-	unknown	-	9.3	-	9.3	No
Tetrachloroethene	13	0	<0.4	-	unknown	3500	-	-	3500	No
1,1,1-trichloroethane	13	2	1.3	-	unknown	-	50	50	50	No
1,1,2-trichloroethane	13	0	<0.4	-	unknown	-	50	50	50	No
Trichloroethene	13	0	<0.4	-	unknown	600	-	-	600	No
Trichlorofluoromethane	6	0	<0.03	-	unknown	-	2000	-	2000	No
1,3,5-trimethylbenzene	7	1	0.87	-	unknown	-	-	-	-	No
Vinyl chloride	6	0	<0.06	-	unknown	-	7.5	-	7.5	No
Polychlorinated Biphenlys										
Arochlor 1242	3	0	<0.1	-	unknown	-	-	-	-	No
Arochlor 1248	3	0	<0.1	-	unknown	-	-	-	-	No
Arochlor 1254	3	2	0.37	-	unknown	-	-	-	-	No
Arochlor 1260	3	0	<0.1	-	unknown	-	-	-	-	No
PCBs (Sum of total)	13	7	1.4	-	unknown	15	-	-	15	No
Chlorinated Phenols										
Pentachlorophenol	2	0	<0.02	-	unknown	300	-	-	300	No
2-chlorophenol	2	0	<0.27	-	unknown	-	-	5	5	No
2,3-Dichlorophenol	2	0	<0.05	-	unknown	-	-	5	5	No
2,4-dichlorophenol	2	0	<0.1	-	unknown	-	-	5	5	No
2,5-Dichlorophenol	2	0	<0.2	-	unknown	-	-	5	5	No
3,4-Dichlorophenol	2	0	<0.05	-	unknown	-	-	5	5	No
3,5-Dichlorophenol	2	0	<0.05	-	unknown	-	-	5	5	No
2,3,4-Trichlorophenol	2	0	<0.01	-	unknown	-	-	5	5	No
2,3,5-Trichlorophenol	2	0	<0.01	-	unknown	-	-	5	5	No
2,3,6-Trichlorophenol	2	0	<0.01	-	unknown	-	-	5	5	No
2,4,5-trichlorophenol	2	0	<0.01	-	unknown	-	-	5	5	No
2,4,6-trichlorophenol	2	0	<0.01	-	unknown	-	-	5	5	No
2,3,4,5-tetrachlorophenol	2	0	<0.01	-	unknown	-	-	5	5	No
2,3,4,6-tetrachlorophenol	2	0	<0.005	-	unknown	-	-	5	5	No
2,3,5,6-Tetrachlorophenol	2	0	<0.01	-	unknown	-	-	5	5	No

Table D3
Utitlity Workers - Chemical of Potential Concern Screening
Groundwater
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Measured Maximum (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Carcinogenic Target Risk -Dermal (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Noncancer Hazard Index - Dermal (ug/L)	Human Health Screening Level (ug/L)	COPC? (Yes/No)
Physical Tests							
Hardness, Total (CaCO3) (mg/L)	45	45	3790	-	-	NA	No
InOrganics							
TDS (Filtered)	15	15	14900000				
EPHs							
EPH10-19	69	14	2690	-	-	-	No
EPH19-32	69	5	410	-	-	-	No
LEPH	68	14	1200	-	-	-	No
HEPH	68	5	410	-	-	-	No
MAHs							
Benzene	67	9	43.5	84	410	84	No
Ethylbenzene	67	9	48.7	110	2600	110	No
Styrene	67	17	24	-	7100	7100	No
Toluene	65	0	<0.5	-	3700	3700	No
Xylenes	67	14	192	-	5500	5500	No
VH C6-C10	59	7	1470			-	No
VPH (C6-C10)	59	6	1180			-	No
MTBE	52	1	0.63	17000	-	17000	No
PAHs							
Acenaphthene	85	21	106	-	680	680	No
Acenaphthylene	85	12	0.707	-	-	-	No
Acridine	85	3	2.18	-	-	-	No
Anthracene	85	17	6.06	-	1800	1800	No
Benzo(a)anthracene	85	18	0.353	-	-	-	No
Benzo(a)pyrene	85	26	0.109	-	-	-	No
Benzo(g,h,i)perylene	85	12	0.089	-	-	-	No
Benzo(b)fluoranthene	85	16	0.147	-	-	-	No
Benzo(k)fluoranthene	67	5	0.11	-	-	-	No
Chrysene	85	18	0.291	-	-	-	No
Dibenz(a,h)anthracene	85	0	<0.05	-	-	-	No
Fluoranthene	85	22	11.1	-	-	-	No
Fluorene	85	19	67.9	-	330	330	No
Indeno(1,2,3-c,d)pyrene	85	12	0.085	-	-	-	No
Naphthalene	90	24	1220	-	500	500	Yes
Phenanthrene	85	19	91.9	-	-	-	No
Pyrene	85	24	5.64	-	110	110	No
Quinoline	85	2	2.5	2.5	-	2.5	No
Dissolved Metals							

Table D3
Utitlity Workers - Chemical of Potential Concern Screening
Groundwater
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Measured Maximum (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Carcinogenic Target Risk -Dermal (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Noncancer Hazard Index - Dermal (ug/L)	Human Health Screening Level (ug/L)	COPC? (Yes/No)
Aluminum	70	34	<150	-	2400000	2400000	No
Antimony	72	5	<150	-	140	140	No
Arsenic	78	37	19.9	83	710	83	No
Barium	75	51	840	-	3300	3300	No
Beryllium	70	0	<50	-	33	33	No
Bismuth	24	0	<1	-	-	-	No
Boron	70	22	2800	-	470000	470000	No
Cadmium	75	18	17	-	59	59	No
Calcium	69	69	318000	-	-	-	No
Chromium	75	10	29	1.1	89	89	No
Cobalt	75	42	28	-	1800	1800	No
Copper	75	39	54	-	95000	95000	No
Iron	70	23	52600	-	1700000	1700000	No
Lead	75	2	<2.5	-	-	-	No
Lithium	69	21	110	-	4700	4700	No
Magnesium	70	70	766000	-	-	-	No
Manganese	70	60	4490	-	2300	2300	Yes
Mercury	75	0	<0.2	-	50	50	No
Molybdenum	75	48	32	-	12000	12000	No
Nickel	75	35	34	-	9500	9500	No
Potassium	24	24	236000	-	-	-	No
Selenium	70	5	<50	-	12000	12000	No
Silicon	24	24	15300	-	-	-	No
Silver	75	0	<1	-	790	790	No
Sodium	70	70	7560000	-	-	-	No
Strontium	25	25	6550	-	1400000	1400000	No
Thallium	69	0	<5	-	24	24	No
Tin	30	1	1	-	1400000	1400000	No
Titanium	70	6	<100	-	-	-	No
Uranium	69	32	3.4	-	-	-	No
Vanadium	69	9	<300	-	12000	12000	No
Zinc	75	28	91	-	1200000	1200000	No
Zirconium	24	0	<10	-	-	-	No
Organotins							
Tributyltin	6	3	<0.24	-	46	46	No
VOCs							
Bromodichloromethane	20	0	<1	160	4600	160	No
Bromoform	20	0	<2	1200	4400	1200	No
Bromomethane	20	0	<10			-	No
Carbon tetrachloride	20	0	<2	37	240	37	No
Chlorobenzene	20	0	<0.5	-	910	910	No
Chlorodibromomethane	20	0	<1	120	4800	120	No
Chloroethane	20	0	<10	-	-	-	No

Table D3
Utitlity Workers - Chemical of Potential Concern Screening
Groundwater
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Measured Maximum (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Carcinogenic Target Risk -Dermal (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Noncancer Hazard Index - Dermal (ug/L)	Human Health Screening Level (ug/L)	COPC? (Yes/No)
Chloroform	20	2	49	250	1800	250	No
Chloromethane	20	0	<10	-	-	-	No
1,2-dibromoethane	14	0	<0.1			-	No
Dibromomethane	14	0	<0.2			-	No
1,2-dichlorobenzene	20	0	<0.5	-	2100	2100	No
1,3-dichlorobenzene	20	0	<0.5	-	-	-	No
1,4-dichlorobenzene	20	0	<0.5	180	1600	180	No
Dichlorodifluoromethane	14	0	<0.2			-	No
1,1-dichloroethane	20	1	1.8	1600	4000	1600	No
1,2-dichloroethane	20	1	4	160	1900	160	No
1,1-dichloroethene	20	1	2.8	-	5900	5900	No
cis-1,2-dichloroethene	20	0	<1	-	250	250	No
trans-1,2-dichloroethene	20	0	<1	-	2500	2500	No
Dichloromethane	20	0	<6	2500	25000	2500	No
1,2-dichloropropane	20	0	<1	200	15000	200	No
cis-1,3-dichloropropene	20	0	<1	67	4700	67	No
trans-1,3-dichloropropene	20	0	<1	67	4700	67	No
2-hexanone	14	0	<20			-	No
Methyl Ethyl Ketone	14	0	<5			-	No
4-Methyl-2-pentanone	14	0	<2			-	No
1,1,2,2-tetrachloroethane	20	0	<2	28	2600	28	No
Tetrachloroethene	20	1	1.2	2.2	270	2.2	No
1,1,1-trichloroethane	20	5	42	-	180000	180000	No
1,1,2-trichloroethane	20	0	<1	170	890	170	No
Trichloroethene	20	0	<1	66	490	66	No
Trichlorofluoromethane	20	0	<5	-	26000	26000	No
1,3,5-trimethylbenzene	5	3	4.9			-	No
Vinyl chloride	20	0	<2	2.6	580	2.6	No

Table D4
Residents - Chemical of Potential Concern Screening
Soil Vapour
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Measured Maximum - Slab -on Grade attenuation (ug/m^3)	BC SCR Schedule 11, Resdiential Land (AL/PL/RL) Standards (ug/m^3)	Human Health Screening Level (mg/kg)	COPC? (Yes/No)
Monocuclic Aromatic						
Benzene	11	11	360	1.5	1.5	Yes
Ethylbenzene	11	8	160	1000	1000	No
Styrene	11	11	240	1000	5000	No
Toluene	9	4	2.4	5000	1000	No
Xylenes	11	11	1200	100	100	Yes
Methyl tert-butyl ether (MTBE)	1	1	0.088	3000	3000	No
VHv (C6-C13)	11	10	200000	-	-	No
VPHv (C6-C13)	11	10	190000	1000	1000	Yes
PAH						
Naphthalene	10	9	5400	3	3	Yes
VOC						
Acetone	10	7	20	20	20	No
Bromodichloromethane	10	0	<0.6	1	1	No
Bromoform	10	0	<0.6	9	9	No
1,3-Butadiene	1	0	<0.04	2	2	No
Carbon tetrachloride	10	0	<0.6	0.65	0.65	No
Chlorobenzene	10	5	<0.6	50	50	No
Chlorodibromomethane	10	0	<0.6	40	40	No
Chloroethane	10	0	<3	10000	10000	No
Decane	11	7	170	2500	2500	No
1,2-dibromoethane	1	0	<0.5	1	1	No
1,2-dichlorobenzene	10	4	<0.6	200	200	No
1,3-dichlorobenzene	10	2	<0.6	80	80	No
1,4-dichlorobenzene	10	3	<0.6	800	800	No
1,1-dichloroethane	10	2	3.4	500	500	No
1,2-dichloroethane	11	0	<.2	0.4	0.4	No
1,1-dichloroethene	10	6	<0.6	1	1	No
cis-1,2-dichloroethene	10	1	1.7	20	20	No
trans-1,2-dichloroethene	10	1	<0.6	60	60	No
1,2-dichloropropane	10	0	<0.6	0.65	0.65	No
cis-1,3-dichloropropene	10	0	<0.6	7.5	7.5	No
trans-1,3-dichloropropene	10	0	<0.6	7.5	7.5	No
Ethyl acetate	10	0	<3	2000	2000	No
Hexane	11	10	13000	700	700	Yes
Isopropylbenzene	11	8	18	400	400	No
Methyl Ethyl Ketone	10	6	<12	5000	5000	No
Methylcyclohexane	1	1	7	3000	3000	No
1,1,1,2-tetrachloroethane	10	0	<0.6	1.5	1.5	No
1,1,2,2-tetrachloroethane	10	0	<0.42	1	1	No
Tetrachloroethene	10	9	46	600	600	No
1,1,1-trichloroethane	10	5	2.6	2000	2000	No
1,1,2-trichloroethane	10	0	<0.6	0.6	0.6	No
Trichloroethene	10	6	0.86	0.5	0.5	Yes
Trichlorofluoromethane	10	6	<0.6	700	700	No
1,2,4-trimethylbenzene	10	10	240	6	6	Yes
1,3,5-trimethylbenzene	10	7	280	6	6	Yes
Vinyl chloride	10	3	46	1	1	Yes

Table D5
Construction/Excavation Workers - Chemical of Potential Concern Screening
Soil Vapour
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Measured Maximum - Outdoor attenuation >1mbgs (ug/m^3)	BC SCR Schedule 11, Residential Land (AL/PL/RL) Standards (ug/m^3)	Human Health Screening Level (mg/kg)	COPC? (Yes/No)
Monocuclic Aromatic						
Benzene	11	11	1.8	4	4	No
Ethylbenzene	11	8	0.8	3000	3000	No
Styrene	11	11	1.2	3000	3000	No
Toluene	9	4	0.012	15000	15000	No
Xylenes	11	11	6	300	300	No
Methyl tert-butyl ether (MTBE)	1	1	0.00044	9000	9000	No
VHv (C6-C13)	11	10	1000	-	-	No
VPHv (C6-C13)	11	10	950	3000	3000	No
PAH						
Naphthalene	10	9	27	9	9	Yes
VOC						
Acetone	10	7	0.1	60	60	No
Bromodichloromethane	10	0	<0.6	2	2	No
Bromoform	10	0	<0.6	30	30	No
1,3-Butadiene	1	0	<0.04	6	6	No
Carbon tetrachloride	10	0	<0.6	2	2	No
Chlorobenzene	10	5	<0.6	150	150	No
Chlorodibromomethane	10	0	<0.6	100	100	No
Chloroethane	10	0	<3	30000	30000	No
Decane	11	7	0.85	80	80	No
1,2-dibromoethane	1	0	<0.5	1	1	No
1,2-dichlorobenzene	10	4	<0.6	600	600	No
1,3-dichlorobenzene	10	2	<0.6	250	250	No
1,4-dichlorobenzene	10	3	<0.6	2500	2500	No
1,1-dichloroethane	10	2	0.017	1500	1500	No
1,2-dichloroethane	11	0	<36	1	1	No
1,1-dichloroethene	10	6	<0.6	1	1	No
cis-1,2-dichloroethene	10	1	0.0085	60	60	No
trans-1,2-dichloroethene	10	1	<0.6	200	200	No
1,2-dichloropropane	10	0	<0.6	2	2	No
cis-1,3-dichloropropene	10	0	<0.6	20	20	No
trans-1,3-dichloropropene	10	0	<0.6	20	20	No
Ethyl acetate	10	0	<3	5500	5500	No
Hexane	11	10	65	2000	2000	No
Isopropylbenzene	11	8	0.09	1000	1000	No
Methyl Ethyl Ketone	10	6	<12	15000	15000	No
Methylcyclohexane	1	1	0.035	9000	9000	No
1,1,1,2-tetrachloroethane	10	0	<0.6	4	4	No
1,1,2,2-tetrachloroethane	10	0	<0.42	1	1	No
Tetrachloroethene	10	9	0.23	2000	2000	No
1,1,1-trichloroethane	10	5	0.013	6500	6500	No
1,1,2-trichloroethane	10	0	<0.6	2	2	No
Trichloroethene	10	6	0.0043	0.5	0.5	No
Trichlorofluoromethane	10	6	<0.6	2000	2000	No
1,2,4-trimethylbenzene	10	10	1.2	20	20	No
1,3,5-trimethylbenzene	10	7	1.4	20	20	No
Vinyl chloride	10	3	0.23	3.5	3.5	No

Table D6
Utility/Trench Workers - Chemical of Potential Concern Screening
Soil Vapour
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Measured Maximum - Trench air attenuation of 0.09 (ug/m^3)	BC SCR Schedule 11, Commercial Land (CL) Standards (ug/m^3)	Human Health Screening Level (mg/kg)	COPC? (Yes/No)
Monocuclic Aromatic						
Benzene	11	11	1620	4	4	Yes
Ethylbenzene	11	8	720	3000	3000	No
Styrene	11	11	1080	3000	3000	No
Toluene	9	4	10.8	15000	15000	No
Xylenes	11	11	5400	300	300	Yes
Methyl tert-butyl ether (MTBE)	1	1	0.396	9000	9000	No
VHv (C6-C13)	11	10	900000	-	-	No
VPHv (C6-C13)	11	10	855000	3000	3000	Yes
PAH						
Naphthalene	10	9	24300	9	9	Yes
VOC						
Acetone	10	7	90	60	60	Yes
Bromodichloromethane	10	0	<2	2	2	No
Bromoform	10	0	<2.7	30	30	No
1,3-Butadiene	1	0	<0.18	6	6	No
Carbon tetrachloride	10	0	<2	2	2	No
Chlorobenzene	10	5	<2.7	150	150	No
Chlorodibromomethane	10	0	<2.7	100	100	No
Chloroethane	10	0	<13.5	30000	30000	No
Decane	11	7	765	80	80	Yes
1,2-dibromoethane	1	0	<0.0045	1	1	No
1,2-dichlorobenzene	10	4	<2.7	600	600	No
1,3-dichlorobenzene	10	2	<2.7	250	250	No
1,4-dichlorobenzene	10	3	<2.7	2500	2500	No
1,1-dichloroethane	10	2	15.3	1500	1500	No
1,2-dichloroethane	11	0	<1	1	1	No
1,1-dichloroethene	10	6	<1	1	1	No
cis-1,2-dichloroethene	10	1	7.65	60	60	No
trans-1,2-dichloroethene	10	1	<2.7	200	200	No
1,2-dichloropropane	10	0	<1	2	2	No
cis-1,3-dichloropropene	10	0	<2.7	20	20	No
trans-1,3-dichloropropene	10	0	<2.7	20	20	No
Ethyl acetate	10	0	<13.5	5500	5500	No
Hexane	11	10	58500	2000	2000	Yes
Isopropylbenzene	11	8	81	1000	1000	No
Methyl Ethyl Ketone	10	6	<54	15000	15000	No
Methylcyclohexane	1	1	31.5	9000	9000	No
1,1,1,2-tetrachloroethane	10	0	<2.7	4	4	No
1,1,2,2-tetrachloroethane	10	0	<1	1	1	No
Tetrachloroethene	10	9	207	2000	2000	No
1,1,1-trichloroethane	10	5	11.7	6500	6500	No
1,1,2-trichloroethane	10	0	<2	2	2	No
Trichloroethene	10	6	3.87	0.5	0.5	Yes
Trichlorofluoromethane	10	6	<2.7	2000	2000	No
1,2,4-trimethylbenzene	10	10	1080	20	20	Yes
1,3,5-trimethylbenzene	10	7	1260	20	20	Yes
Vinyl chloride	10	3	207	3.5	3.5	Yes

Table D7
Residents - Chemical of Potential Concern Screening
Roche Point Creek Sediment
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Schedule 5 Intake of Contaminated Soil PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests								
pH	4	4	7.63	-	-	-	-	No
Extractable Petroleum Hydrocarbons								
EPH10-19	4	0	<200	-	-	1000	1000	No
EPH19-32	4	0	<200	-	-	1000	1000	No
LEPH	4	0	<200	-	-	1000	1000	No
HEPH	4	0	<200	-	-	1000	1000	No
Polycyclic Aromatic Hydrocarbons (PAHs)								
2-Methylnaphthalene	4	0	<0.05	-	-	-	-	No
Acenaphthene	4	0	<0.05	-	-	-	-	No
Acenaphthylene	4	0	<0.05	-	-	-	-	No
Anthracene	4	0	<0.05	-	-	-	-	No
Benzo(a)anthracene	4	0	<0.05	-	-	1	1	No
Benzo(a)pyrene	4	2	0.073	5	-	-	5	No
Benzo(g,h,i)perylene	4	2	0.078	-	-	-	-	No
Benzo(b)fluoranthene	4	2	0.153	-	-	1	1	No
Benzo(k)fluoranthene	4	0	<0.05	-	-	1	1	No
Chrysene	4	2	0.072	-	-	-	-	No
Dibenz(a,h)anthracene	4	0	<0.05	-	-	1	1	No
Fluoranthene	4	2	0.123	-	-	-	-	No
Fluorene	4	0	<0.05	-	-	-	-	No
Indeno(1,2,3-c,d)pyrene	4	2	0.079	-		1	1	No
Naphthalene	4	0	<0.05	-	-	5	5	No
Phenanthrene	4	0	<0.05	-	-	5	5	No
Pyrene	4	2	0.12	-	-	10	10	No
Metals								
Antimony	4	4	0.34	-	-	20	20	No
Arsenic	4	4	3.01	100	-	-	100	No
Barium	4	4	43.4	6500	-	-	6500	No
Beryllium	4	0	<0.2	-	-	4	4	No
Cadmium	4	4	0.118	35	-	-	35	No
Chromium	4	4	17.6	100	-	-	100	No
Cobalt	4	4	5.12	-	-	50	50	No
Copper	4	4	21.9	15000	-	-	15000	No
Lead	4	4	5.37	500	-	-	500	No
Mercury	4	0	<0.05	15	-	-	15	No
Molybdenum	4	1	2.47	-	-	10	10	No
Nickel	4	4	8.25	-	-	100	100	No
Selenium	4	0	<0.2	-	-	3	3	No
Silver	4	0	<0.1	-	-	20	20	No
Thallium	4	0	<0.05	-	-	-	-	No
Tin	4	0		-	50	50	50	Yes
Uranium	4	4	0.849	-	16	-	16	No
Vanadium	4	4	39.2	-	-	200	200	No
Zinc	4	4	76.6	10000	-	-	10000	No

Table D8
Residents - Chemical of Potential Concern Screening
Roche Point Creek Surface Water
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Modelled Maximum (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Carcinogenic Target Risk -Dermal (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Noncancer Hazard Index - Dermal (ug/L)	Human Health Screening Level (ug/L)	COPC? (Yes/No)
Physical Tests							
Hardness, Total (CaCO3) (mg/L)	45	45	379	-	-	NA	No
InOrganics							
TDS (Filtered)	15	15	-				
EPHs							
EPH10-19	69	14	269	-	-	-	No
EPH19-32	69	5	41	-	-	-	No
LEPH	68	14	120	-	-	-	No
HEPH	68	5	41	-	-	-	No
MAHs							
Benzene	67	9	4.35	84	410	84	No
Ethylbenzene	67	9	4.87	110	2600	11	No
Styrene	67	17	2.4	-	7100	7100	No
Toluene	65	0	<0.05	-	3700	3700	No
Xylenes	67	14	19.2	-	5500	5500	No
VH C6-C10	59	7	147			-	No
VPH (C6-C10)	59	6	118			-	No
MTBE	52	1	0.063	17000	-	17000	No
PAHs							
Acenaphthene	85	21	10.6	-	680	680	No
Acenaphthylene	85	12	0.0707	-	-	-	No
Acridine	85	3	0.218	-	-	-	No
Anthracene	85	17	0.606	-	1800	1800	No
Benzo(a)anthracene	85	18	0.0353	-	-	-	No
Benzo(a)pyrene	85	26	0.0109	-	-	-	No
Benzo(g,h,i)perylene	85	12	0.0089	-	-	-	No
Benzo(b)fluoranthene	85	16	0.0147	-	-	-	No
Benzo(k)fluoranthene	67	5	0.011	-	-	-	No
Chrysene	85	18	0.0291	-	-	-	No
Dibenz(a,h)anthracene	85	0	<0.005	-	-	-	No
Fluoranthene	85	22	1.11	-	-	-	No
Fluorene	85	19	6.79	-	330	330	No
Indeno(1,2,3-c,d)pyrene	85	12	0.0085	-	-	-	No
Naphthalene	90	24	122	-	500	500	No
Phenanthrene	85	19	9.19	-	-	-	No
Pyrene	85	24	0.564	-	110	110	No
Quinoline	85	2	0.25	2.5	-	2.5	No
Dissolved Metals							
Aluminum	70	34	<15	-	2400000	2400000	No
Antimony	72	5	<15	-	140	140	No
Arsenic	78	37	1.99	83	710	83	No
Barium	75	51	84	-	3300	3300	No
Beryllium	70	0	<5	-	33	33	No
Bismuth	24	0	<0.1	-	-	-	No
Boron	70	22	280	-	470000	470000	No
Cadmium	75	18	1.7	-	59	59	No
Calcium	69	69	31800	-	-	-	No
Chromium	75	10	2.9	1.1	89	89	No
Cobalt	75	42	2.8	-	1800	1800	No
Copper	75	39	5.4	-	95000	95000	No
Iron	70	23	5260	-	1700000	1700000	No
Lead	75	2	<0.25	-	-	-	No
Lithium	69	21	11	-	4700	4700	No
Magnesium	70	70	76600	-	-	-	No
Manganese	70	60	449	-	2300	2300	No
Mercury	75	0	<0.02	-	50	50	No

Table D8
Residents - Chemical of Potential Concern Screening
Roche Point Creek Surface Water
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Modelled Maximum (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Carcinogenic Target Risk -Dermal (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Noncancer Hazard Index - Dermal (ug/L)	Human Health Screening Level (ug/L)	COPC? (Yes/No)
Dissolved Metals							
Molybdenum	75	48	3.2	-	12000	12000	No
Nickel	75	35	3.4	-	9500	9500	No
Potassium	24	24	23600	-	-	-	No
Selenium	70	5	<5	-	12000	12000	No
Silicon	24	24	1530	-	-	-	No
Silver	75	0	<0.1	-	790	790	No
Sodium	70	70	756000	-	-	-	No
Strontium	25	25	655	-	1400000	1400000	No
Thallium	69	0	<0.5	-	24	24	No
Tin	30	1	0.1	-	1400000	1400000	No
Titanium	70	6	<10	-	-	-	No
Uranium	69	32	0.34	-	-	-	No
Vanadium	69	9	<30	-	12000	12000	No
Zinc	75	28	9.1	-	1200000	1200000	No
Zirconium	24	0	<1	-	-	-	No
Organotins							
Tributyltin	6	3	<0.024	-	46	46	No
VOCs							
Bromodichloromethane	20	0	<0.1	160	4600	160	No
Bromoform	20	0	<0.2	1200	4400	1200	No
Bromomethane	20	0	<1			-	No
Carbon tetrachloride	20	0	<0.2	37	240	37	No
Chlorobenzene	20	0	<0.5	-	910	910	No
Chlorodibromomethane	20	0	<0.1	120	4800	120	No
Chloroethane	20	0	<1	-	-	-	No
Chloroform	20	2	490	250	1800	250	No
Chloromethane	20	0	<1	-	-	-	No
1,2-dibromoethane	14	0	<0.01			-	No
Dibromomethane	14	0	<0.02			-	No
1,2-dichlorobenzene	20	0	<0.05	-	2100	2100	No
1,3-dichlorobenzene	20	0	<0.05	-	-	-	No
1,4-dichlorobenzene	20	0	<0.05	180	1600	180	No
Dichlorodifluoromethane	14	0	<0.02			-	No
1,1-dichloroethane	20	1	18	1600	4000	1600	No
1,2-dichloroethane	20	1	40	160	1900	160	No
1,1-dichloroethene	20	1	28	-	5900	5900	No
cis-1,2-dichloroethene	20	0	<0.1	-	250	250	No
trans-1,2-dichloroethene	20	0	<0.1	-	2500	2500	No
Dichloromethane	20	0	<0.6	2500	25000	2500	No
1,2-dichloropropane	20	0	<0.1	200	15000	200	No
cis-1,3-dichloropropene	20	0	<0.1	67	4700	67	No
trans-1,3-dichloropropene	20	0	<0.1	67	4700	67	No
2-hexanone	14	0	<2			-	No
Methyl Ethyl Ketone	14	0	<0.5			-	No
4-Methyl-2-pentanone	14	0	<0.2			-	No
1,1,2,2-tetrachloroethane	20	0	<0.2	28	2600	28	No
Tetrachloroethene	20	1	12	2.2	270	2.2	No
1,1,1-trichloroethane	20	5	420	-	180000	180000	No
1,1,2-trichloroethane	20	0	<0.1	170	890	170	No
Trichloroethene	20	0	<0.1	66	490	66	No
Trichlorofluoromethane	20	0	<0.5	-	26000	26000	No
1,3,5-trimethylbenzene	5	3	49			-	No
Vinyl chloride	20	0	<0.5	2.6	580	2.6	No

Table D9
Residents - Chemical of Potential Concern Screening
Roche Point Creek Surface Water
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests										
pH	19	19	8.8	-	unknown	-	-	-	-	No
Total Petroleum Hydrocarbons										
F4 (C34-C50)	3	2	63	-	unknown	-	-	-	-	No
F2-Naphth	3	0	<30	-	unknown	-	-	-	-	No
F3-PAH	3	3	125	-	unknown	-	-	-	-	No
F4G-SG	2	0	<500	-	unknown	-	-	-	-	No
Extractable Petroleum Hydrocarbons										
EPH10-19	8	2	970	-	unknown	-	-	1000	1000	No
EPH19-32	8	4	3610	-	unknown	-	-	1000	1000	Yes
LEPH	8	2	960	-	unknown	-	-	1000	1000	No
HEPH	8	4	3600	-	unknown	-	-	1000	1000	Yes
Monocyclic Aromatic Hydrocarbons (MAHs)										
Benzene	3	0	<0.04	-	unknown	1000	-	-	1000	No
Ethylbenzene	3	2	0.076	-	unknown	3500	-	-	3500	No
Toluene	3	0	<0.1	-	unknown	40000	-	-	40000	No
Styrene	3	0	<0.05	-	unknown	-	-	5	5	No
Xylene Total	3	3	1.1	-	unknown	65000	-	-	65000	No
MTBE	3	0	<0.2	-	unknown	-	320	-	320	No
Polyclyclic Aromatic Hydrocarbons (PAHs)										
2-Methylnaphthalene	31	11	0.896	-	unknown	-	-	-	-	No
Acenaphthene	31	18	3.39	-	unknown	-	-	-	-	No
Acenaphthylene	31	12	0.687	-	unknown	-	-	-	-	No
Anthracene	31	21	4.18	-	unknown	-	-	-	-	No
Benzo(a)anthracene	31	24	10.3	-	unknown	-	-	1	1	Yes
Benzo(a)pyrene	31	24	11.2	-	unknown	5	-	-	5	Yes
Benzo(g,h,i)perylene	31	24	6.8	-	unknown	-	-	-	-	No
Benzo(b)fluoranthene	31	25	15.2	-	unknown	-	-	1	1	Yes
Benzo(k)fluoranthene	31	24	6.34	-	unknown	-	-	1	1	Yes
Chrysene	31	24	9.48	-	unknown	-	-	-	-	No
Dibenz(a,h)anthracene	31	13	1.57	-	unknown	-	-	1	1	Yes
Fluoranthene	31	25	30.8	-	unknown	-	-	-	-	No
Fluorene	31	17	1.89	-	unknown	-	-	-	-	No
Indeno(1,2,3-c,d)pyrene	31	24	7.56	-	unknown	-		1	1	Yes
Naphthalene	31	15	1.26	-	unknown	-	-	5	5	No
Phenanthrene	31	25	11.8	-	unknown	-	-	5	5	Yes
Pyrene	31	25	25	-	unknown	-	-	10	10	Yes
Metals										
Aluminum	8	8	27200	-	unknown	-	-	-	-	No
Antimony	33	15	121	4	yes	-	-	20	20	Yes
Arsenic	31	21	595	15	yes	100	-	-	100	Yes
Barium	31	31	969	150	yes	6500	-	-	6500	No
Beryllium	31	4	2.95	1	yes	-	-	4	4	No
Boron	8	5	14	-	unknown	-	-	-	-	No
Cadmium	31	13	236	0.55	yes	35	-	-	35	Yes
Calcium	8	8	103000	-	unknown	-	-	-	-	No
Chromium	31	31	79	100	yes	100	-	-	100	No
Cobalt	31	31	34	15	yes	-	-	50	50	No
Copper	33	33	5960	100	yes	15000	-	-	15000	No
Iron	8	8	104000	-	yes	-	-	-	-	No
Lead	31	18	304	300	yes	500	-	-	500	No
Magnesium	8	8	17200	-	unknown	-	-	-	-	No
Mercury	33	25	3.68	0.4	yes	15	-	-	15	No
Molybdenum	31	12	11	6	yes	-	-	10	10	Yes

Table D9
Residents - Chemical of Potential Concern Screening
Roche Point Creek Surface Water
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
Nickel	31	30	50.3	75	yes	-	-	100	100	No
Phosphorus	8	8	1210	-	unknown	-	-	-	-	No
Potassium	8	8	3480	-	unknown	-	-	-	-	No
Selenium	31	0	<3	2	no	-	-	3	3	No
Silver	31	5	<2	1	yes	-	-	20	20	No
Sodium	8	8	850	-	unknown	1000000	-	-	1000000	No
Strontium	11	3	250	-	unknown	-	47000	-	47000	No
Thallium	11	3	0.076	-	unknown	-	-	-	-	No
Tin	33	14	23.5	4	yes	-	50	50	50	No
Titanium	8	8	681	-	unknown	-	-	-	-	No
Uranium	11	11	1.14	-	unknown	-	16	-	16	No
Vanadium	31	31	209	100	yes	-	-	200	200	Yes
Zinc	31	31	2980	90	yes	10000	-	-	10000	No
Zirconium	8	8	16	-	unknown	-	-	-	-	No
Organontins										
Dibutyltin	7	7	0.52	-	unknown	-	-	-	-	No
Monobutyltin	7	7	0.11	-	unknown	-	-	-	-	No
Tributyltin	7	7	3.66	-	unknown	-	-	-	-	No
Volatile Organic Compounds										
Bromodichloromethane	3	0	<0.05	-	unknown	-	8.2	-	8.2	No
Bromoform	3	0	<0.05	-	unknown	-	620	-	620	No
Carbon tetrachloride	3	0	<0.05	-	unknown	-	-	5	5	No
Chlorobenzene	3	0	<0.05	-	unknown	-	-	1	1	No
Chlorodibromomethane	3	0	<0.05	-	unknown	-	11	-	11	No
Chloroethane	3	0	<0.1	-	unknown	-	30	-	30	No
Chloroform	3	0	<0.1	-	unknown	-	-	5	5	No
Chloromethane	3	0	<0.1	-	unknown	-	47	-	47	No
1,2-dichlorobenzene	3	0	<0.05	-	unknown	-	-	1	1	No
1,3-dichlorobenzene	3	0	<0.05	-	unknown	-	-	1	1	No
1,4-dichlorobenzene	3	0	<0.05	-	unknown	-	-	1	1	No
1,1-dichloroethane	3	0	<0.05	-	unknown	-	5	5	5	No
1,2-dichloroethane	3	0	<0.05	-	unknown	-	-	5	5	No
1,1-dichloroethene	3	0	<0.05	-	unknown	-	-	5	5	No
cis-1,2-dichloroethene	3	0	<0.05	-	unknown	-	5	-	5	No
trans-1,2-dichloroethene	3	0	<0.05	-	unknown	-	5	-	5	No
Dichloromethane	3	0	<1.5	-	unknown	-	-	5	5	No
1,2-dichloropropane	3	0	<0.05	-	unknown	-	5	5	5	No
cis-1,3-dichloropropene	3	0	<0.05	-	unknown	-	-	5	5	No
trans-1,3-dichloropropene	3	0	<0.05	-	unknown	-	-	5	5	No
1,1,1,2-tetrachloroethane	3	0	<0.05						-	-
1,1,2,2-tetrachloroethane	3	0	<0.05	-	unknown	-	4.1	-	4.1	No
Tetrachloroethene	3	0	<0.05	-	unknown	1000	-	-	1000	No
1,1,1-trichloroethane	3	0	<0.05	-	unknown	-	5	5	5	No
1,1,2-trichloroethane	3	0	<0.05	-	unknown	-	5	5	5	No
Trichloroethene	3	0	<0.05	-	unknown	200	-	-	200	No
Trichlorofluoromethane	3	0	<0.1	-	unknown	-	390	-	390	No
Vinyl chloride	3	0	<0.1	-	unknown	-	0.79	-	0.79	No
Polychlorinated Biphenlys										
Arochlor 1242	2	0	<0.03	-	unknown	-	-	-	-	No
Arochlor 1248	2	0	<0.03	-	unknown	-	-	-	-	No
Arochlor 1254	2	0	<0.03	-	unknown	-	-	-	-	No
Arochlor 1260	2	0	<0.03	-	unknown	-	-	-	-	No
PCBs (Sum of total)	6	3	0.324	-	unknown	5	-	-	5	No

Appendix 5

Ecological COPC Screening Sheets

Table E1
Soil Invertbrates and Plants - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Toxicity to Soil Inverts and Plants PL/RL Land Use (mg/kg) ¹	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Ecological Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests										
pH	177	177	9.8	-	unknown	-	-	-	-	No
Total Petroleum Hydrocarbons										
Mineral Oil and Grease	13	8	41000	-	unknown	-	-	-	-	No
Total EH	1	1	12	-	unknown	-	-	-	-	No
Extractable Petroleum Hydrocarbons										
EPH10-19	73	12	6450	-	unknown	-	-	1000	1000	Yes
EPH19-32	73	21	14900	-	unknown	-	-	1000	1000	Yes
LEPH	53	6	6200	-	unknown	-	-	1000	1000	Yes
HEPH	53	13	13700	-	unknown	-	-	1000	1000	Yes
Monocyclic Aromatic Hydrocarbons (MAHs)										
Benzene	56	6	<0.4	-	unknown	70	-	-	70	No
Ethylbenzene	56	11	1.7	-	unknown	1	-	-	1	Yes
Toluene	56	6	0.9	-	unknown	1.5	-	-	1.5	No
Styrene	54	0	<0.2	-	unknown	-	-	5	5	No
Xylene Total	56	14	13.4	-	unknown	5	-	-	5	Yes
VH C6-C10	49	5	420	-	unknown	-	-	-	-	No
VPH (C6-C10)	49	5	410	-	unknown	-	-	200	200	Yes
MTBE	39	0	<0.25	-	unknown	-	320	-	320	No
Polyclyclic Aromatic Hydrocarbons (PAHs)										
2-Methylnaphthalene	54	16	11.5	-	unknown	-	-	-	-	No
Acenaphthene	57	13	18.6	-	unknown	-	-	-	-	No
Acenaphthylene	57	9	15.4	-	unknown	-	-	-	-	No
Anthracene	57	18	103	-	unknown	-	-	-	-	No
Benzo(a)anthracene	57	23	159	-	unknown	-	-	1	1	Yes
Benzo(a)pyrene	57	22	197	-	unknown	1	-	-	1	Yes
Benzo(g,h,i)perylene	57	18	83.9	-	unknown	-	-	-	-	No
Benzo(b)fluoranthene	54	22	261	-	unknown	-	-	1	1	Yes
Benzo(k)fluoranthene	54	12	109	-	unknown	-	-	1	1	Yes
Chrysene	57	23	160	-	unknown	-	-	-	-	No
Dibenz(a,h)anthracene	57	12	18.9	-	unknown	-	-	1	1	Yes
Fluoranthene	57	27	383	-	unknown	-	-	-	-	No
Fluorene	57	13	31.2	-	unknown	-	-	-	-	No
Indeno(1,2,3-c,d)pyrene	57	19	106	-	unknown	-	-	1	1	Yes
Naphthalene	60	17	28.5	-	unknown	-	-	5	5	Yes
Phenanthrene	57	26	245	-	unknown	-	-	5	5	Yes
Pyrene	57	26	328	-	unknown	-	-	10	10	Yes
Metals										
Aluminum	53	53	50300	-	unknown	-	-	-	-	No
Antimony	152	101	121	4	yes	-	-	20	20	Yes
Arsenic	170	132	595	15	yes	50	-	-	50	Yes
Barium	169	169	969	150	yes	1000	-	-	1000	No
Beryllium	150	51	2.95	1	yes	-	-	4	4	No
Boron	53	29	14	-	unknown	-	-	-	-	No
Cadmium	169	115	236	0.55	yes	70	-	-	70	Yes
Calcium	53	53	84500	-	unknown	-	-	-	-	No
Chromium	169	169	326	100	yes	300	-	-	300	Yes
Cobalt	169	168	37	15	yes	-	-	50	50	No
Copper	176	176	8130	100	yes	150	-	-	150	Yes
Iron	53	53	41600	-	yes	-	-	-	-	No
Lead	175	165	3550	300	yes	1000	-	-	1000	Yes
Magnesium	53	53	12000	-	unknown	-	-	-	-	No
Manganese	34	34	502	-	unknown	-	1800	-	1800	No
Mercury	169	115	39.5	0.4	yes	100	-	-	100	No
Molybdenum	169	77	37.5	6	yes	-	-	10	10	Yes
Nickel	169	169	142	75	yes	-	-	100	100	Yes
Phosphorus	53	53	930	-	unknown	-	-	-	-	No

Table E1
Soil Invertbrates and Plants - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Toxicity to Soil Inverts and Plants PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Ecological Screening Level (ug/L)	COPC ? (Yes/No)
Potassium	53	53	2700	-	unknown	-	-	-	-	No
Selenium	169	47	2	2	no	-	-	3	3	No
Silver	169	59	2	1	yes	-	-	20	20	No
Sodium	53	53	4050	-	unknown	200	-	-	200	Yes
Strontium	34	34	250	-	unknown	-	47000	-	47000	No
Thallium	96	39	0.365	-	unknown	-	-	-	-	No
Tin	171	58	83.7	4	yes	-	50	50	50	Yes
Titanium	53	53	864	-	unknown	-	-	-	-	No
Uranium	96	96	6.24	-	unknown	-	16	-	16	No
Vanadium	150	150	393	100	yes	-	-	200	200	Yes
Zinc	170	170	4300	90	yes	450	-	-	450	Yes
Zirconium	53	53	8	-	unknown	-	-	-	-	No
Organontins										
Tributyltin	6	5	937	-	unknown	-	-	-	-	No
Volatile Organic Compounds										
Bromodichloromethane	4	0	<0.03	-	unknown	-	8.2	-	8.2	No
Bromoform	4	0	<0.03	-	unknown	-	620	-	620	No
Bromomethane	4	0	<0.12	-	unknown	-	3.9	-	3.9	No
Carbon tetrachloride	7	0	<0.2	-	unknown	-	-	5	5	No
Chlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
Chlorodibromomethane	4	0	<0.03	-	unknown	-	11	-	11	No
Chloroethane	4	0	<0.06	-	unknown	-	30	-	30	No
Chloroform	7	0	<0.1	-	unknown	-	-	5	5	No
Chloromethane	4	0	<0.12	-	unknown	-	47	-	47	No
1,2-dibromoethane	4	0	<0.03	-	unknown	-	0.32	-	0.32	No
Dibromomethane	4	0	<0.03	-	unknown	-	67	-	67	No
1,2-dichlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
1,3-dichlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
1,4-dichlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
Dichlorodifluoromethane	4	0	<0.06	-	unknown	-	94	-	94	No
1,1-dichloroethane	7	0	<0.1	-	unknown	-	5	5	5	No
1,2-dichloroethane	7	0	<0.2	-	unknown	-	-	5	5	No
1,1-dichloroethene	7	0	<0.1	-	unknown	-	-	5	5	No
cis-1,2-dichloroethene	7	0	<0.1	-	unknown	-	5	-	5	No
trans-1,2-dichloroethene	7	0	<0.1	-	unknown	-	5	-	5	No
Dichloromethane	7	2	<0.9*	-	unknown	-	-	5	5	No
1,2-dichloropropane	7	0	<0.1	-	unknown	-	5	5	5	No
cis-1,3-dichloropropene	7	0	<0.1	-	unknown	-	-	5	5	No
trans-1,3-dichloropropene	7	0	<0.1	-	unknown	-	-	5	5	No
2-hexanone	4	0	<1.5	-	unknown	-	-	-	0	No
Methyl Ethyl Ketone	4	0	<1.5	-	unknown	-	22000	-	22000	No
4-Methyl-2-pentanone	4	0	<0.06	-	unknown	-	5300	-	5300	No
1,1,2,2-tetrachloroethane	7	0	<0.2	-	unknown	-	4.1	-	4.1	No
Tetrachloroethene	7	0	<0.1	-	unknown	5	-	-	5	No
1,1,1-trichloroethane	7	0	<0.2	-	unknown	-	5	5	5	No
1,1,2-trichloroethane	7	0	<0.1	-	unknown	-	5	5	5	No
Trichloroethene	7	0	<0.1	-	unknown	5	-	-	5	No
Trichlorofluoromethane	4	0	<0.03	-	unknown	-	390	-	390	No
1,3,5-trimethylbenzene	3	0	<0.1	-	unknown	-	-	-	-	No
Vinyl chloride	4	0	<0.06	-	unknown	-	0.79	-	0.79	No
Polychlorinated Biphenlys										
Arochlor 1242	2	0	<0.1	-	unknown	-	-	-	-	No
Arochlor 1248	2	0	<0.1	-	unknown	-	-	-	-	No
Arochlor 1254	2	2	0.37	-	unknown	-	-	-	-	No
Arochlor 1260	2	0	<0.1	-	unknown	-	-	-	-	No
PCBs (Sum of total)	10	5	1.4	-	unknown	5	-	-	5	No

Table E2
Wildlife - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Toxicity to Soil Inverts and Plants PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Ecological Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests										
pH	177	177	9.8	-	unknown	-	-	-	-	No
Total Petroleum Hydrocarbons										
Mineral Oil and Grease	13	8	41000	-	unknown	-	-	-	-	No
Total EH	1	1	12	-	unknown	-	-	-	-	No
Extractable Petroleum Hydrocarbons										
EPH10-19	77	12	6450	-	unknown	-	-	1000	1000	Yes
EPH19-32	77	21	14900	-	unknown	-	-	1000	1000	Yes
LEPH	57	6	6200	-	unknown	-	-	1000	1000	Yes
HEPH	57	13	13700	-	unknown	-	-	1000	1000	Yes
Monocyclic Aromatic Hydrocarbons (MAHs)										
Benzene	56	6	<0.4	-	unknown	70	-	-	70	No
Ethylbenzene	56	11	1.7	-	unknown	1	-	-	1	Yes
Toluene	56	6	0.9	-	unknown	1.5	-	-	1.5	No
Styrene	54	0	<0.2	-	unknown	-	-	5	5	No
Xylene Total	56	14	13.4	-	unknown	5	-	-	5	Yes
VH C6-C10	49	5	420	-	unknown	-	-	-	-	No
VPH (C6-C10)	49	5	410	-	unknown	-	-	200	200	Yes
MTBE	39	0	<0.25	-	unknown	-	320	-	320	No
Polyclyclic Aromatic Hydrocarbons (PAHs)										
2-Methylnaphthalene	58	16	11.5	-	unknown	-	-	-	-	No
Acenaphthene	61	13	18.6	-	unknown	-	-	-	-	No
Acenaphthylene	61	9	15.4	-	unknown	-	-	-	-	No
Anthracene	61	18	103	-	unknown	-	-	-	-	No
Benzo(a)anthracene	61	23	159	-	unknown	-	-	1	1	Yes
Benzo(a)pyrene	61	24	197	-	unknown	1	-	-	1	Yes
Benzo(g,h,i)perylene	61	20	83.9	-	unknown	-	-	-	-	No
Benzo(b)fluoranthene	58	24	261	-	unknown	-	-	1	1	Yes
Benzo(k)fluoranthene	58	12	109	-	unknown	-	-	1	1	Yes
Chrysene	61	25	160	-	unknown	-	-	-	-	No
Dibenz(a,h)anthracene	61	12	18.9	-	unknown	-	-	1	1	Yes
Fluoranthene	61	29	383	-	unknown	-	-	-	-	No
Fluorene	61	13	31.2	-	unknown	-	-	-	-	No
Indeno(1,2,3-c,d)pyrene	61	21	106	-	unknown	-	-	1	1	Yes
Naphthalene	64	17	28.5	-	unknown	-	-	5	5	Yes
Phenanthrene	61	26	245	-	unknown	-	-	5	5	Yes
Pyrene	61	28	328	-	unknown	-	-	10	10	Yes
Metals										
Aluminum	53	53	50300	-	unknown	-	-	-	-	No
Antimony	156	105	121	4	yes	-	-	20	20	Yes
Arsenic	174	136	595	15	yes	50	-	-	50	Yes
Barium	173	173	969	150	yes	1000	-	-	1000	No
Beryllium	154	51	2.95	1	yes	-	-	4	4	No
Boron	53	29	14	-	unknown	-	-	-	-	No
Cadmium	173	119	236	0.55	yes	70	-	-	70	Yes
Calcium	53	53	84500	-	unknown	-	-	-	-	No
Chromium	173	173	326	100	yes	300	-	-	300	Yes
Cobalt	173	172	37	15	yes	-	-	50	50	No
Copper	180	180	8130	100	yes	150	-	-	150	Yes
Iron	53	53	41600	-	yes	-	-	-	-	No
Lead	178	169	3550	300	yes	1000	-	-	1000	Yes
Magnesium	53	53	12000	-	unknown	-	-	-	-	No
Manganese	34	34	502	-	unknown	-	1800	-	1800	No
Mercury	173	115	39.5	0.4	yes	100	-	-	100	No
Molybdenum	173	78	37.5	6	yes	-	-	10	10	Yes
Nickel	173	173	142	75	yes	-	-	100	100	Yes
Phosphorus	53	53	930	-	unknown	-	-	-	-	No

Table E2
Wildlife - Chemical of Potential Concern Screening
Surface and Sub-Surface Soil
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Toxicity to Soil Inverts and Plants PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Ecological Screening Level (ug/L)	COPC ? (Yes/No)
Potassium	53	53	2700	-	unknown	-	-	-	-	No
Selenium	173	47	2	2	no	-	-	3	3	No
Silver	173	59	2	1	yes	-	-	20	20	No
Sodium	53	53	4050	-	unknown	200	-	-	200	Yes
Strontium	34	34	250	-	unknown	-	47000	-	47000	No
Thallium	100	39	0.365	-	unknown	-	-	-	-	No
Tin	175	58	83.7	4	yes	-	50	50	50	Yes
Titanium	53	53	864	-	unknown	-	-	-	-	No
Uranium	100	100	6.24	-	unknown	-	16	-	16	No
Vanadium	154	154	393	100	yes	-	-	200	200	Yes
Zinc	174	174	4300	90	yes	450	-	-	450	Yes
Zirconium	53	53	8	-	unknown	-	-	-	-	No
Organontins										
Tributyltin	6	5	937	-	unknown	-	-	-	-	No
Volatile Organic Compounds										
Bromodichloromethane	4	0	<0.03	-	unknown	-	8.2	-	8.2	No
Bromoform	4	0	<0.03	-	unknown	-	620	-	620	No
Bromomethane	4	0	<0.12	-	unknown	-	3.9	-	3.9	No
Carbon tetrachloride	7	0	<0.2	-	unknown	-	-	5	5	No
Chlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
Chlorodibromomethane	4	0	<0.03	-	unknown	-	11	-	11	No
Chloroethane	4	0	<0.06	-	unknown	-	30	-	30	No
Chloroform	7	0	<0.1	-	unknown	-	-	5	5	No
Chloromethane	4	0	<0.12	-	unknown	-	47	-	47	No
1,2-dibromoethane	4	0	<0.03	-	unknown	-	0.32	-	0.32	No
Dibromomethane	4	0	<0.03	-	unknown	-	67	-	67	No
1,2-dichlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
1,3-dichlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
1,4-dichlorobenzene	7	0	<0.1	-	unknown	-	-	1	1	No
Dichlorodifluoromethane	4	0	<0.06	-	unknown	-	94	-	94	No
1,1-dichloroethane	7	0	<0.1	-	unknown	-	5	5	5	No
1,2-dichloroethane	7	0	<0.2	-	unknown	-	-	5	5	No
1,1-dichloroethene	7	0	<0.1	-	unknown	-	-	5	5	No
cis-1,2-dichloroethene	7	0	<0.1	-	unknown	-	5	-	5	No
trans-1,2-dichloroethene	7	0	<0.1	-	unknown	-	5	-	5	No
Dichloromethane	7	2	<0.9*	-	unknown	-	-	5	5	No
1,2-dichloropropane	7	0	<0.1	-	unknown	-	5	5	5	No
cis-1,3-dichloropropene	7	0	<0.1	-	unknown	-	-	5	5	No
trans-1,3-dichloropropene	7	0	<0.1	-	unknown	-	-	5	5	No
2-hexanone	4	0	<1.5	-	unknown	-	-	-	0	No
Methyl Ethyl Ketone	4	0	<1.5	-	unknown	-	22000	-	22000	No
4-Methyl-2-pentanone	4	0	<0.06	-	unknown	-	5300	-	5300	No
1,1,2,2-tetrachloroethane	7	0	<0.2	-	unknown	-	4.1	-	4.1	No
Tetrachloroethene	7	0	<0.1	-	unknown	5	-	-	5	No
1,1,1-trichloroethane	7	0	<0.2	-	unknown	-	5	5	5	No
1,1,2-trichloroethane	7	0	<0.1	-	unknown	-	5	5	5	No
Trichloroethene	7	0	<0.1	-	unknown	5	-	-	5	No
Trichlorofluoromethane	4	0	<0.03	-	unknown	-	390	-	390	No
1,3,5-trimethylbenzene	3	0	<0.1	-	unknown	-	-	-	-	No
Vinyl chloride	4	0	<0.06	-	unknown	-	0.79	-	0.79	No
Polychlorinated Biphenlys										
Arochlor 1242	2	0	<0.1	-	unknown	-	-	-	-	No
Arochlor 1248	2	0	<0.1	-	unknown	-	-	-	-	No
Arochlor 1254	2	2	0.37	-	unknown	-	-	-	-	No
Arochlor 1260	2	0	<0.1	-	unknown	-	-	-	-	No
PCBs (Sum of total)	10	5	1.4	-	unknown	5	-	-	5	No

Table E3
Freshwater Aquatic Life - Chemical of Potential Concern Screening
Roche Point Creek Surface Water
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Modelled Maximum (ug/L)	BC Approved and Working Water Quality Guidelines Freshwater Aquatic Life (ug/L)	Ecological Screening Level (ug/L)	COPC? (Yes/No)
Physical Tests						
Hardness, Total (CaCO3) (mg/L)	45	45	379	-	NA	No
InOrganics						
TDS (Filtered)	15	15	-			
EPHs						
EPH10-19	69	14	269	-	-	No
EPH19-32	69	5	41	-	-	No
LEPH	68	14	120	-	-	No
HEPH	68	5	41	-	-	No
MAHs						
Benzene	67	9	4.35	40	40	No
Ethylbenzene	67	9	4.87	200	200	No
Styrene	67	17	2.4	72	72	No
Toluene	65	0	<0.05	0.5	0.5	No
Xylenes	67	14	19.2	30	30	No
VH C6-C10	59	7	147	-	-	No
VPH (C6-C10)	59	6	118	-	-	No
MTBE	52	1	0.063	3400	3400	No
PAHs						
Acenaphthene	85	21	10.6	6	6	Yes
Acenaphthylene	85	12	0.0707	-	-	No
Acridine	85	3	0.218	-	-	No
Anthracene	85	17	0.606	4	4	No
Benzo(a)anthracene	85	18	0.0353	0.1	0.1	No
Benzo(a)pyrene	85	26	0.01	0.01	0.01	No
Benzo(g,h,i)perylene	85	12	0.0089	-	-	No
Benzo(b)fluoranthene	85	16	0.0147	-	-	No
Benzo(k)fluoranthene	67	5	0.011	-	-	No
Chrysene	85	18	0.0291	-	-	No
Dibenz(a,h)anthracene	85	0	<0.005	-	-	No
Fluoranthene	85	22	1.11	4	4	No
Fluorene	85	19	6.79	12	12	No
Indeno(1,2,3-c,d)pyrene	85	12	0.0085	-	-	No
Naphthalene	90	24	122	1	1	Yes
Phenanthrene	85	19	9.19	0.3	0.3	No
Pyrene	85	24	0.564	-	-	No
Quinoline	85	2	0.25	3.4	3.4	No
Dissolved Metals						
Aluminum	70	34	<15	50-100	50-100	No
Antimony	72	5	<15	20*	20*	No
Arsenic	78	37	1.99	5*	5*	No
Barium	75	51	84	1000*	1000*	No
Beryllium	70	0	<5	5.3*	5.3*	No
Bismuth	24	0	<0.1	-	-	No
Boron	70	22	280	1200*	1200*	No
Cadmium	75	18	1.7	0.01 - 0.06*	0.01 - 0.06*	Yes
Calcium	69	69	31800	4000*	4000*	Yes
Chromium	75	10	2.9	8.9*	8.9*	No
Cobalt	75	42	2.8	4*	4*	No
Copper	75	39	5.4	0.04*	0.04*	Yes
Iron	70	23	5260	350*	350*	Yes
Lead	75	2	<0.25	4*	4*	No
Lithium	69	21	11	14*	14*	No
Magnesium	70	70	76600	-	-	No
Manganese	70	60	449	800 - 3800*	800 - 3800*	No
Mercury	75	0	<0.02	0.02*	0.02*	No
Molybdenum	75	48	3.2	1000*	1000*	No

Table E3
Freshwater Aquatic Life - Chemical of Potential Concern Screening
Roche Point Creek Surface Water
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Modelled Maximum (ug/L)	BC Approved and Working Water Quality Guidelines Freshwater Aquatic Life (ug/L)	Ecological Screening Level (ug/L)	COPC? (Yes/No)
Dissolved Metals						
Nickel	75	35	3.4	25*	25*	No
Potassium	24	24	23600	373000*	373000*	No
Selenium	70	5	<5	2*	2*	No
Silicon	24	24	1530	-	-	No
Silver	75	0	<0.1	1.5*	1.5*	No
Sodium	70	70	756000	-	-	No
Strontium	25	25	655	-	-	No
Thallium	69	0	<0.5	0.8*	0.8*	No
Tin	30	1	0.1	-	-	No
Titanium	70	6	<10	2000*	2000*	No
Uranium	69	32	0.34	300*	300*	No
Vanadium	69	9	<3	6*	6*	No
Zinc	75	28	9.1	7.5-240*	7.5-240*	No
Zirconium	24	0	<1	-	-	No
Organotins						
Tributyltin	6	3	<0.024	0.008	0.008	No
VOCs						
Bromodichloromethane	20	0	<0.1	-	-	No
Bromoform	20	0	<0.2	-	-	No
Bromomethane	20	0	<1	-	-	No
Carbon tetrachloride	20	0	<0.2	13.3	13.3	No
Chlorobenzene	20	0	<0.05	1.3	1.3	No
Chlorodibromomethane	20	0	<0.1	-	-	No
Chloroethane	20	0	<1	-	-	No
Chloroform	20	2	4.9	1.8	1.8	Yes
Chloromethane	20	0	<1	-	-	No
1,2-dibromoethane	14	0	<0.1	-	-	No
Dibromomethane	14	0	<0.02	-	-	No
1,2-dichlorobenzene	20	0	<0.05	0.7	0.7	No
1,3-dichlorobenzene	20	0	<0.05	150	150	No
1,4-dichlorobenzene	20	0	<0.05	26	26	No
Dichlorodifluoromethane	14	0	<0.02	-	-	No
1,1-dichloroethane	20	1	0.18	-	-	No
1,2-dichloroethane	20	1	0.4	100	100	No
1,1-dichloroethene	20	1	0.28	-	-	No
cis-1,2-dichloroethene	20	0	<0.1	-	-	No
trans-1,2-dichloroethene	20	0	<0.1	-	-	No
Dichloromethane	20	0	<0.6	-	-	No
1,2-dichloropropane	20	0	<0.1	-	-	No
cis-1,3-dichloropropene	20	0	<0.1	-	-	No
trans-1,3-dichloropropene	20	0	<0.1	-	-	No
2-hexanone	14	0	<2	-	-	No
Methyl Ethyl Ketone	14	0	<0.5	-	-	No
4-Methyl-2-pentanone	14	0	<0.2	-	-	No
1,1,2,2-tetrachloroethane	20	0	<0.2	111	111	No
Tetrachloroethene	20	1	0.12	-	-	No
1,1,1-trichloroethane	20	5	4.2	11.1	11.1	No
1,1,2-trichloroethane	20	0	<0.1	21	21	No
Trichloroethene	20	0	<0.1	21	21	No
Trichlorofluoromethane	20	0	<0.5	-	-	No
1,3,5-trimethylbenzene	5	3	0.49	-	-	No
Vinyl chloride	20	0	<0.5	-	-	No

* Value is for total metals

Table E4
Wildlife - Chemical of Potential Concern Screening
Roche Point Creek Surface Water
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Modelled Maximum (ug/L)	BC Approved and Working Water Quality Guidelines Wildlife Water Supply (ug/L)	BC CSR Schedule 6 and Schedule 10 DW Standards (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Noncancer (ug/L)	Ecological Screening Level (ug/L)	COPC? (Yes/No)
Physical Tests								
(mg/L)	45	45	379	-	-	-	NA	No
InOrganics								
TDS (Filtered)	15	15	-		-			
EPHs								
EPH10-19	69	14	269	-	5000	-	5000	No
EPH19-32	69	5	41	-	-	-	-	No
LEPH	68	14	120	-	-	-	-	No
HEPH	68	5	41	-	-	-	-	No
MAHs								
Benzene	67	9	4.35	-	5	63	5	No
Ethylbenzene	67	9	4.87	-	2.4	1600	2.4	Yes
Styrene	67	17	2.4	-	-	3100	3100	No
Toluene	65	0	<0.05	-	24	1300	24	No
Xylenes	67	14	19.2	-	300	3100	300	No
VH C6-C10	59	7	147	-	15000	-	15000	No
VPH (C6-C10)	59	6	118	-	-	-	-	No
MTBE	52	1	0.063	-	15	-	15	No
PAHs								
Acenaphthene	85	21	10.6	-	-	63	63	No
Acenaphthylene	85	12	0.0707	-	-	-	-	No
Acridine	85	3	0.218	-	-	-	-	No
Anthracene	85	17	0.606	-	-	4700	4700	No
Benzo(a)anthracene	85	18	0.0353	-	-	-	-	No
Benzo(a)pyrene	85	26	0.0109	0.01	-	-	-	No
Benzo(g,h,i)perylene	85	12	0.0089	-	-	-	-	No
Benzo(b)fluoranthene	85	16	0.0147	-	-	-	-	No
Benzo(k)fluoranthene	67	5	0.011	-	-	-	-	No
Chrysene	85	18	0.0291	-	-	-	-	No
Dibenz(a,h)anthracene	85	0	<0.005	-	-	-	-	No
Fluoranthene	85	22	1.11	-	-	630	630	No
Fluorene	85	19	6.79	-	-	630	630	No
Indeno(1,2,3-c,d)pyrene	85	12	0.0085	-	-	-	-	No
Naphthalene	90	24	122	-	-	310	310	No
Phenanthrene	85	19	9.19	-	-	-	-	No
Pyrene	85	24	0.564	-	-	470	470	No
Quinoline	85	2	0.25	-	-	-	-	No
Dissolved Metals								
Aluminum	70	34	<15	5000*	9500	16000*	5000	No
Antimony	72	5	<15	-	6	6.3*	6	No
Arsenic	78	37	1.99	25*	10	4.7*	25	No
Barium	75	51	84	-	1000	3100*	1000	No
Beryllium	70	0	<5	-	-	31*	31	No
Bismuth	24	0	<0.1	-	-	-	-	No
Boron	70	22	280	5000*	5000	3100*	5000	No
Cadmium	75	18	1.7	-	5	7.8*	5	No
Calcium	69	69	31800	-	-	-	-	No
Chromium	75	10	2.9	-	50	-	50	No
Cobalt	75	42	2.8	-	-	4.7*	4.7	No
Copper	75	39	5.4	300*	1000	630*	300	No
Iron	70	23	5260	-	6500	1100*	6500	No
Lead	75	2	<0.25	100*	10	-	100	No
Lithium	69	21	11	-	-	31*	31	No
Magnesium	70	70	76600	-	100000	-	100000	No
Manganese	70	60	449	-	550	380*	550	No
Mercury	75	0	<0.02	-	1	4.7*	1	No
Molybdenum	75	48	3.2	50*	250	78*	50	No
Nickel	75	35	3.4	-	-	780*	780	No

Table E4
Wildlife - Chemical of Potential Concern Screening
Roche Point Creek Surface Water
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Modelled Maximum (ug/L)	BC Approved and Working Water Quality Guidelines Wildlife Water Supply (ug/L)	BC CSR Schedule 6 and Schedule 10 DW Standards (ug/L)	US EPA Region 9 Adjusted RSLs - Tap water Noncancer (ug/L)	Ecological Screening Level (ug/L)	COPC? (Yes/No)
Dissolved Metals								
Potassium	24	24	23600	-	-	-	-	No
Selenium	70	5	<5	4*	10	78*	4	No
Silicon	24	24	1530	-	-	-	-	No
Silver	75	0	<0.1	-	-	78*	78	No
Sodium	70	70	756000	-	200000	-	200000	No
Strontium	25	25	655	-	22000	9400*	22000	No
Thallium	69	0	<0.5	-	-	0.16*	0.16	No
Tin	30	1	0.1	-	22000	9400*	22000	No
Titanium	70	6	<10	-	-	-	-	No
Uranium	69	32	0.34	-	20	47*	20	No
Vanadium	69	9	<3	-	-	79*	79	No
Zinc	75	28	9.1	-	5000	4700*	5000	No
Zirconium	24	0	<1	-	-	-	-	No
Organotins								
Tributyltin	6	3	<0.024	-		46*	46	No

* Value is for total metals

Table E5
Freshwater Aquatic Benthos - Chemical of Potential Concern Screening
Roche Point Creek Sediment
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Schedule 9 standards for typical freshwater Sites (mg/kg) [1]	Human Health Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests						
pH	4	4	7.63	-	-	No
Extractable Petroleum Hydrocarbons						
EPH10-19	4	0	<200	-	-	No
EPH19-32	4	0	<200	-	-	No
LEPH	4	0	<200	-	-	No
HEPH	4	0	<200	-	-	No
Polyclyclic Aromatic Hydrocarbons (PAHs)						
2-Methylnaphthalene	4	0	<0.05	0.24	0.24	No
Acenaphthene	4	0	<0.05	0.11	0.11	No
Acenaphthylene	4	0	<0.05	0.15	0.15	No
Anthracene	4	0	<0.05	0.29	0.29	No
Benzo(a)anthracene	4	0	<0.05	0.46	0.46	No
Benzo(a)pyrene	4	2	0.073	0.94	0.94	No
Benzo(g,h,i)perylene	4	2	0.078	-	-	No
Benzo(b)fluoranthene	4	2	0.153	-	-	No
Benzo(k)fluoranthene	4	0	<0.05	-	-	No
Chrysene	4	2	0.072	1	1	No
Dibenz(a,h)anthracene	4	0	<0.05	0.16	0.16	No
Fluoranthene	4	2	0.123	2.8	2.8	No
Fluorene	4	0	<0.05	0.17	0.17	No
Indeno(1,2,3-c,d)pyrene	4	2	0.079	-	-	No
Naphthalene	4	0	<0.05	0.47	0.47	No
Phenanthrene	4	0	<0.05	0.65	0.65	No
Pyrene	4	2	0.12	1.1	1.1	No
Metals						
Antimony	4	4	0.34	-	-	No
Arsenic	4	4	3.01	20	20	No
Barium	4	4	43.4	-	-	No
Beryllium	4	0	<0.2	-	-	No
Cadmium	4	4	0.118	4.2	4.2	No
Chromium	4	4	17.6	110	110	No
Cobalt	4	4	5.12	-	-	No
Copper	4	4	21.9	240	240	No
Lead	4	4	5.37	110	110	No
Mercury	4	0	<0.05	0.58	0.58	No
Molybdenum	4	1	2.47	-	-	No
Nickel	4	4	8.25	-	-	No
Selenium	4	0	<0.2	-	-	No
Silver	4	0	<0.1	-	-	No
Thallium	4	0	<0.05	-	-	No
Uranium	4	4	0.849	-	-	No
Vanadium	4	4	39.2	-	-	No
Zinc	4	4	76.6	380	380	No

Table E6
Marine Benthos - Chemical of Potential Concern Screening
Burrard Inlet Sediment
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Schedule 9 standards for typical freshwater Sites (mg/kg) [1]	Ecological Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests						
pH	47	47	8.8	-	-	No
PHC Fractions						
F2 (C10-C16)	4	0	<90	-	-	No
F3 (C16-C34)	4	2	<150	-	-	No
F4 (C34-C50)	10	3	<150	-	-	No
F2-Naphth	6	0	<30	-	-	No
F3-PAH	6	6	125	-	-	No
F4G-SG	3	0	<500	-	-	No
Extractable Petroleum Hydrocarbons						
EPH10-19	12	2	970	-	-	No
EPH19-32	12	4	3610	-	-	No
LEPH	12	2	960	-	-	No
HEPH	12	4	3600	-	-	No
MAHs						
Benzene	6	0	<0.1	-	-	No
Ethylbenzene	6	2	<0.1	-	-	No
Styrene	6	0	<0.2	-	-	No
Toluene	6	0	<0.2	-	-	No
Xylenes	6	3	1.1	-	-	No
MTBE	4	0	<0.2	-	-	No
Polycyclic Aromatic Hydrocarbons (PAHs)						
2-Methylnaphthalene	118	32	1	0.24	0.24	Yes
Acenaphthene	127	65	6.9	0.11	0.11	Yes
Acenaphthylene	127	29	<1	0.15	0.15	Yes
Anthracene	127	82	8.2	0.29	0.29	Yes
Benzo(a)anthracene	127	98	15	0.83	0.83	Yes
Benzo(a)pyrene	127	102	11.2	0.92	0.92	Yes
Benzo(g,h,i)perylene	127	96	8	-	-	No
Benzo(b)fluoranthene	118	96	15.2	-	-	No
Benzo(k)fluoranthene	118	65	6.34	-	-	No
Chrysene	127	100	17	1	1	Yes
Dibenz(a,h)anthracene	127	49	3.4	0.16	0.16	Yes
Fluoranthene	127	106	34	1.8	1.8	Yes
Fluorene	127	63	14	0.17	0.17	Yes
Indeno(1,2,3-c,d)pyrene	127	97	7.56	-	-	No
Naphthalene	128	49	3.6	0.47	0.47	Yes
Phenanthrene	127	103	66	0.65	0.65	Yes
Pyrene	127	107	34	1.7	1.7	Yes
Metals						
Antimony	98	24	58.3	-	-	No
Arsenic	102	62	527	50	50	Yes
Barium	101	101	735	-	-	No
Beryllium	100	5	1.7	-	-	No
Boron	28	17	31	-	-	No
Cadmium	101	32	5.61	5	5	Yes
Chromium	101	101	1680	190	190	Yes
Cobalt	101	98	34	-	-	No
Copper	110	110	5960	130	130	Yes
Iron	36	36	151000	-	-	No
Lead	101	60	1130	130	130	Yes
Magnesium	28	28	17200	-	-	No
Manganese	17	17	522	-	-	No

Table E6
Marine Benthos - Chemical of Potential Concern Screening
Burrard Inlet Sediment
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Schedule 9 standards for typical freshwater Sites (mg/kg) [1]	Ecological Screening Level (ug/L)	COPC ? (Yes/No)
Metals						
Mercury	103	82	17.8	0.84	0.84	Yes
Molybdenum	101	28	2.47	-	-	No
Nickel	101	97	8.25	-	-	No
Selenium	101	2	<0.2	-	-	No
Silver	101	7	<0.1	-	-	No
Sodium	28	28	10500	-	-	No
Strontium	17	17	387	-	-	No
Thallium	17	5	0.147	-	-	No
Tin	103	33	42	-	-	No
Uranium	17	17	3.33	-	-	No
Vanadium	100	100	209	-	-	No
Zinc	103	103	5520	330	330	Yes
Organotins						
Dibutyltin	11	11	0.52	-	-	-
Monobutyltin	11	11	0.11	-	-	-
Tributyltin	30	28	3.66	-	-	-
VOCs						
Bromodichloromethane	4	0	<0.05	-	-	No
Bromoform	4	0	<0.05	-	-	No
Carbon tetrachloride	6	0	<0.2	-	-	No
Chlorobenzene	6	0	<0.1	-	-	No
Chlorodibromomethane	4	0	<0.05	-	-	No
Chloroethane	4	0	<0.1	-	-	No
Chloroform	6	0	<0.1	-	-	No
Chloromethane	4	0	<0.1	-	-	No
1,2-dichlorobenzene	6	0	<0.1	-	-	No
1,3-dichlorobenzene	6	0	<0.1	-	-	No
1,4-dichlorobenzene	6	0	<0.1	-	-	No
1,1-dichloroethane	6	0	<0.1	-	-	No
1,2-dichloroethane	6	0	<0.2	-	-	No
1,1-dichloroethene	6	0	<0.1	-	-	No
cis-1,2-dichloroethene	6	0	<0.1	-	-	No
trans-1,2-dichloroethene	6	0	<0.1	-	-	No
Dichloromethane	6	1	<1.5	-	-	No
1,2-dichloropropane	6	0	<0.1	-	-	No
cis-1,3-dichloropropene	6	0	<0.1	-	-	No
trans-1,3-dichloropropene	6	0	<0.1	-	-	No
1,1,1,2-tetrachloroethane	4	0	<0.05	-	-	No
1,1,2,2-tetrachloroethane	6	0	<0.2	-	-	No
Tetrachloroethene	6	0	<0.1	-	-	No
1,1,1-trichloroethane	6	0	<0.2	-	-	No
1,1,2-trichloroethane	6	0	<0.1	-	-	No
Trichloroethene	6	0	<0.1	-	-	No
Trichlorofluoromethane	4	0	<0.1	-	-	No
1,3,5-trimethylbenzene	2	0	<0.1	-	-	No
Vinyl chloride	4	0	<0.1	-	-	No
PCBs						
Arochlor 1242	3	1	0.05	-	-	No
Arochlor 1248	3	0	<0.03	-	-	No
Arochlor 1254	3	1	0.08	-	-	No
Arochlor 1260	3	0	<0.03	-	-	No
PCBs (Sum of total)	22	8	0.324	0.23	0.23	Yes

Table E7
Wildlife - Chemical of Potential Concern Screening
Burrard Inlet Sediment
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil PL/RL Land Use (mg/kg) [1]	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Ecological Screening Level (ug/L)	COPC ? (Yes/No)
Physical Tests										
pH	19	19	8.8	-	unknown	-	-	-	-	No
Total Petroleum Hydrocarbons										
F4 (C34-C50)	3	2	63	-	unknown	-	-	-	-	No
F2-Naphth	3	0	<30	-	unknown	-	-	-	-	No
F3-PAH	3	3	125	-	unknown	-	-	-	-	No
F4G-SG	2	0	<500	-	unknown	-	-	-	-	No
Extractable Petroleum Hydrocarbons										
EPH10-19	8	2	970	-	unknown	-	-	1000	1000	No
EPH19-32	8	4	3610	-	unknown	-	-	1000	1000	Yes
LEPH	8	2	960	-	unknown	-	-	1000	1000	No
HEPH	8	4	3600	-	unknown	-	-	1000	1000	Yes
Monocyclic Aromatic Hydrocarbons (MAHs)										
Benzene	3	0	<0.04	-	unknown	70	-	-	70	No
Ethylbenzene	3	2	0.076	-	unknown	1	-	-	1	No
Toluene	3	0	<0.1	-	unknown	1.5	-	-	1.5	No
Styrene	3	0	<0.05	-	unknown	-	-	5	5	No
Xylene Total	3	3	1.1	-	unknown	5	-	-	5	No
MTBE	3	0	<0.2	-	unknown	-	320	-	320	No
Polyclyclic Aromatic Hydrocarbons (PAHs)										
2-Methylnaphthalene	31	11	0.896	-	unknown	-	-	-	-	No
Acenaphthene	31	18	3.39	-	unknown	-	-	-	-	No
Acenaphthylene	31	12	0.687	-	unknown	-	-	-	-	No
Anthracene	31	21	4.18	-	unknown	-	-	-	-	No
Benzo(a)anthracene	31	24	10.3	-	unknown	-	-	1	1	Yes
Benzo(a)pyrene	31	24	11.2	-	unknown	1	-	-	1	Yes
Benzo(g,h,i)perylene	31	24	6.8	-	unknown	-	-	-	-	No
Benzo(b)fluoranthene	31	25	15.2	-	unknown	-	-	1	1	Yes
Benzo(k)fluoranthene	31	24	6.34	-	unknown	-	-	1	1	Yes
Chrysene	31	24	9.48	-	unknown	-	-	-	-	No
Dibenz(a,h)anthracene	31	13	1.57	-	unknown	-	-	1	1	Yes
Fluoranthene	31	25	30.8	-	unknown	-	-	-	-	No
Fluorene	31	17	1.89	-	unknown	-	-	-	-	No
Indeno(1,2,3-c,d)pyrene	31	24	7.56	-	unknown	-		1	1	Yes
Naphthalene	31	15	1.26	-	unknown	-	-	5	5	No
Phenanthrene	31	25	11.8	-	unknown	-	-	5	5	Yes
Pyrene	31	25	25	-	unknown	-	-	10	10	Yes
Metals										
Aluminum	8	8	27200	-	unknown	-	-	-	-	No
Antimony	33	15	121	4	yes	-	-	20	20	No
Arsenic	31	21	595	15	yes	50	-	-	50	Yes
Barium	31	31	969	150	yes	1000	-	-	1000	No
Beryllium	31	4	2.95	1	yes	-	-	4	4	No
Boron	8	5	14	-	unknown	-	-	-	-	No
Cadmium	31	13	236	0.55	yes	70	-	-	70	Yes
Calcium	8	8	103000	-	unknown	-	-	-	-	No
Chromium	31	31	79	100	yes	300	-	-	300	No
Cobalt	31	31	34	15	yes	-	-	50	50	No
Copper	33	33	5960	100	yes	150	-	-	150	Yes
Iron	8	8	104000	-	yes	-	-	-	-	No
Lead	31	18	304	300	yes	1000	-	-	1000	No
Magnesium	8	8	17200	-	unknown	-	-	-	-	No
Mercury	33	25	3.68	0.4	yes	100	-	-	100	No

Table E7
Wildife - Chemical of Potential Concern Screening
Burrard Inlet Sediment
3919 and 3829 Dollarton Highway

Parameter	Number of Samples Analyzed	Number Detected	Maximum Concentration Detected (mg/kg)	BC CSR Regional Background Level - Greater Vancouver Area (mg/kg) (Protocol 4)	Maximum Concentration Detected Above Background Level ?	BC CSR Schedule 5 Intake of Contaminated Soil PL/RL Land Use (mg/kg) ^{1}	BC CSR Schedule 10 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	BC CSR Schedule 4 Generic Numerical Soil Standards PL/RL Land Use (mg/kg)	Ecological Screening Level (ug/L)	COPC ? (Yes/No)
Metals										
Molybdenum	31	12	11	6	yes	-	-	10	10	Yes
Nickel	31	30	50.3	75	yes	-	-	100	100	No
Phosphorus	8	8	1210	-	unknown	-	-	-	-	No
Potassium	8	8	3480	-	unknown	-	-	-	-	No
Selenium	31	0	<3	2	no	-	-	3	3	No
Silver	31	5	<2	1	yes	-	-	20	20	No
Sodium	8	8	850	-	unknown	200	-	-	200	Yes
Strontium	11	3	250	-	unknown	-	47000	-	47000	No
Thallium	11	3	0.076	-	unknown	-	-	-	-	No
Tin	33	14	23.5	4	yes	-	50	50	50	No
Titanium	8	8	681	-	unknown	-	-	-	-	No
Uranium	11	11	1.14	-	unknown	-	16	-	16	No
Vanadium	31	31	209	100	yes	-	-	200	200	Yes
Zinc	31	31	2980	90	yes	450	-	-	450	Yes
Zirconium	8	8	16	-	unknown	-	-	-	-	No
Organontins										
Dibutyltin	7	7	0.52	-	unknown	-	-	-	-	No
Monobutyltin	7	7	0.11	-	unknown	-	-	-	-	No
Tributyltin	7	7	3.66	-	unknown	-	-	-	-	No
Volatile Organic Compounds										
Bromodichloromethane	3	0	<0.05	-	unknown	-	8.2	-	8.2	No
Bromoform	3	0	<0.05	-	unknown	-	620	-	620	No
Carbon tetrachloride	3	0	<0.05	-	unknown	-	-	5	5	No
Chlorobenzene	3	0	<0.05	-	unknown	-	-	1	1	No
Chlorodibromomethane	3	0	<0.05	-	unknown	-	11	-	11	No
Chloroethane	3	0	<0.1	-	unknown	-	30	-	30	No
Chloroform	3	0	<0.1	-	unknown	-	-	5	5	No
Chloromethane	3	0	<0.1	-	unknown	-	47	-	47	No
1,2-dichlorobenzene	3	0	<0.05	-	unknown	-	-	1	1	No
1,3-dichlorobenzene	3	0	<0.05	-	unknown	-	-	1	1	No
1,4-dichlorobenzene	3	0	<0.05	-	unknown	-	-	1	1	No
1,1-dichloroethane	3	0	<0.05	-	unknown	-	5	5	5	No
1,2-dichloroethane	3	0	<0.05	-	unknown	-	-	5	5	No
1.1-dichloroethene	3	0	<0.05	-	unknown	-	-	5	5	No
cis-1,2-dichloroethene	3	0	<0.05	-	unknown	-	5	-	5	No
trans-1,2-dichloroethene	3	0	<0.05	-	unknown	-	5	-	5	No
Dichloromethane	3	0	<1.5	-	unknown	-	-	5	5	No
1,2-dichloropropane	3	0	<0.05	-	unknown	-	5	5	5	No
cis-1,3-dichloropropene	3	0	<0.05	-	unknown	-	-	5	5	No
trans-1,3-dichloropropene	3	0	<0.05	-	unknown	-	-	5	5	No
1,1,1,2-tetrachloroethane	3	0	<0.05						-	-
1,1,2,2-tetrachloroethane	3	0	<0.05	-	unknown	-	4.1	-	4.1	No
Tetrachloroethene	3	0	<0.05	-	unknown	5	-	-	5	No
1,1,1-trichloroethane	3	0	<0.05	-	unknown	-	5	5	5	No
1,1,2-trichloroethane	3	0	<0.05	-	unknown	-	5	5	5	No
Trichloroethene	3	0	<0.05	-	unknown	5	-	-	5	No
Trichlorofluoromethane	3	0	<0.1	-	unknown	-	390	-	390	No
Vinyl chloride	3	0	<0.1	-	unknown	-	0.79	-	0.79	No
Polychlorinated Biphenlys										
Arochlor 1242	2	0	<0.03	-	unknown	-	-	-	-	No
Arochlor 1248	2	0	<0.03	-	unknown	-	-	-	-	No
Arochlor 1254	2	0	<0.03	-	unknown	-	-	-	-	No
Arochlor 1260	2	0	<0.03	-	unknown	-	-	-	-	No
PCBs (Sum of total)	6	3	0.324	-	unknown	5	-	-	5	No

Table E8
Marine Benthos - Chemical of Potential Concern Screening
Burrard Inlet Port Water
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Measured Maximum (ug/L)	Modelled Maximum (ug/L)	BC Approved and Working Water Quality Guidelines MarineAquatic Life (ug/L)	Ecological Screening Level (ug/L)	COPC? (Yes/No)
Physical Tests							
Hardness, Total (CaCO3) (mg/L)	45	45	3790	379	-	NA	No
InOrganics							
TDS (Filtered)	15	15	14900000	-			
EPHs							
EPH10-19	69	14	2690	269	-	-	No
EPH19-32	69	5	410	41	-	-	No
LEPH	68	14	1200	120	-	-	No
HEPH	68	5	410	41	-	-	No
MAHs							
Benzene	67	9	43.5	4.35	110	110	No
Ethylbenzene	67	9	48.7	4.87	250	250	No
Styrene	67	17	24	2.4	-	-	No
Toluene	65	0	<0.5	<0.05	-	-	No
Xylenes	67	14	192	19.2	-	-	No
VH C6-C10	59	7	1470	147	-	-	No
VPH (C6-C10)	59	6	1180	118	-	-	No
MTBE	52	1	0.63	0.063	440	440	No
PAHs							
Acenaphthene	85	21	106	10.6	6	6	Yes
Acenaphthylene	85	12	0.707	0.0707	-	-	No
Acridine	85	3	2.18	0.218	-	-	No
Anthracene	85	17	6.06	0.606	-	-	No
Benzo(a)anthracene	85	18	0.353	0.0353	-	-	No
Benzo(a)pyrene	85	26	0.109	0.01	0.01	0.01	No
Benzo(g,h,i)perylene	85	12	0.089	0.0089	-	-	No
Benzo(b)fluoranthene	85	16	0.147	0.0147	-	-	No
Benzo(k)fluoranthene	67	5	0.11	0.011	-	-	No
Chrysene	85	18	0.291	0.0291	0.1	0.1	No
Dibenz(a,h)anthracene	85	0	<0.05	<0.005	-	-	No
Fluoranthene	85	22	11.1	1.11	-	-	No
Fluorene	85	19	67.9	6.79	12	12	No
Indeno(1,2,3-c,d)pyrene	85	12	0.085	0.0085	-	-	No
Naphthalene	90	24	1220	122	1	1	Yes
Phenanthrene	85	19	91.9	9.19	-	-	No
Pyrene	85	24	5.64	0.564	-	-	No
Quinoline	85	2	2.5	0.25	-	-	No
Dissolved Metals							
Aluminum	70	34	<150	<15	-	-	No
Antimony	72	5	<150	<15	-	-	No
Arsenic	78	37	19.9	1.99	12.5*	12.5*	No
Barium	75	51	840	84	500*	500*	No
Beryllium	70	0	<50	<5	100*	100*	No
Bismuth	24	0	<1	<0.1	-	-	No
Boron	70	22	2800	280	1200*	1200*	No
Cadmium	75	18	17	1.7	0.12*	0.12*	Yes
Calcium	69	69	318000	31800	-	-	No
Chromium	75	10	29	2.9	56*	56*	No
Cobalt	75	42	28	2.8	-	-	No
Copper	75	39	54	5.4	2*	2*	Yes
Iron	70	23	52600	5260	-	-	No
Lead	75	2	<2.5	<0.25	2*	2*	No
Lithium	69	21	110	11	-	-	No
Magnesium	70	70	766000	76600	-	-	No
Manganese	70	60	4490	449	-	-	No
Mercury	75	0	<0.2	<0.02	0.02*	0.02*	No

Table E8
Marine Benthos - Chemical of Potential Concern Screening
Burrard Inlet Port Water
3919 and 3829 Dollarton Highway

Chemical	Number of Analyses	Number Detected	Measured Maximum (ug/L)	Modelled Maximum (ug/L)	BC Approved and Working Water Quality Guidelines MarineAquatic Life (ug/L)	Ecological Screening Level (ug/L)	COPC? (Yes/No)
Dissolved Metals							
Molybdenum	75	48	32	3.2	-	-	No
Nickel	75	35	34	3.4	8.3*	8.3*	No
Potassium	24	24	236000	23600	-	-	No
Selenium	70	5	<50	<5	2*	2*	No
Silicon	24	24	15300	1530	-	-	No
Silver	75	0	<1	<0.1	-	-	No
Sodium	70	70	7560000	756000	-	-	No
Strontium	25	25	6550	655	-	-	No
Thallium	69	0	<5	<0.5	-	-	No
Tin	30	1	1	0.1	-	-	No
Titanium	70	6	<100	<10	-	-	No
Uranium	69	32	3.4	0.34	100*	100*	No
Vanadium	69	9	<300	<30	50*	50*	No
Zinc	75	28	91	9.1	10*	10*	No
Zirconium	24	0	<10	<1	-	-	No
Organotins							
Tributyltin	6	3	<0.24	<0.024	0.001	0.001	No
VOCs							
Bromodichloromethane	20	0	<1	<0.1	-	-	No
Bromoform	20	0	<2	<0.2	-	-	No
Bromomethane	20	0	<10	<1	-	-	No
Carbon tetrachloride	20	0	<2	<0.2	-	-	No
Chlorobenzene	20	0	<0.5	<0.05	25	25	No
Chlorodibromomethane	20	0	<1	<0.1	-	-	No
Chloroethane	20	0	<10	<1	-	-	No
Chloroform	20	2	49	4.9	-	-	No
Chloromethane	20	0	<10	<1	-	-	No
1,2-dibromoethane	14	0	<0.1	<0.1	-	-	No
Dibromomethane	14	0	<0.2	<0.02	-	-	No
1,2-dichlorobenzene	20	0	<0.5	<0.05	42	42	No
1,3-dichlorobenzene	20	0	<0.5	<0.05	-	-	No
1,4-dichlorobenzene	20	0	<0.5	<0.05	-	-	No
Dichlorodifluoromethane	14	0	<0.2	<0.02	-	-	No
1,1-dichloroethane	20	1	1.8	0.18	-	-	No
1,2-dichloroethane	20	1	4	0.4	-	-	No
1,1-dichloroethene	20	1	2.8	0.28	-	-	No
cis-1,2-dichloroethene	20	0	<1	<0.1	-	-	No
trans-1,2-dichloroethene	20	0	<1	<0.1	-	-	No
Dichloromethane	20	0	<6	<0.6	-	-	No
1,2-dichloropropane	20	0	<1	<0.1	-	-	No
cis-1,3-dichloropropene	20	0	<1	<0.1	-	-	No
trans-1,3-dichloropropene	20	0	<1	<0.1	-	-	No
2-hexanone	14	0	<20	<2	-	-	No
Methyl Ethyl Ketone	14	0	<5	<0.5	-	-	No
4-Methyl-2-pentanone	14	0	<2	<0.2	-	-	No
1,1,2,2-tetrachloroethane	20	0	<2	<0.2	-	-	No
Tetrachloroethene	20	1	1.2	0.12	-	-	No
1,1,1-trichloroethane	20	5	42	4.2	-	-	No
1,1,2-trichloroethane	20	0	<1	<0.1	-	-	No
Trichloroethene	20	0	<1	<0.1	-	-	No
Trichlorofluoromethane	20	0	<5	<0.5	-	-	No
1,3,5-trimethylbenzene	5	3	4.9	0.49	-	-	No
Vinyl chloride	20	0	<5	<0.5	-	-	No

* Value is for total metals

Stage 1 Preliminary Site Investigation

SCANNED
Doc # 2205702

3829 to 3919 Dollarton Highway
North Vancouver, BC

Prepared for:
Polygon Development 270 Ltd.
Suite 900, 1333 West Broadway
Vancouver, BC
V6H 4C2

Prepared by:
Pottinger Gaherty Environmental Consultants Ltd.
#1200 – 1185 West Georgia Street
Vancouver, BC
V6E 4E6

PGL File: 1543-09.03
MOE Site ID#: 3412/14456

October 2013

PGL

Executive Summary

Polygon Development 270 Ltd. (Polygon) retained Pottinger Gaherty Environmental Consultants Ltd. (PGL) to complete this Stage 1 Preliminary Site Investigation (PSI) report for 3919 and 3829 Dollarton Highway and adjacent leased Port Metro Vancouver lands to the south in North Vancouver, BC (the Site). This report forms part of PGL's overall submission to secure a release of permits for re-development of the Site.

The Site contains a terrestrial area of roughly 1.9ha, and extends north from the historical foreshore of Burrard Inlet to the south side of Dollarton Highway in North Vancouver. Partially filled water lots leased from Port Metro Vancouver are attached to the Site to the south. The terrestrial portion of the Site is comprised of four freehold fee simple lots. The freehold land at the 3829 Property comprises one legal lot, while the freehold land at the 3919 Property consists of three legal lots.

The Site is occupied by two industrial shipyard operators: Noble Towing to the west at 3829 Dollarton and McKenzie Barge and Marine Ways to the east at 3919 Dollarton. The Site is bounded by Dollarton Highway to the north, Burrard Inlet to the south, residential properties to the west, and Cates Park to the east.

To assess areas of potential environmental concern (APECs) resulting from past or present Site uses or use of adjacent properties, PGL conducted an archival review and physical inspection of the Site and surrounding area. The Stage 1 PSI included:

- Review of the subject Site and surrounding area including land use, zoning, utility servicing, climate, local Site geology, and hydrogeology;
- Completion of an archival review which included fire insurance maps, aerial photographs, a land title and insurance document search, water well search, criss-cross business directory search, BC Ministry of Environment Site Registry search, and municipal search;
- Site reconnaissance, which included observation of current Site structures and operations, neighbouring buildings, Site topography, and current surface drainage patterns; and
- Interviews with people familiar with the Site and surrounding area.

Our Stage 1 PSI identified 21 APECs and their respective potential contaminants of concern as presented in the following table:

APEC	Name/Activity	Potential Contaminants of Concern	
		Primary	Secondary
1	General Shipbuilding and Brickyard Activities (3829 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, TBT	PAH ,VOC
2	Sediments - Foreshore and Marine Ways – General Shipyard Activities	Metals, PAH, TBT	PCB
3	Imported Fill East of Shipyard Building (3829 Dollarton)	Metals	LEPH/HEPH, PAH

APEC	Name/Activity	Potential Contaminants of Concern	
		Primary	Secondary
4	In-filled Sandblasting and Painting Area with Accumulated Sandblast Grit (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, VOC, TBT	PAH, PCB,
5	Offsite Filled Foreshore and Former Materials storage/ Burning Area East of Site	Metals, LEPH/HEPH, PAH, MAH, VPH, TBT	PCB, VOC
6	Historical Boiler House (3829 Dollarton)	LEPH/HEPH, PAH	
7	Historical Work Shop (3829 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, VOC	PAH
8	Machine Shop (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, VOC	PAH
9	Shed on Western Side of 3919 Dollarton (former machine and blacksmith shop)	Metals, LEPH/HEPH, MAH, VPH	PAH, PCB
10	Waste Dump (3829 Dollarton)	Metals, LEPH/HEPH, PAH (screening parameters only, all waste was removed several years ago)	MAH, VPH, VOC, TBT
11	Buried Barge and Metal Debris (Water Lot South of 3829 Dollarton)	Metals, PAH	
12	Historical Solvent and Paint Storage Area (3829 Dollarton)	Metals, VOC, VPH, LEPH/HEPH	MAH
13	Former Storage Area for Creosoted Ties (3919 Dollarton)	LEPH/HEPH, PAH	
14	Former Gasoline Underground Storage Tank and Outdoor Battery Storage Area (3919 Dollarton)	MAH, VPH, LEPH, Metals (for battery storage)	Metals, MTBE, EDB (1,2-dibromoethane), DCA (1,2-dichloroethane)
15	Former Drum Rack (3919 Dollarton)	LEPH/HEPH, MAH, VPH, VOC	
16	Northwest Bone Yard (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH	PCB, PAH, VOC
17	Northeast Bone Yard (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH	PCB, PAH, VOC
18	Staining and Stressed Vegetation in Area of Former Office/Bunkhouse/Cookhouse (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH	PAH, VOC, PCB

APEC	Name/Activity	Potential Contaminants of Concern	
		Primary	Secondary
19	Winch Shed/Area Beneath Decking North of Marine Ways (3919 Dollarton)	Metals, LEPH/HEPH, PAH, MAH, PCB, TBT	
20	Paint and Solvent Storage Building (old office) (3919 Dollarton)	Metals, VOC, VPH	LEPH/HEPH, MAH
21	Regulated building materials	Asbestos, PCBs, etc. in building materials only	

Notes:
LEPH/HEPH = light and heavy extractable petroleum hydrocarbons
PAH = polycyclic aromatic hydrocarbons
MAH = monocyclic aromatic hydrocarbons
MTBE = methyl tertiary butyl ether
VPH = volatile petroleum hydrocarbons
VOC = volatile organic compounds
PCB = polychlorinated biphenyls
TBT = tributyl tin

Based on the results of the Stage 1 PSI, PGL recommends that a Stage 2 PSI/Detailed Site Investigation be completed to further investigate APEC 1 to APEC 20.

This Executive Summary is subject to the same standard limitations as contained in the report and must be read in conjunction with the entire report.

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FIGURES

Figures follow the Bibliography

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APPENDICES

List of Acronyms

APEC	-	area of potential environmental concern
AST	-	aboveground storage tank
CSR	-	BC Contaminated Sites Regulation
DNAPL	-	dense non-aqueous phase liquids
DSI	-	Detailed Site Investigation
LNAPL	-	light non-aqueous phase liquid
MOE	-	BC Ministry of Environment
NAPL	-	non-aqueous phase liquid
NDM	-	Norecol, Dames & Moore
PAH	-	polycyclic aromatic hydrocarbon
PCBs	-	polychlorinated biphenyls
PCOC	-	potential contaminant(s) of concern
PGL	-	Pottinger Gaherty Environmental Consultants Ltd.
PSI	-	Preliminary Site Investigation
UST	-	underground storage tank

1.0 INTRODUCTION

Pottinger Gaherty Environmental Consultants Ltd. (PGL) prepared this report of our Stage 1 Preliminary Site Investigation (PSI) of a site including the properties at 3919 and 3829 Dollarton Highway and adjacent leased Port Metro Vancouver lands to the south in North Vancouver, BC (the Site, Figure 1). The Site contains a terrestrial area of roughly 2.85ha, and is bounded by Dollarton Highway to the north, Burrard Inlet to the south, residential properties to the west, and Cates Park to the east.

PGL was contracted to perform the work by Polygon Development 270 Ltd. (Polygon), to support plans to redevelop the Site. Polygon approved work programs designed by PGL to meet the desired objectives. PGL's work complied with the protocols established by the Ministry of Environment (MOE) for PSIs and Detailed Site Investigations (DSI).

This report was prepared, and the investigations were carried out, in accordance with the requirements of the *Environmental Management Act* and BC Contaminated Sites Regulations (CSR). This report may be submitted as part of an application for a Certificate of Compliance under the Roster of Approved Professionals provisions of the *Environmental Management Act* and CSR, and may be relied upon by the MOE and the Contaminated Sites Approved Professionals Society for this purpose.

1.1 Objective

We are seeking to obtain a Release of municipal permits from the MOE for 3829 and 3919 Dollarton Highway, North Vancouver, BC (the Site). The MOE Release will facilitate the redevelopment of the Site for residential use. Future development plans for the Site include 8 multi-tenant residential buildings containing 99 residential units.

1.2 Site Description

The terrestrial portion of the Site extends north from the foreshore of Burrard Inlet to the south side of Dollarton Highway in North Vancouver (Figure 1). The Site is comprised of four freehold fee-simple lots and two partially filled water lots leased from the Vancouver Port Authority doing business as Port Metro Vancouver (Figure 2). The freehold land at the 3829 Property comprises one legal lot, while the freehold land at the 3919 Property consists of 3 legal lots. Current land titles and legal plans are provided in Appendix 1.

The topography of the Site slopes very steeply up to the north from Burrard Inlet towards Dollarton Highway. Roche Point Creek crosses the Site from north to south, creating a natural east-west divide between the two Site water lots. The creek runs through the property at 3829 Dollarton Highway, including underneath the northeast corner of the main building on that property.

The Site is occupied by two industrial shipyard operators: Noble Towing to the west at 3829 Dollarton and McKenzie Barge and Marine Ways to the east at 3919 Dollarton.

Table A: Site Identification Information

Civic Address	3829 to 3919 Dollarton Highway, North Vancouver, BC
PID	008-965-358 008-965-404 015-994-937 015-994-902
Legal Descriptions**	LOT 1, Blocks A and D, District Lot 230, Plan 12037; LOT 2, Blocks A and D, District Lot 230, Plan 12037; The East 66 feet of the West 1/3 of Lot A (Reference Plan 757) District Lot 230 Group 1, New Westminster Land District; and The Centre 1/3 of Lot A (Reference Plan 757) District Lot 230 Group 1, New Westminster Land District.
Owner	M.A.N. Estates Ltd. (3829 Dollarton Hwy); McKenzie Enterprises Ltd. (3919 Dollarton Hwy)
Land Use	Industrial
Zoning	I-1 (Waterfront Industrial) Map in Appendix 4
Proposed Land Use	Residential
Latitude*	49° 18' 13" North*
Longitude*	122° 57' 51" West*
Site Areas	Terrestrial Fee Simple Area = 19,236m^2 Total (four legal lots) In-filled Port Metro Vancouver Water Lot Leases = 5426m^2 Total (Parcel A south of 3919 Dollarton is 5,196m^2 and Parcel C south of 3829 Dollarton is 230m^2) Port Metro Vancouver Water Lots = 31,960m^2 Total (Parcel B south of 3919 Dollarton is 13,015m^2; Parcels A, B, D, and E south of 3829 Dollarton are 18,945m^2).
MOE Site #	3412/14456

* *Source: Google Earth*

** Port Metro Vancouver properties are not filed with the Land Title Office, therefore, there are no official legal descriptions or parcel identifier numbers.

The Noble Towing property to the west contains one large warehouse building enclosing one active marine way. The building occupies about 50% of the Noble Towing property and about 22% of the entire Site area. There is also a two-storey, residential-style office building in the northeast corner of the Noble Towing property. There is one paved-parking area north of the warehouse building and a gravel parking and storage area in the southwest corner of the Site near the beach.

The McKenzie Barge property to the east contains an office building/maintenance shop along Dollarton Highway, a large, centrally located steel-frame building where large-scale welding takes place, two uncovered marine ways for servicing barges/boats, and several additional storage buildings. A large portion of the McKenzie Barge property is unpaved ground used for storage of various equipment and debris.

1.3 Report Participants

David Bell, B.Sc. was the project manager for the 2013 Stage 1 Site inspection and research. Kathy Minehan, M.Sc., P.Geo. was the project manager for previous 2010 Limited Stage 1 and Stage 2 Site Investigation work completed at the two properties. Assemblage of Stage 1 research materials was facilitated by Carla Shaw, Enviro. Dipl.

Senior review was provided by Will Gaherty, M.S., P.Eng. The Approved Professional was Duncan Macdonald, P.Eng.

David Bell has more than nine years of consulting experience, which includes more than six years of experience in contaminated site assessments. David has managed projects, coordinated fieldwork, and completed reporting for numerous projects, in both urban and remote locations. He has supervised subsurface investigations as well as soil, groundwater, and soil-vapour remediation projects.

Kathy Minehan, M.Sc., P.Geo. has been an environmental consultant since 1990. Her work experience includes environmental site assessments, audits, contaminated sites investigation and remediation, waste management, and classification and transport of hazardous materials and wastes.

Carla Shaw, Enviro. Dipl. is an environmental scientist with more than 10 years of experience in environmental consulting. Carla coordinates Phase 1 PSI projects throughout Canada. Her responsibilities in this area include project cost estimating, historical research, investigative interviews, aerial photograph interpretation, reporting, site visits, and client liaison. Carla also provides assistance in sampling wells located on contaminated sites.

Duncan Macdonald is a senior environmental engineer and project manager, with more than 16 years of experience in contaminated sites environmental investigation and remediation. He was appointed to the Roster of Approved Professionals for Contaminated Sites in British Columbia as a standards assessor in 2007. As a roster member, Duncan has made 21 submissions to the MOE and is intimately familiar with both provincial and federal regulations.

Will Gaherty is an environmental engineer specializing in contaminant fate, environmental chemistry, and clean up. He has consulted on over 1,000 site investigations and audits since 1985, in environmental auditing, contaminated site investigation/clean up, landfill design and monitoring, landfill gas assessment, environmental toxicology, and groundwater assessment. His academic training includes contaminant hydrogeology and environmental toxicology. He has worked on projects across Canada, and in the United States, Mexico, and Taiwan. Will's project management experience includes complex projects and involves planning, design, execution, coordinating staff and contractors, liaising with clients and stakeholders, providing ongoing project updates, tracking and maintaining budgets, and dealing with provincial and federal regulatory authorities. He has extensive experience as an expert witness for legal proceedings.

2.0 BACKGROUND

The two properties that comprise the Site (3829 and 3919 Dollarton Highway) have each been the subject of previous environmental investigations. In this report we will refer to the west property at 3829 Dollarton Highway as the Noble Towing property and the larger east property at 3919 Dollarton Highway as the McKenzie Barge property.

At both of the properties, a previous Phase 1 investigation (1992), and Phase 2 soil, groundwater and sediment investigations (1993), and two additional phases of sediment investigation (December 2005 and January 2006) were conducted by others. The reports are discussed further in Section 3.4.7.

PGL began investigation of the properties in 2007. Site inspections, interviews, and a limited historical review were conducted in January 2007 at the McKenzie Barge property and November 2007 at the Noble Towing property. After a detailed review of the previous soil, groundwater and sediment investigations, an investigation program was developed to provide increased Site coverage, fill data gaps and attempt to achieve contaminant delineation. Between February 2007 and April 2009, PGL advanced 11 boreholes and installed 4 monitoring wells at the Noble Towing property and advanced 22 boreholes and installed 14 monitoring wells at the McKenzie Barge property. Two phases of sediment investigation (in marine ways and in deeper water) were also conducted in the water lot south of the McKenzie Barge property.

We have chosen to rely on other consultant's reports only to the extent of reviewing the data in the context of writing this Stage 1 PSI report, but have formed our own independent conclusions from that data after duly considering the data contained in the reports.

Phase2/Stage 2 PSI results/findings will be discussed in detail under separate cover in our Stage 2 PSI and DSI report.

3.0 STAGE 1 PRELIMINARY SITE INVESTIGATION

PGL's Stage 1 PSI was initiated in May 2013.

3.1 Work Program

To assess areas of potential environmental concern (APECs) resulting from past or present Site uses or use of adjacent properties, PGL conducted an archival review and physical inspection of the Site and surrounding area. The Stage 1 PSI included:

- Review of prior PGL environmental investigation findings;
- Review of the subject Site and surrounding area including land use, zoning, utility servicing, climate, local Site geology and hydrogeology;
- Completion of an archival review which included aerial photographs, fire insurance maps, a land title and insurance document search, water well search, criss-cross business directory search, BC MOE Site Registry search, and municipal search;
- Site reconnaissance, which included observation of current Site structures and operations, neighbouring buildings, Site topography, and current surface drainage patterns; and
- Interviews with people familiar with the Site and surrounding area.

The Stage 1 PSI generally complies with environmental assessment procedures and guidelines prepared by the Canadian Standards Association (Standard Z768-01). It is equivalent to a Stage 1 PSI as described in Section 58 of the Contamination Sites Regulation (CSR), and is intended for submission to MOE. Canadian Standards Association and MOE set standards for the review of information pertaining to a site and describe detailed checklists that assist the investigator in preparing the final investigation report. The fieldwork conducted was carried out in accordance with PGL's standard field procedures. Sources reviewed for the Site are referenced in the attached bibliography and selected information is included in the appendices.

3.1.1 Identifying APECs, Potential Contaminants of Concern and Media at Risk

Based on experience, PGL has developed a process to identify APECs, potential contaminants of concern (PCOCs), and media at risk which is applied in this investigation.

3.1.1.1 APECs

To identify APECs on adjoining properties, we apply a default records review radius of 300m as specified in *Guidance Document #10*. In this context, we considered prospective offsite APECs only if they are/were:

- Within 300m of the Site;
- Include a Schedule 2 or other risk use; and
- Are not separated from the Site by surface water (surface water is an effective contaminant migration barrier).

Some contaminant and Site-specific screening criteria allow us to simplify the identification of APECs. To allow earlier focus on relevant APECs and avoid discussion of irrelevant ones, offsite areas are pre-screened for relevance based on a set of potential contaminant-specific and setting-specific criteria. We do not present or discuss properties identified during the aerial photograph, fire insurance maps, and city directories record review that are outside our screening criteria. These criteria include:

- Retail dry cleaners that operated after the 1960s less than 100m in any direction from the Site, or within 300m if located upgradient of the Site. Stand-alone dry-cleaning machines became available in the 1960s, and most cleaners operating before this period were drop-off/pick-up facilities that did not conduct dry cleaning onsite and are therefore not considered an environmental risk. PGL has not observed significant effects (i.e., exceedence of applicable regulatory numerical standards for groundwater) more than 300m downgradient from this type of use, but there are case histories in the scientific literature where these dry-cleaning solvent plumes extend many times this distance;
- Other CSR Schedule 2 activities that use significant quantities of dense non-aqueous phase liquids (DNAPL) within 100m downgradient or cross-gradient of the Site, or within 300m if located upgradient of the Site. DNAPL movement in the subsurface is controlled by the soil stratigraphy near the Site, and unlike floating light non-aqueous phase liquids (LNAPL), the denser DNAPLs can sink beneath the water table and can migrate along stratigraphic layers against the prevailing groundwater-flow direction. Therefore, we apply a larger investigation radius when evaluating these DNAPL sites as opposed to LNAPL sites;
- CSR Schedule 2 activities that use significant quantities of LNAPL, such as gas stations, that are less than 50m downgradient or cross-gradient from the Site. It is considered unlikely that these floating contaminants would disperse laterally or upgradient along the top of the groundwater-saturated zone at a greater distance than this. For these potential APECs located upgradient of the Site, we apply a radius of 200m, as groundwater contamination rarely extends for more than 200m downgradient from a LNAPL site due to intrinsic biodegradation of the dissolved contaminants;
- Other CSR Schedule 2 activities less than 25m in any direction from the Site, or 100m upgradient from the Site. While greater distance effects on groundwater quality can be observed in some non-non-aqueous phase liquid (NAPL) scenarios, this seldom occurs for sources consistent with urban scales (and is more likely associated with long-term heavy industrial uses); and

- Utility corridors below the water table can act as hydraulic drains for groundwater and contaminants. This makes it unlikely for contaminants to migrate across utility corridors that intercept the water table, but contaminants could migrate along them. Migrating contaminants from sources that are greater than 100m from the Site are exposed to numerous utility corridors, which may be preferential pathways for groundwater flow. The presence of utility corridors may extend or reduce the range of contamination extending from a potential APEC, and are evaluated on a Site-specific basis.

The distance we consider is somewhat dependent on our confidence in groundwater-flow direction. Where confidence is lower, the radius is correspondingly modified. These criteria have been incorporated into the documentation review summaries provided in the following sections and are illustrated on Figure 3.

3.1.1.2 Media at Risk

Generally, if the APEC is on the Site, we will consider soil, soil vapour, and groundwater as being media at risk. However, where groundwater or vapour transport from offsite sources is identified as a risk, we do not consider the soil matrix to be at risk unless the PCOC is a NAPL. This is a reflection that groundwater does not result in much mass transport. For NAPL contaminants, which can move independent of groundwater, we consider that soil becomes a matrix of concern if groundwater contamination is present exceeding standards and so would trigger analysis of appropriate numbers of applicable PCOC(s).

3.2 Site Details

The following sections discuss Site infiltration and contamination migration potential.

3.2.1 Potable Water

The Site and surrounding area receives potable water from the Greater Vancouver Water District Capilano Watershed, which is greater than 1.5km west and upgradient of the Site.

3.2.2 Drainage and Sewers

Municipal storm and sanitary sewer, and water systems are located along Dollarton Highway north of the Site. Utility drawings showing Site connections are provided in Appendix 2.

3.2.3 Climate

Mean annual precipitation from 1971 to 2000 the North Vancouver Second Narrows Environment Canada weather station (about 3km west of the Site) was 1,855.2mm, of which 1,817.1mm fell as rain. Most precipitation falls between November and February. The Site is in an area of low flood risk. Climate data is provided in Appendix 3.

3.2.4 Surficial Geology

Surficial geology maps indicate the surficial geology consists of Vashon Drift and Capilano Sediments. The stratigraphy consists of glacial drift including lodgment and minor flow till, lenses and interbeds of substratified glaciofluvial sand to gravel and lenses and interbeds of glacial lake laminated stony silt. These units are up to 25m thick but in most places less than 8m thick and overlain by glaciomarine and marine deposits normally less than 3m but in places up to 10m thick. (Surficial Geology, Vancouver, British Columbia, Geological Survey of Canada, Map 1486A).

Below the original high-water mark, imported or dredged fill has been used to extend the shoreline south into Burrard Inlet, and above the high-water mark fill has been used to level portions of the Site.

3.2.5 Hydrogeology

The local topography generally slopes steeply down to the south towards Burrard Inlet. Roche Point Creek runs south through the centre of the Site and another unnamed creek runs south through Cates Park east of the Site. Groundwater-flow direction is inferred to follow topography and flow south. The water table depth in the area varies with distance from Burrard Inlet. It is approximately 15m below ground surface near the northern property boundary and about 2m below ground in the south portion of the Site. Groundwater levels near Burrard Inlet fluctuate with the tides. A contour map of the area is provided in Appendix 4.

Underground utilities such as water lines, storm and sanitary sewers and telecommunications conduits can affect groundwater flow patterns, direction and velocity. They can act as preferred pathways for contaminant transport given their high hydraulic conductivity relative to the surrounding native soils. District of North Vancouver utilities are located north of and upgradient of the Site. There are some underground utilities servicing Site buildings but it is not likely that these utility trenches are deeper than 2m below grade. The potential for underground utilities to intersect groundwater at the Site and act as preferred pathways is low.

A review of Wild, Threatened, Endangered, and Lost streams of the Lower Fraser Valley Summary Report (1997), shows no buried streams near the Site.

Based on the soil type and texture, surface cover, depth to groundwater, and the presence of underground utilities and other features, the Site is considered to be moderately to highly susceptible to groundwater contamination. The migration potential of contaminants that become dissolved in groundwater is considered to be high, given the soil texture and setting.

3.3 Neighbouring Property Characteristics

The properties surrounding the Site are residential properties and parkland.

3.3.1 Current Neighbouring Land Use

The area immediately surrounding the Site is residential to the west and across Dollarton Highway to the north and undeveloped parkland to the east (Figure 3). Surrounding property uses include:

- North (upgradient) – Dollarton Highway followed by single-family residential properties;
- East (cross-gradient) – Cates Park;
- South (downgradient) – Burrard Inlet; and
- West (cross-gradient) – residential properties.

3.3.2 Potential Receptors

Use of surface and groundwater, and use for agriculture and parks are relevant to determining the applicable standards and understanding the significance of contamination.

3.3.2.1 Surface Water Bodies

Burrard Inlet (a salt-water body) borders the Site to the south and Roche Point Creek (a freshwater creek) runs south through the centre of the Site. An unnamed stream runs through Cates Park approximately 100m east of the Site. There is no surface water bodies used for drinking water within 500m of the Site.

Aquatic Life Standards for the protection of freshwater and marine life apply to groundwater at the Site.

3.3.2.2 Water Well Search

The EcoLog ERIS report in Appendix 7 included a search for registered water wells within 500m of the Site. No water wells were identified in the search. There are no water wells used for drinking water within 500m of the Site.

3.3.2.3 Agricultural Land Reserve

The Agricultural Land Reserve does not include any areas in the District of North Vancouver. The closest Agricultural Land Reserve is separated from the Site by Burrard Inlet. Agricultural soil Standards and Irrigation and Livestock watering use Standards do not apply to the Site.

3.3.2.4 Parks and Recreational Facilities

There are five parks within 1km of the Site as described in the following list and shown on a figure in Appendix 5:

- Cates Park is adjacent to the Site to the east;
- Dollarton Highway beach access is adjacent to the Site to the west;
- Roche Point Park is about 160m north of the Site; and
- Fairway Park is about 560m northeast of the Site;

Parkland Standards do not apply to the Site but do apply to the adjacent parks. Parkland Standards will also likely apply to a proposed District of North Vancouver Right of Way along the original high-water mark.

3.4 Records Review

Aerial photographs, a fire insurance map and business directories indicate that the west part of the Site (currently 3829 Dollarton Highway) was first developed as a brickyard in the 1920s or 1930s and redeveloped as a shipyard in the late 1940s or early 1950s. Between 1950 and 1989 I.M. Matsumoto constructed aluminum fishing boats onsite. M.A.N. Estates purchased the property in 1989 and Noble Towing began its boat building and maintenance operations at that time.

The large warehouse building onsite at 3829 Dollarton was constructed in several phases. Based on aerial photograph reviews, the first phase was built sometime between 1926 and 1946 (the earliest aerial photographs reviewed). This original building is no longer standing but was in the vacant area south and west of the current shipyard building. In the 1950s, an addition was constructed east of this original building. In the 1970s, a large addition was constructed to the north, and then in the early 1980s, the largest addition was constructed to the east.

The area of the former brickyard and general shipyard activities at 3829 Dollarton have been identified as **APEC 1.** Because shipbuilding activities extended into the foreshore area south of the Site, sediments in the foreshore lease area have also been identified as **APEC 2**.

Between the 1950s and early 1980s, prior to the expansion of the shipyard building at 3829 Dollarton, aerial photographs indicate the eastern edge of the property was active area for boat building and maintenance. Aerial photographs indicate the area east of the current building was filled in the early 1980s during construction of the eastern section of the building. The fill in this area was reportedly imported from an unknown source in East Vancouver. The imported fill material east of the Noble Towing building has been identified as **APEC 3**.

The east portion of the Site (currently 3919 Dollarton Highway) has been owned by the McKenzie family since 1931. The McKenzie Barge Company began building and repairing ships onsite at that time. Wooden boats were built early in the history of the property with very little metal cutting or welding until the late 1950s. We understand through interviews that creosoting of wood for barges was not done onsite but that treated timbers were brought onsite. Ship building activities have not been carried out on the property since 1989 but ship repair and maintenance operations continue to this day. The general shipyard activities on the foreshore and in marine ways at the McKenzie Barge property has been included as part of **APEC 2** which encompasses the entire foreshore area and sediments south of the Site.

Filling of the foreshore at 3829 Dollarton began in the 1960s. The central portion of the foreshore west of the marine ways was filled by 1963. In 1965, the westernmost lot comprising the 3919 property was purchased and subdivided from I.M. Matsumoto (former owners of the property at 3829 Dollarton). By 1974, filling of the foreshore south of this western-property addition extended the western half of the Site about 50m south into Burrard Inlet. This in-filled area on the west side of the 3919 Dollarton property has since been used as a sandblasting and painting area and has been identified as **APEC 4**.

Many of the current buildings at 3919 Dollarton were constructed when the McKenzie Barge shipyard was first developed. Until about 1970, there was a cluster of smaller buildings centrally located onsite, in a current grassy area northwest of the westernmost marine way. The former buildings in this area included an office building, cookhouse, bunkhouse, and wash house. The current office building at the northeast corner of the property was constructed in 1963.

A squatter shack is present east of the southeast Site corner south of Cates Park off the Site. It was not clear during Site visits if the shack is currently occupied but interviews indicated that a squatter has regularly occupied this area southeast of the Site. Arial photographs indicate that this former foreshore area was filled in the late 1950s. After this, the area was reportedly used for burning scrap wood from the building of wooden boats up until about 1995. Seams on the wooden boats were reportedly caulked with "oakum"[1] and then sealed with pitch or tar from a tar shed historically located in the area. McKenzie Barge reports this filled-in area, below the high-water mark, has never been leased by McKenzie Barge and is owned by Port Metro Vancouver. The area north of the filled area and original high-water mark (now Cates Park) was reportedly used by Cates Towing and later by Seaspan. The history and use of this area east of the south portion of the Site is not clear. The offsite in-filled foreshore and former materials storage, boat building, and burning area has been identified as **APEC 5**.

3.4.1 Historical Title Search

West Coast Title Search Ltd. conducted current and historical land title searches for the four Site legal lots. Copies of the title searches are included in Appendix 1 along with a copy of the legal plan for the Site.

3.4.1.1 LOT 1 Blocks A and D, District Lot 230, Plan 12037 (P ID 008-965-358)

The historical title search indicates that M.A.N. Estates Inc. has owned the westernmost legal lot (the current property at 3829 Dollarton Highway) since 1989 and prior to that it was held by Matsumoto Shipyards and the Matsumoto family since 1950. Prior to that, the property was owned by John D. Mather for a short time in 1950, by the District of North Vancouver between 1934-1949. Prior to that, Lot 1 was split into two titles, both owned by Alecia Mary Taylor between 1912 or 1913 to 1934. Title 7817-I was previously owned by John Taylor for a short time in 1913, by the Imperial Car Shipbuilding and Drydock Corporation between 1910-1913, and was tied to the title of the eastern lot of the current McKenzie Barge property prior to 1910. Title 73001-I was previously owned by John Taylor from 1888 to 1912 and was crown land prior to 1888.

The three lots that comprise the McKenzie Barge property at 3919 Dollarton Highway are all currently owned by McKenzie Enterprises Ltd.

3.4.1.2 LOT 2 Blocks A and D, District Lot 230, Plan 12037 (P ID 008-965-404)

The title search shows that the westernmost lot (Lot 2) was subdivided from the Matsumoto property (Lot 1) in 1965.

3.4.1.3 The East 66 feet of the West 1/3 of Lot A (Reference Plan 757) District Lot 230 Group 1, New Westminster Land District (PID 015-994-937)

The central lot (the east 66 feet of the west 1/3 of Lot A) has been owned by McKenzie Enterprises / McKenzie Barge & Marine Ways since the title was registered in 1990. Prior to this the title for the central lot was tied to the eastern lot (Centre 1/3 of Lot A).

3.4.1.4 The Centre 1/3 of Lot A (Reference Plan 757) District Lot 230 Group 1, New Westminster Land District (PID 015-994-902)

The eastern lot (the Center 1/3 of Lot A), has been owned by McKenzie Enterprises/McKenzie Barge & Marine Ways since 1935. Prior to that, the lot was held by John Kenneth McKenzie between 1931 and 1935; by Alfred Bowen between 1925 and 1931; by members of the Taylor family between 1881 and 1925; by the Rocke Land Company Ltd. between 1886 and 1888; by a group of five individuals between 1883 and 1886; and was Crown land prior to 1883.

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[1] A rope-like substance received in bales.

No additional risks to the Site were present in the title search that had not already been identified from other sources.

3.4.2 Business Directory Search

To examine the history of the Site and surrounding area, criss-cross business directories were studied at five-year intervals from 2001 back to 1940 (street directories for the subject area were not published prior to 1940). Directory searches were completed by InfoAction, an information and research centre at the Vancouver Public Library. Copies of the directories reviewed are included in Appendix 6. Such directories are not available after 2001, and so it is not possible to comment on uses since then.

3.4.2.1 The Site

The presence of shipyards on both Site properties was confirmed/identified through review of historical business directories. The directories show that the civic addresses of the properties changed between 1960 and 1965. No listings were present for Site properties prior to 1960. A summary of historical directory listings for the Site is presented in the following table.

Table B: Site Address Directory Search

Address	Listing	Period
3829 Dollarton Highway	Cetek Services Ltd. Dollarton Ship Yard	2001
	Marine Petrobulk Ltd.; Noble Towing Ltd.; and Pacific Western Shipbuilders Co. Ltd.	1990-1995/96
	Matsumoto Shipyards Ltd. (listed at 4760 Dollarton Highway in 1960)	1960-1985
	Property not listed	Prior to 1960
3919 Dollarton Highway	McKenzie Barge and Marine Ways Ltd.	1970-2001
	McKenzie Barge and Derrick Ship Yard	1965
	McKenzie Barge and Marine Ways Ship Yard (listed at 4810 Dollarton Highway in 1960)	1960
	Property not listed	Prior to 1960

The McKenzie Barge and Marine Ways shipyard is listed at 4810 Dollarton Highway in 1960 and then at 3919 Dollarton Highway in the 1965-2001 directories.

Matsumoto Shipyards is listed at 4760 Dollarton Highway and then at 3829 Dollarton Highway in the 1965-1985 directories. Businesses listed at 3829 Dollarton between 1990-2001 include Noble Towing Ltd., Pacific Western Shipbuilders Co. Ltd., Marine Petrobulk Ltd., and Cetek Services Ltd Dollarton Ship Yard.

An interview regarding the property indicated that Marine Petrobulk Ltd. only occupied portions of the office building at 3829 Dollarton and Cetek Services Ltd. is a movie set builder that has only occupied portions of the warehouse for equipment storage. These operations have not been retained as APECs.

Shipyard operations at the properties have been retained as Site APECs. As discussed in Section 3.4, general shipbuilding activities at 3829 Dollarton Highway have been identified as **APEC 1** and sediments in Site water lots and marine ways have been identified as **APEC 2**. More specific APECs at the properties are identified in later sections of this report.

3.4.2.2 Neighbouring Properties

A directory search was completed for the following streets within a 300m radius of the Site, for every five years between 1940, the first directory published, and 2001, the most current directory published:

- Blantyre Place;
- Deercrest Drive;
- Dollarton Highway;
- Fairway Drive;
- Fairway Place;
- Raven Woods Drive;
- Roche Place;
- Roche Point Drive;
- Sparrow Lane; and
- Windcrest Drive.

Our review of directory listings for properties near the Site did not identify any potential risks requiring further assessment.

No offsite APECs were identified through our review of historical directories.

3.4.3 BC MOE Site Registry

PGL conducted a search of the BC MOE Site Registry using EcoLog ERIS to identify nearby sites that are registered with MOE (Appendix 7). The Site Registry returns information in the following five categories:

1. General – information on a site's location, fee category, overall clean-up status and current site profile;
2. Notations – information on legal events, such as issuance of pollution abatement, pollution prevention, and remediation orders, Certificates of Compliance, and Approvals in Principle; and administrative notations (for example, onsite investigation and remediation reports);
3. Participants – information on people and organizations involved in a site and their roles;
4. Documents – information on the existence of reports concerning a site; and
5. Land Use – information on the land use related to a site.

The most recent Site Registry search was conducted by EcoLog ERIS on September 4, 2013 for a 0.5km radius from the Site. Our search identified five files within a 0.5km radius of the subject Site. Three of the Site Registry entries refer to Site properties at 3829 and 3919 Dollarton Highway. Site Profiles were submitted to the MOE for the Site properties in 2012 and the Site Registry entries note requirements for a DSI.

The remaining two offsite Site Registry entries are discussed in the following Section 3.4.3.1.

3.4.3.1 Cates Park (Site IDs 3445 / 3473)

Cates Park is located adjacent to the Site to the east and is entered in the Site Registry under two separate entries. The Site Registry status for both entries is listed as "Active - Under Assessment". The entry for Site ID 3473 references an abandoned underground storage tank (UST) and the entry for Site ID 3445 references an abandoned pump island, both in the dock area of Cates Park. This area is approximately 270m southeast of and cross gradient to the Site. This property has not been identified as an APEC given the distance (almost 300m from the Site) and because the fuelling facilities were likely located on or near the water.

3.4.4 Municipal Search

A records check was conducted in person at the District of North Vancouver on September 9, 2013. The only available information for review was building permits and plans which revealed some Site details (Appendix 8).

At 3829 Dollarton Highway, Matsumoto Shipyards was issued several building permits including:

- August 31, 1954 to erect an office building. The address was listed as 4752 Dollarton on this permit;
- March 28, 1955 to erect a gantry crane in a marine way;
- October 12, 1967 to construct a shop building. The plan notes asbestos cladding;
- February 27, 1973 to extend the shop with two small buildings and a portion of a third building. The drawing for the expansion is contained in Appendix 8; and
- September 22 and 24, 1980 to expand the shipyard building to capacity to build two vessels. The permit references building activities near Roche Point Creek and also shows the movement of the office building to the northeast corner of the property. The drawing for this expansion is contained in Appendix 8.

At 3919 Dollarton Highway, McKenzie Barge and Marine Ways were issued several building permits including:

- November 3, 1955 - to add a concrete-foundation building extension and new marine ways. The address was listed as 4800 Dollarton on this permit. The drawing for this expansion is contained in Appendix 8; and
- November 3, 1964 to add a steel building with timber-frame mezzanine to be used for future offices and washroom facilities.

No further APECs were identified based on our review of municipal building permits and plans which corroborated information from other sources.

3.4.5 Aerial Photographs

We reviewed all available historical aerial photographs from the University of British Columbia Geography department, which supported information obtained from other sources. The aerial photograph review was valuable in determining the timing of construction and filling activities in the area. In particular, aerial photographs document the filling of the offsite adjacent foreshore southeast of the Site south of Cates Park in the late 1950s. Equipment storage and industrial activities appear to have taken place on this in-filled foreshore between the late 1950s and late 1970s. The offsite in-filled foreshore and former material storage, boat building, and burning area were identified earlier in this report as **APEC 5**. No additional risks to the Site were noted in the aerial photograph review that had not already been identified from other sources.

Copies of reviewed aerial photographs and a list of all photographs reviewed are included in Appendix 9, along with a detailed summary of observations.

3.4.6 Fire Insurance Maps

PGL obtained fire insurance maps for a 300m radius around the Site. The only fire insurance map available for review was dated April 1965. The information contained in the map corroborated information from other sources.

The fire insurance map shows there was a work shop/lunch room onsite at the 3829 Dollarton property and a different office building than the current one. These buildings also appear in aerial photographs between the mid-1950s and early 1980s. The current office building was reportedly constructed in the early 1970s; however, aerial photographs and building permits indicate the building was moved to the northeast corner of the property in the early 1980s.

The fire insurance map also shows a smaller warehouse-type building with a floating wharf and two marine ways at 3829 Dollarton. A second larger marine way is located east of the warehouse building. Other Site features on the map include a boiler room near the northwest corner of the warehouse, a workshop at the north end of the easternmost marine way, and an office building. The former boiler house and workshop have been identified as **APEC 6** and **APEC 7**, respectively.

At the McKenzie Barge property, the fire insurance map shows a machine shop beneath the main office building and a machine shop with attached blacksmith shop in the shed near the west property line and Roche Point Creek. The machine shop in the main office building has been identified as **APEC 8**. The shed containing the former machine shop and blacksmith shop has been identified as **APEC 9**.

An inset on the fire insurance map shows the Dollar Shopping Centre which includes an auto service garage and dry cleaners. These businesses were also listed in business directories but were discounted as APECs due to their location greater than 700m northeast of the Site in the 400 block of Dollarton Highway North.

A copy of the 1965 fire insurance map is provided in Appendix 10.

3.4.7 Previous Environmental Investigations by Others

PGL reviewed the following previously prepared reports for the Site. Copies of the available sections of the reports are provided in Appendix 11.

- *Phase 1 Environmental Site Investigation - 3829 and 3919 Dollarton Highway, North Vancouver, British Columbia, File 5-202-01.01,* Norecol Environmental Management Ltd., April 15, 1992;
- *Preliminary Environmental Investigation Report, 3828 and 3919 Dollarton Highway, North Vancouver, British Columbia. Job. No. 26674-002-313;* Norecol, Dames & Moore, July 8, 1993;
- *Final Report, Phase 1 Environmental Site Assessment and Sediment Investigation, Waterlots Adjacent to 3785 and 3829 Dollarton Highway, North Vancouver, BC. File: 302-015.01,* December 9, 2005. Hemmera Envirochem Inc.; and
- Addendum *Report – Supplemental Coring Investigation, VPA Waterlots Adjacent to 3785 and 3829 Dollarton Highway, North Vancouver, BC. File: 302-015.02,* Hemmera Envirochem Inc., January 24, 2006.

The reports are summarized briefly in the following sections.

3.4.7.1 Phase 1 Report (Norecol Environmental Management Ltd., April 1992)

Information from the Norecol Environmental Management Ltd. (Norecol) Phase 1 report corroborated information collected during PGL's Stage 1 Site inspection and interviews and has been presented in the relevant sections of this report. Norecol concluded that the potential for contamination at the Site was relatively high.

3.4.7.2 Preliminary Environmental Investigation Report (Norecol Dames & Moore, June 1993)

The approach of the Norecol, Dames & Moore (NDM) Preliminary Environmental Investigation was to investigate areas most likely to be contaminated. NDM advanced a total of 18 boreholes at the Site and installed "observation" wells in 7 of these boreholes.

NDM also collected several surface soil samples at the Site and several foreshore sediment samples south of the Site.

NDM did not identify specific Site APECs in their reports but did identify the following PCOCs:

- Metals from painting and sandblasting;
- Polychlorinated biphenyls (PCBs) from electrical equipment;
- Petroleum hydrocarbons from fuel storage and use as lubricants;
- Volatile organic compounds from solvent use; and
- Wood preservatives from treated wood.

NDM applied the regulatory standards of the day as follows:

- BC MOE's[2] Criteria for Managing Contaminated Sites in British Columbia was applied to the freehold portions of the Site;
- Canadian Council of Ministers of the Environment's Interim Canadian Environmental Quality Criteria for Contaminated Sites was applied to the portion of the Site leased from Port Metro Vancouver (south of the high-water mark); and
- Environment Canada's Benthic Apparent Effects Thresholds were used to assess sediment quality.

NDM identified metals contamination (greater than Industrial Standards) in soil, and metals and polycyclic aromatic hydrocarbons (PAH) contamination in sediments at 3829 Dollarton. NDM identified metals and hydrocarbon contamination (greater than Industrial Standards/Criteria) in soil and groundwater, and metals and PAH contamination in sediments at 3919 Dollarton. Special Waste (now referred to as hazardous waste) was also identified in the north end of the eastern marine way at 3919 Dollarton.

NDM's investigation and findings were used in our assessment of APECs and PCOCs at the Site and in the preparation of investigation plans for a DSI.

3.4.7.3 Phase 1 Environmental Site Assessment and Sediment Investigation (Hemmera Envirochem Inc., December 2005)

The 2005 investigation by Hemmera Envirochem Inc. (Hemmera) comprised a Phase 1 Environmental Site Assessment and sediment investigation at 3829 Dollarton as well as the adjacent water lot to the west. The study area was not considered an environmentally sensitive area so standards for Typical Marine and Estuarine Sediments were applied.

Hemmera identified eight APECs at 3829 Dollarton as follows:

1. Boat Servicing Area: corresponds to the south end of the eastern marine way at 3829 Dollarton;
2. Waste Dump: documented by the Vancouver Port Authority in a letter dated July 8, 2002. Waste steel drums, wood products, scrap metal, plastics, and other unknown materials were deposited in the southwest section of the shipyard building[3];
3. Dock and Wharf Head;
4. Former Metal Debris and Old Buried Barge Area; offshore, south of the warehouse building;
5. Hull Sandblasting and Painting Area (northern portion of the eastern marine way);
6. Former Solvent and Paint Storage Area; corresponds to the southwest corner of the Site;
7. Possible PCB-containing Electrical Equipment; and
8. McKenzie Barge and Marine Ways at 3919 Dollarton.

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[2] BC Ministry of Environment, Lands and Parks in 1993.

[3] This corresponds to an area reportedly cleaned up by Lark Noble. Extraneous materials were reportedly appropriately disposed of offsite.

Hemmera collected 22 surface sediment samples from the water lots sand concluded that sediments were impacted with metals, PAHs, PCBs and organotins.

In 2006, Hemmera returned to the Site to complete a supplemental coring investigation to collect deeper sediment samples since the Site is in an area of sediment deposition. Using a barge-mounted drill rig, six sediment cores were advanced to a maximum of 1.5m depth. Metals contamination, including organotins, was identified south of the main shipbuilding marine ways at 3829 Dollarton.

Based on Hemmera's reports, PGL identified the following three APECs:

- **APEC 10**: Waste Dump. While Hemmera's figure indicates this APEC is outside (south of) the warehouse building at 3829 Dollarton, its report indicates it is within the southwest section of the building. The location within the building was corroborated by PGL interviews with Ms. Lark Noble;
- **APEC 11:** Offshore Buried Barge and Metal Debris southwest of the building at 3829 Dollarton; and
- **APEC 12**: Historical Solvent and Paint Storage Area west of the building at 3829 Dollarton.

3.4.8 Previous Environmental Investigations by PGL

PGL previously prepared the following reports for the Site properties.

- January 2010. Limited Stage 1 and 2 Environmental Site Investigation. McKenzie Barge and Marine Ways Ltd., 3919 Dollarton Highway, North Vancouver, BC.

- February 2010. Limited Stage 1 and Stage 2 Preliminary Site Investigation. Noble Towing, 3829 Dollarton Highway, North Vancouver, BC.

Information from the previous PGL reports was used in the appropriate sections of this Stage 1 PSI and in the preparation of investigation plans for a DSI.

3.5 Site Reconnaissance

Previous PGL Site visits took place in 2007 and 2010 to identify APECs during the preparation of the previous Limited Stage 1 reports at the Site properties. PGL staff visited the Site on May 21, 2013 to assess current Site conditions and APECs. Photographs taken during the Site inspections are provided in Appendix 12.

At the time of our inspections, the Site was comprised of two operating shipyards. No new additional offsite environmental risks were identified.

3.5.1 Noble Towing Property, 3829 Dollarton Highway, North Vancouver, BC

The west Site lot at 3829 Dollarton Highway is an active shipyard. It is occupied by three structures including a large, L-shaped steel-frame building where ship maintenance activities including welding and sandblasting take place, a two-storey wood-frame office building, and a small shed. The small shed in the southwest corner of the Site is used for storage of equipment used by movie set builders. In general, housekeeping onsite was good.

The large L-shaped steel-frame building at 3829 Dollarton was constructed in several phases between the 1950s and the 1980s. The east-west oriented section of the building is referred to as the foyer and is used for materials storage. There is a mezzanine at the west end of the east-west arm of the building. The north-south oriented sections are or were marine service bays and their southern extents are over water. Within the north-south arm of the steel-frame building there is one active concrete-lined marine way in the eastern section of the building, and an inactive marine way that has been filled with concrete in the western and central sections of the building. The marine ways are equipped with cable winches lubricated with petroleum lubricants (grease).

The bulk of sandblasting work is conducted at the north end of the eastern marine way, on concrete above the high-tide line. Sandblast grit is reportedly excavated and trucked offsite on a regular basis. Relatively small accumulations of blasting grit were observed in the eastern marine way during the Site visit.

Currently inside the western and central sections of the steel-frame building are a small maintenance shop, a paint storage area, a blasting grit storage area, and an auto mechanic in a leased space at the south-central portion of the building. The auto mechanic bay has a concrete floor in good condition with no floor pits or drains observed. It was represented that the auto mechanic has been there for about five years. No new APEC has been identified for the mechanic as it overlaps **APEC 1** which involves the same potential contaminants of concern.

3.5.2 McKenzie Barge Property, 3919 Dollarton Highway, North Vancouver, BC

The east Site property at 3919 Dollarton Highway is also an active shipyard. It contains an office building along Dollarton Highway with maintenance shop below, a large, centrally located steel-frame building where large-scale welding takes place, two outdoor uncovered marine ways for servicing barges/boats, and several additional storage buildings.

Housekeeping onsite at 3919 Dollarton is still relatively poor but has improved considerably since 2007. Interviews and observations indicate that effort has been made to tidy the property in the past few years. A PGL inspector noted in their 2007 Site visit that full and empty containers of paints were observed scattered across the Site (including inside the winch house, in the open area in the southeast corner of the Site, and in the northeast boneyard). These containers and creosote-treated ties that were also reportedly stored in many areas across the Site in 2007 were not observed in 2013. The area formerly known to be used for storage of creosoted ties is identified as **APEC 13**.

In 2007, sandblast grit, creosoted ties, and empty anti-fouling paint cans were observed in the southwest corner of the McKenzie Barge property. The accumulations of large volumes of sandblasting grit (up to 15cm in some areas) that were observed in 2007 have since been cleaned up and placed in storage bins in the western shed. Surficial sandblast grit is still visible throughout the southwest portion of the McKenzie Barge property. This sandblasting and painting area at the southwest corner of the property was previously identified as **APEC 4**.

Significant accumulations of sandblast grit were also observed along the southeast property boundary and appear to encroach on to the filled area offsite to the southeast. This area has been previously identified as **APEC 5** due to fill of unknown origin, boat building, and material storage and burning reported in the area.

A maintenance shop is located beneath the office building and has a concrete-slab floor. The shop contains welding equipment, metal working (grinding) equipment, drums of cutting oil, and a solvent parts washer. During Site visits the floor appeared to be in good condition with no cracks. A strip drain and an oil/water separator were noted to be present in 2007. No information was available regarding the construction or maintenance of the oil/water separator and it has not been located during any PGL Site visits. Strip drains were not observed in 2013, but steel capped cuts in the floor containing electrical conduits were observed and could have been misidentified as strip drains in 2007.The general area of the maintenance shop was previously identified as **APEC 8**.

In 2007, the PGL inspector observed a gasoline UST and associated fuel pump south of the maintenance shop/office building. It was reported at the time that the tank was empty and had not been used since 1997. On May 17, 2012, PGL observed the UST removal and sampled soil from the tank nest excavation limits. In 2007, PGL also noted two pallets containing about 30 waste batteries stored outside on a gravel area adjacent to the UST. These batteries were not present during UST removal in 2012 and had reportedly been disposed of appropriately. The area of the former UST and outdoor battery storage is identified as **APEC 14**.

A horizontal, wooden-drum rack with capacity for about six drums was formerly located northwest of the painting shelter. Drums containing various hazardous materials would have been stored and used there in the past to fill smaller containers for use elsewhere onsite. At the time of PGL's 2007 Site inspection there was one drum of kerosene stored there. There was reportedly no secondary containment. The drum rack is no longer onsite but its former location is identified as **APEC 15**.

A paint and solvent storage locker was reportedly formerly located northwest of the former drum rack. We understand that containers of hazardous materials were not opened at the locker but transported away from the locker for use. This area was also located on asphalt and has not been identified as an APEC.

The northwest corner of the McKenzie property was formerly used as a bone yard. In 2007, the PGL inspector observed creosote-treated wood beams, scrap metal, a pile of tires, an old generator, an old forklift, a derelict truck, and several old trucks. NDM also described this area in 1993 as used for parking and to store wood beams, scrap steel and wood, old fuel pumps, drums and other miscellaneous materials. This area has recently been cleaned up but still contains some scrap metal and old vehicle. This northwest bone yard area at 3919 Dollarton has been identified as **APEC 16**.

During PGL's 2007 Site visit another bone yard along the northeast Site property line contained scrap wood and metal and a few empty pails of anti-fouling paint. This area has also been tidied up since that time but is still being used for storage of wood planks. The northeast bone yard area is adjacent to the painting shed which is located on decking over the north end of the eastern marine way. The northeast bone yard is identified as **APEC 17**.

During the 2007 PGL Site visit at 3919 Dollarton, vegetation in the grassy area northwest of the western marine way was identified as stressed and surficial staining was evident. This area was formerly the location of an office, bunkhouse and cookhouse and is identified as **APEC 18**.

A corrugated metal shed is located on the west side of the McKenzie Barge property near Roche Point Creek. The shed is constructed on a concrete pad and is open on three sides with a wall to the west. During PGL's 2007 Site visit, two aboveground storage tanks (ASTs), which appeared to be about 500 gallons and 750 gallons respectively, were observed inside the shed and one AST with a capacity of about 750 gallons was outside the shed on the gravel surface. The two tanks inside the shed were present and empty in 2013 and the third tank appears to have been removed from the Site. In 2007, the presence of several pails of what appeared to be paints and tar were also documented inside the shed along with scrap electrical motors. These materials appear to have since been removed from the Site. The shed was previously identified upon reviewing the fire insurance map as the former location of a machine shop and was identified as **APEC 9.**

The two marine ways at the McKenzie Barge foreshore are equipped with cable winches, which are electric. The cables are lubricated with petroleum lubricants (grease). Sandblast grit accumulates in the marine ways. It is common practice for fuels and oils to be drained from vessels being serviced in the marine ways; historical practices regarding fuel and oil handling are unclear. The area of the two marine ways was previously identified as **APEC 2** along with the foreshore Site sediments. The winch shed and adjacent areas beneath the decking north of the marine ways is identified as **APEC 19.**

A double-walled diesel AST is stored outside on paved decking, just north of the winch shed. The capacity of the tank appears to be about 750 gallons. The tank and hose are not equipped with secondary containment. The AST is elevated on decking above the water; therefore, there is no onsite media at risk from the operation of this AST. This AST has not been identified as an APEC, but the area below the decking is included in **APEC 19.**

The 1993 NDM investigation report mentions five small ASTs and drums of petroleum products in the area of the painting shelter. The painting shelter is also located on decking above the north end of the marine ways and is included in **APEC 19.**

Anti-fouling paints and solvents are stored on the ground floor of the old office building northwest of the marine ways at the McKenzie Barge property. The building has a wood floor with minor staining evident. We understand that paint cans were opened and paint transferred into smaller containers here. This paint and solvent storage building has been identified as **APEC 20.**

Hazardous building materials in Site buildings were identified as **APEC 21**.

3.6 Interviews

During our Site investigations, interviews were conducted to further assess if past activities at the Site might have resulted in contamination of the Site. Important information gained from interviews is provided in the relevant sections of this report.

3.7 Summary of Investigation Findings

The following chronology summarizes key events relating to the Site as identified during the Stage 1 PSI investigation:

Table C: Chronology of Key Site Events

Date(s)	Event	Environmental Concern
October 1883	Grants from Crown.	N
1920s or 1930s	Western portion of Site (currently 3829 Dollarton) was developed as a brickyard.	Y
1931	McKenzie family purchases the east portions of the McKenzie Barge property at 3919 Dollarton and began the McKenzie Barge and Marine Ways shipyard operations.	Y
1940s	3829 Property was developed as a shipyard.	Y
1950s	I.M. Matsumoto purchased the 3829 Dollarton property and expanded the building for the Matsumoto Shipyards operation.	Y
1960s	McKenzie Barge began filling activities in the foreshore to extend the Site further south into Burrard Inlet.	Y
1965	The westernmost lot currently comprising 3919 Dollarton was purchased and subdivided from the Matsumoto property at 3829 Dollarton.	N
1974	Filling of the foreshore south of the western lot at 3919 Dollarton extended the western half of the Site about 50m south into Burrard Inlet.	Y
1980s	Fill was imported to 3829 Dollarton and placed at the east side of the property between the shipyard building and Roche Point Creek.	Y
1989	M.A.N. Estates purchased the Matsumoto property at 3829 Dollarton and began operating Noble Towing.	Y
1950s-1995	Offsite foreshore area adjacent to the Site to the southeast was filled in the 1950s and used for boat building, material storage, dumping and burning. The exact use and responsible parties are not clear.	Y

3.8 Site Schedule 2 Use Activities

The BC CSR contains a listing of operations with a purpose or activity that MOE considers potential sources of environmental contamination. This listing forms Schedule 2 of the CSR. The historical Schedule 2 Land Use activities conducted on the Site are shown in Table D.

Table D: Historical Schedule 2 Land Uses

Tenant	Date	Schedule 2 Activity
Matsumoto Shipyards	Late 1940s/early 1950s to 1989	G4 - Dry docks, ship building or boat repair including paint removal from hulls
Noble Towing	1989 to present	G4 - Dry docks, ship building or boat repair including paint removal from hulls
Automobile service in shipyard building at 3829 Dollarton	Late 2000s to present	G2 - automotive, truck, bus, subway or other motor vehicle repair, salvage or wrecking
McKenzie Barge and Marine Ways	1931 to present	G4 - Dry docks, ship building or boat repair including paint removal from hulls

3.9 Identified Areas of Potential Environmental Concern

Based on the information gathered during the Stage 1 PSI investigation, PGL has identified 20 APECs at the Site and one offsite APEC adjacent to the Site (Figures 3 and 4).

In the following sections we summarize each APEC and identify PCOCs. APECs are identified as having a risk of being contaminated.

Despite the availability of previous investigation data, for simplicity we have considered all areas of concern as APECs rather than areas of environmental concern, areas known to be contaminated. Existing investigation data was reviewed prior to planning DSI work and will be included in the DSI report for the Site.

3.9.1 APEC 1 – General Shipbuilding Activities and Former Brickyard (3829 Dollarton)

A brickyard operated at the 3829 Dollarton property in the 1920s or 1930s and a shipyard has been onsite since the late 1940s/early 1950s.

3.9.2 APEC 2 – Sediments - Foreshore and Marine Ways - General Shipyard Activities

The sediments in the foreshore of Burrard Inlet and the marine ways south of the Site have been exposed to potential contaminants or concern due to long-term shipyard activities at both Site properties.

3.9.3 APEC 3 – Imported Fill Material East of the Shipyard Building (3829 Dollarton)

The area east of the current building at 3829 Dollarton was filled in the early 1980s during construction of the eastern section of the building. The fill in this area was reportedly imported from an unknown source in East Vancouver and has been identified as an APEC.

3.9.4 APEC 4 – In-filled Sandblasting and Painting Area with Accumulated Sandblast Grit (3919 Dollarton)

By 1974, filling of the foreshore south of the western portion of the McKenzie Barge property extended the western half of the Site about 50m south into Burrard Inlet. This in-filled area on the west side of the 3919 Dollarton property has since been used as a sandblasting and painting area.

3.9.5 APEC 5 – Offsite In-filled Foreshore and Former Materials Storage, Boat Building, and Burning Area

Aerial photographs indicate that this former foreshore area southeast of the Site was filled in the late 1950s. After this, the area was reportedly used for burning scrap wood from the building of wooden boats up until about 1995.

3.9.6 APEC 6 – Historic Boiler House (3829 Dollarton)

A former boiler house at 3829 Dollarton was identified in the 1965 fire insurance map.

3.9.7 APEC 7 – Historic Work Shop (3829 Dollarton)

A former workshop at the north end of the easternmost marine way was identified in the 1965 insurance map.

3.9.8 APEC 8 – Machine Shop Beneath McKenzie Barge Office Building (3919 Dollarton)

A machine shop beneath the main office building has been present since at least 1965.

3.9.9 APEC 9 – Shed Containing Former Maintenance Shop and Blacksmith (3919 Dollarton)

The shed near the western property line of the McKenzie Barge property contained a maintenance shop and adjacent blacksmith in the 1965 fire insurance map. ASTs and electrical equipment were also identified in the shed in recent years.

3.9.10 APEC 10 - Waste Dump (3829 Dollarton)

Hemmera's Phase 1 report identified a waste dump in the southwest section of the building at 3829 Dollarton. The waste was reportedly removed years ago but we have identified this area as an APEC.

3.9.11 APEC 11 - Offshore Buried Barge and Metal Debris (3829 Dollarton)

Hemmera's Phase 1 report identified an offshore barge and buried metal debris in the foreshore southwest of the shipyard building at 3829 Dollarton.

3.9.12 APEC 12 - Historical Solvent and Paint Storage Area (3829 Dollarton)

Hemmera's Phase 1 report identified an area of historical solvent and paint storage in the current gravel parking lot area southwest of the shipyard building at 3829 Dollarton.

3.9.13 APEC 13 – Former Storage Area for Creosoted Ties (3919 Dollarton)

An area formerly known to be used for storage of creosoted ties is located in the northwest portion of the McKenzie Barge property.

3.9.14 APEC 14 – Former Gasoline UST and Outdoor Battery Storage Area (3919 Dollarton)

A gasoline UST and associated fuel pump was removed from the area south of the McKenzie Barge office building in 2012. In 2007, a PGL Site inspector noted two pallets containing about 30 waste batteries stored on a gravel area adjacent to the UST.

3.9.15 APEC 15 – Former Drum Rack (3919 Dollarton)

A former drum rack for storage of miscellaneous chemicals was present at 3919 Dollarton south of the former UST.

3.9.16 APEC 16 - Northwest Boneyard (3919 Dollarton)

The northwest boneyard at the McKenzie Barge property formerly stored creosote-treated wood beams, a pile of tires, an old generator, an old forklift, and currently contains scrap metal and old vehicles.

3.9.17 APEC 17 - Northeast Boneyard (3919 Dollarton)

This area along the northeast Site property line formerly contained scrap wood and metal and empty pails of anti-fouling paint and currently contains wood planks.

3.9.18 APEC 18 - Staining and Stressed Vegetation in Area of Former Office/ Bunkhouse/Cookhouse (3919 Dollarton)

During the 2007 PGL Site visit at 3919 Dollarton, vegetation in the grassy area northwest of the western marine way was identified as stressed and surficial staining was evident.

3.9.19 APEC 19 - Winch Shed and Area Beneath Decking North of Marine Ways (3919 Dollarton)

The winch shed and adjacent areas beneath the decking north of the marine ways has been identified as an APEC. The APEC includes the area beneath a diesel AST and the painting shelter.

3.9.20 APEC 20 - Paint and Solvent Storage Building (Old Office at 3919 Dollarton)

Anti-fouling paints and solvents are stored on the ground floor of the old McKenzie Barge office building northwest of the marine ways.

3.9.21 APEC 21 - Hazardous Building Materials

Due to the age of Site buildings, hazardous building materials have been identified as an APEC.

PCOCs were identified based on the findings of PGL's previous Limited Stage 1 reports, the findings of NDM's soil, groundwater and sediment investigation, and our experience on similar industrial shipyard and boat building sites. The PCOCs identified are for soil, soil vapour, groundwater, and sediment. The PCOCs for each APEC are identified in Table E.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the previous investigations and supplemental information collected by PGL, Twenty onsite APECs, and one offsite APEC were identified for the Site. The identified APECs and their associated PCOCs are shown in Table E. PGL recommends that a Stage 2 PSI be completed to further investigate APEC 1 to APEC 20.

Table E: APECs and PCOCs

APEC	Name/Activity	PCOCs	
		Primary	Secondary
1	General Shipbuilding and Brickyard Activities (3829 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, VOC, TBT	PAH
2	Sediments - Foreshore and Marine Ways – General Shipyard Activities	Metals, PAH, TBT	PCB
3	Imported Fill East of Shipyard Building (3829 Dollarton)	Metals, LEPH/HEPH	PAH
4	In-filled Sandblasting and Painting Area with Accumulated Sandblast Grit (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, VOC, TBT	PAH, PCB
5	Offsite Filled Foreshore and Former Materials Storage / Burning Area East of Site	Metals, LEPH/HEPH, PAH, MAH, VPH, TBT	PCB, VOC
6	Historic Boiler House (3829 Dollarton)	LEPH/HEPH, PAH	
7	Historical Work Shop (3829 Dollarton)	Metals, LEPH/HEPH, MAHs, VPH, VOC	PAH
8	Machine Shop (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH, VOC	PAH

APEC	**Name/Activity**	**PCOCs**	
		Primary	**Secondary**
9	Shed on Western Side of 3919 Dollarton (former machine and blacksmith shop)	Metals, LEPH/HEPH, MAH, VPH	PAH, PCB
10	Waste Dump (3829 Dollarton)	Metals, LEPH/HEPH, PAH (screening parameters only, all waste was removed several years ago)	MAH, VPH, VOC
11	Buried Barge and Metal Debris (Water Lot South of 3829 Dollarton)	Metals, PAH	
12	Historical Solvent and Paint Storage Area (3829 Dollarton)	Metals, VOC, VPH, LEPH/HEPH	MAH
13	Former Storage Area for Creosoted Ties (3919 Dollarton)	LEPH/HEPH, PAH	
14	Former Gasoline UST and Outdoor Battery Storage Area (3919 Dollarton)	MAH, VPH, LEPH, Metals (for battery storage)	MTBE, EDB (1,2-dibromoethane), DCA (1,2-dichloroethane)
15	Former Drum Rack (3919 Dollarton)	LEPH/HEPH, MAH, VPH, VOC	
16	Northwest Bone Yard (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH	PCB, PAH, VOC
17	Northeast Bone Yard (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH	PCB, PAH, VOC
18	Staining and stressed vegetation in area of former office/bunkhouse/cookhouse (3919 Dollarton)	Metals, LEPH/HEPH, MAH, VPH	PAH, VOC, PCB
19	Winch Shed / Area beneath decking north of Marine Ways (3919 Dollarton)	Metals, LEPH/HEPH, PAH, MAH, PCB, TBT	
20	Paint and solvent storage building (old office) (3919 Dollarton)	Metals, VOC, VPH	LEPH/HEPH, MAH
21	Regulated building materials	Asbestos, PCBs, etc. in building materials only	

Notes:
LEPH/HEPH = light and heavy extractable petroleum hydrocarbons
PAH = polycyclic aromatic hydrocarbons
MAH = monocyclic aromatic hydrocarbons
MTBE = methyl tertiary butyl ether
VPH = volatile petroleum hydrocarbons
VOC = volatile organic compounds
PCB = polychlorinated biphenyls
TBT = tributyl tin

5.0 PROFESSIONAL STATEMENT

Pursuant to the requirements of Part 16 of the Contaminated Sites Regulation, PGL affirms that:

- This documentation has been prepared in accordance with all requirements of the *Waste Management Act* and Regulations; and
- The persons signing this report have demonstrable experience with this type of investigation and the Site conditions.

6.0 STANDARD LIMITATIONS

PGL prepared this report for Polygon Development 270 Ltd. and its agents, the Ministry of Environment and Contaminated Sites Approved Professionals Society exclusively. PGL accepts no responsibility for any damages that may be suffered by third parties as a result of decisions or actions based on this report.

The purpose of this report is to provide an assessment of the potential for environmental contamination on the subject property. Our investigation identified reasonably foreseeable risks that can be detected by normal archival research and untimed Site visits with no sampling or testing. Our conclusions rely on there having been complete and accurate disclosure of conditions by the client and other relevant sources of information. As with all environmental investigations the potential remains for unknown, unidentified, or unforeseen contamination to exist which has not been identified herein. Environmental investigations are limited by both practical limitations in scope and inherent limitations in technique.

The findings and conclusions are Site-specific and were developed in a manner consistent with that level of care and skill normally exercised by environmental professionals currently practicing under similar conditions in the area. Conclusions and costs are time sensitive, so this report is for use now. This report should not be used after that without PGL review/approval. Use of this report should recognize that the rapid pace of change in the environmental field and related regulations means that environmental investigations and their conclusions can quickly become dated.

The project has been conducted according to our instructions and work program. Additional conditions and limitations on our liability are set forth in our work program/contract. This report is neither an endorsement nor a condemnation of the subject property. No warranty, expressed or implied, is made.

Respectfully submitted,

POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD.

Per:

David Bell, B.Sc.
Environmental Scientist

William Gaherty, M.S., P.Eng.
President

DWB/WDG/slr

Bibliography

Aerial photographs:

Year	Serial No.	Photo No.
2009	SRS 7987	270
2004	SRS 6929	119, 120
2002	SRS 6600	105, 106
1999	SRS 6064	191, 192
1997	FFC VCR9700	237, 238
1996	30BCC96082	96, 97
1994	FFC VCR94	260, 261
1992	30BCB92018	11,12
1991	FF9131	182, 183
1990	SRS 4335	266, 267
1989	A27396	78, 79
1987	FF 8727	108, 109
1984	A26511	97, 98
1982	A25941	45, 46
1979	30BC79047	71, 72
1976	BC5721	80, 81
1974	BC5573	225, 226
1971	BC5406	232, 233
1969	BC5325	202, 203
1966	BC5194	101, 102
1963	BC5059	242,243
1959	A16830	100, 101
1957	BC2347	1
1952	BC1633	24, 25
1949	BC728	105, 106
1947	XL39	10, 11
1946	A10399	107, 108
1926	BA23	69

Henderson Business Directories:

- Blantyre Place: 2001, 1995/96, 1990
- Deercrest Drive: 2001

- Dollarton Highway: 2001, 1995/96, 1990, 1985, 1980, 1975, 1970, 1965, 1960, 1955, 1950, 1945, 1940
- Fairway Drive: 2001, 1996, 1990, 1985, 1980, 1975, 1970, 1965, 1960
- Fairway Place: 2001, 1995/96, 1990, 1985, 1980, 1975
- Roche Place: 2001
- Roche Point Drive: 2001, 1996, 1990,
- Sparrow Lane: 2001, 1995/96
- Windcrest Drive: 2001, 1995/96, 1990

Fire Insurance Map: 1965

Wild, Threatened, Endangered, and Lost streams of the Lower Fraser Valley Summary Report, 1997.

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Interviews:

- Mr. Brian Moffatt, McKenzie Barge and Marine Ways Ltd.
- Mr. Robert McKenzie, Owner McKenzie Barge and Marine Ways Ltd
- Ms. Lark Noble, Owner Noble Towing Ltd.

District of North Vancouver GEOweb: http://www.geoweb.dnv.org

EcoLog ERIS: 0.5km radius area search