# A SPECIAL MEETING
# OF THE TOWN OF LADYSMITH COUNCIL
# AGENDA
# 5:30 P.M.

**Tuesday, May 19, 2020**
**This meeting will be held electronically**

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Pages

## 1. CALL TO ORDER

Call to Order 5:30 p.m. in Open Session, in order to retire immediately into Closed Session.

*Members of the public are welcome to attend all Open Meetings of Council, but may not attend Closed Meetings.*

## 2. CLOSED SESSION

Recommendation
That, in accordance with section 90(1) of the *Community Charter,* Council retire into closed session in order to consider items related to the following:

- Personal information about an identifiable individual - Section 90(1)(a)
- Negotiations regarding the provision of a municipal service - Section 90(1)(k)

## 3. SPECIAL OPEN MEETING (7:00 p.m.)

Please go to https://www.youtube.com/channel/UCH3qHAExLiW8YrSuJk5R3uA/featured to view this meeting.

## 4. AGENDA APPROVAL

Recommendation
That Council approve the agenda for this Special Meeting of Council for May 19, 2020,

## 5. RISE AND REPORT- Items from Closed Session

## 6. MINUTES

### 6.1 Minutes of the Special Meeting of Council held May 5, 2020 — 5

Recommendation

That Council approve the minutes of the Special Meeting of Council held May 5, 2020.

### 6.2 Minutes of the Special Meeting of Council held May 12, 2020 — 12

Recommendation

That Council approve the minutes of the Special Meeting of Council held May 12, 2020.

## 7. PROCLAMATIONS

### 7.1 Local Government Awareness Week, May 17-23, 2020 — 14

Mayor Stone has proclaimed May 17 to 23, 2020 as "Local Government Awareness Week".

### 7.2 Intergenerational Day Canada, June 1, 2020 — 15

Mayor Stone has proclaimed June 1, 2020 as "Intergenerational Day Canada" in the Town of Ladysmith.

## 8. REPORTS

### 8.1 RDN Referral - Rezoning and OCP Amendment Nanaimo Airport Lands — 16

Recommendation

That Council endorse the response to the referral from the Regional District of Nanaimo related to proposed OCP and Zoning Bylaw amendments for the Nanaimo Airport, attached as Appendix A to the report prepared by the Director of Development Services dated May 19, 2020.

### 8.2 Waterfront Area Plan Implementation: Uplands Remediation Process — 32

Recommendation

That Council:

1. Receive the Regulatory Path to Closure and Stage 1 Preliminary Site Investigation prepared by Golder Associates provided in Appendix A of the staff report from the Director of Development Services dated May 19, 2020;

2. Direct Staff to amend the 2020-2024 Financial Plan to include up to $400,000 from general surplus and development reserves to cover the cost of a detailed site investigation over the course of 2020-2021; and

3. Direct staff to:
   a. submit an application on behalf of the Town to the Federation of Canadian Municipalities to obtain funding for a detailed site investigation of the uplands and to obtain the services of a consultant, if required, to prepare the grant application; and

   b. seek the services of a qualified environmental engineering firm to complete a detailed site investigation of the uplands.

## 9. DISCUSSION

### 9.1 COVID-19 Recovery

- Investing in Ladysmith website/app
- Parklets/Sidewalk patios
- Infrastructure/Capital projects
- Grant Opportunities
- Lobbying Senior Government
- Feasibility of closing section of 1st Avenue to vehicle traffic on select days/nights (Thursday, Friday, and/or Saturday)

## 10. NEW BUSINESS

### 10.1 Vancouver Island Rail Corridor 231

At the May 5, 2020 Council meeting, Councillor Johnson provided notice of his intent to discuss the Island Rail Corridor at a future meeting of Council.

The Island Rail Corridor Condition Assessment Summary Report is attached. To access the appendices, please click on the link below:

https://www2.gov.bc.ca/gov/content/transportation/transportation-reports-and-reference/reports-studies/vancouver-island/island-rail

## 11. QUESTION PERIOD

Residents can submit questions to Council via email at info@ladysmith.ca or on YouTube during the meeting.

- Persons wishing to address Council must be Town of Ladysmith residents, non-resident property owners, or operators of a business.
- Individuals must include their name and address for identification purposes.
- Questions put forth must be on topics which are not normally dealt with by Town staff as a matter of routine.
- Questions must be brief and to the point.
- No commitments shall be made by the Chair in replying to a question. Matters which may require action of the Council shall be referred to a future meeting of the Council

## 12. ADJOURNMENT

LADYSMITH

# MINUTES OF A SPECIAL MEETING OF COUNCIL

**Tuesday, May 5, 2020**
**5:30 P.M.**
**This meeting was held electronically**

**Council Members Present:**

Mayor Aaron Stone
Councillor Duck Paterson
Councillor Amanda Jacobson
Councillor Rob Johnson
Councillor Tricia McKay
Councillor Marsh Stevens
Councillor Jeff Virtanen

**Staff Present:**

Guillermo Ferrero
Chris Barfoot
Jake Belobaba
Erin Anderson
Geoff Goodall
Donna Smith
Joanna Winter
Ian Paydli
Chris Geiger
Mike Gregory
Sue Bouma
Christina Hovey

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## 1. CALL TO ORDER

Mayor Stone called this Special Meeting of Council to order at 5:30 p.m., in order to retire immediately into Closed Session.

## 2. CLOSED SESSION

**CS 2020-128**
That, in accordance with section 90(1) of the *Community Charter,* Council retire into closed session in order to consider items related to the following:

- Human resources matter - Section 90(1)(c)
- The security of the property of the municipality - Section 90(1)(d)
- Legal advice - Section 90(1)(i)
- Negotiations regarding the provision of a municipal service - Section 90(1)(k)

*Motion Carried*

## 3. SPECIAL OPEN MEETING (7:00 p.m.)

Council and staff showed their appreciation for the front line workers in Ladysmith by cheering and showing hearts.

Mayor Stone called this Special Meeting of Council to order at 7:00 p.m., recognizing that it was taking place in various locations throughout Coast Salish territory. He then took a moment to recognize Red Dress Day, a day to honour and bring awareness to the issue of murdered and missing indigenous women and girls in Canada.

## 4. AGENDA APPROVAL

**CS 2020-129**
That Council approve the agenda for this Special Meeting of Council for May 5, 2020 as amended to include the following items:

- Item 12.2, Opening Transfer Beach and Holland Creek Parking Lots
- Item 12.3, Island Corridor Foundation

*Motion Carried*

## 5. DELEGATIONS

### 5.1 Cory Vanderhorst, CPA, CA - MNP Auditors for the Town of Ladysmith

Mr. Vanderhorst presented a summary of the draft audited Financial Statements for the Town of Ladysmith for 2019. He stated that this is an unqualified or clean audit. Mr. Vanderhorst responded to questions from Council.

**CS 2020-130**
That Council accept the 2019 Draft Financial Statements as presented by MNP, auditors for the Town of Ladysmith.
*Motion Carried*

## 6. MINUTES

### 6.1 Minutes of the Special Meeting of Council held April 21, 2020

**CS 2020-131**
That Council approve the minutes of the Special Meeting of Council held April 21, 2020.
*Motion Carried*

## 7. PROCLAMATIONS

### 7.1 National Missing Children's Day and Child Find's Green Ribbon of Hope Month

Mayor Stone proclaimed May 25th as National Missing Children's Day and the month of May as Child Find's Green Ribbon of Hope Month. He encouraged citizens to wear a green ribbon as a symbol of Hope for the recovery of all missing children.

## 8. DEVELOPMENT APPLICATIONS

### 8.1 Development Permit for a Coach House – 517 Symonds Street

**CS 2020-132**
That Council:
1. Issue Development Permit 3060-20-08 for a coach house dwelling at 517 Symonds Street; and
2. Authorize the Mayor and Corporate Officer to sign Development Permit 3060-20-08.

*Motion Carried*

## 9. REPORTS

### 9.1 Cowichan Valley Fire Department Regional Mutual Aid Agreement

**CS 2020-133**
That Council direct the Mayor and the Corporate Officer to sign the Cowichan Valley Fire Department Regional Mutual Aid Agreement.
*Motion Carried*

### 9.2 Adjustments to Water Billing Accounts

**CS 2020-134**
That Council approve an adjustment to the water billing for Property Account No.1052005 in the amount of $3,394.30 as a result of a water leak.
*Motion Carried*

### 9.3 Ladysmith Secondary School and Stz'uminus First Nation 2020 Graduates

**CS 2020-135**

That, due to the likely cancellation of graduation ceremonies and festivities for the 2020 graduation classes because of the COVID-19 pandemic, Council:

1. Commemorate the accomplishments of the Ladysmith Secondary School and Stz’uminus First Nation graduating classes by sending each graduate a personalized letter from Council; and
2. Honour their graduation through print media and social media posts.

*Motion Carried*

OPPOSED: Councillor Johnson

### 9.4 Facility Usage Request for Aggie Hall

**CS 2020-136**

That Council:

1. Support the request from Ladysmith Family and Friends to reopen Aggie Hall during their existing booked hours in order to continue making and distributing resources to Ladysmith families in a safe manner during the COVID-19 pandemic; and
2. Direct staff to work with Ladysmith Family and Friends staff to accomplish this request safely and in accordance with the orders of the Provincial Health Officer.

*Motion Carried*

### 9.5 Machine Shop: Projected Cost Increase

**CS 2020-137**

That Council receive as information the report from staff providing a status update and revised cost projections for structural upgrades to the Machine Shop.

*Motion Carried*

## 10. BYLAWS

### 10.1 2020 Financial Plan, Property Taxes and Parcel Taxes

**CS 2020-138**

That Council give first 3 readings to:

a. 2020-2024 Financial Plan Bylaw 2020, No. 2036;
b. 2020 Property Tax Rates Bylaw 2020, No. 2037;
c. 2020 Water Parcel Tax Bylaw 2020, No. 2038;
d. 2020 Sewer Parcel Tax Bylaw 2020, No. 2039.

*Motion Carried*

**CS 2020-139**

That Council adopt:

a. 2020-2024 Financial Plan Bylaw 2020, No. 2036;
b. 2020 Property Tax Rates Bylaw 2020, No. 2037;
c. 2020 Water Parcel Tax Bylaw 2020, No. 2038;
d. 2020 Sewer Parcel Tax Bylaw 2020, No. 2039.

*Motion Carried*

## 11. CORRESPONDENCE

### 11.1 Ladysmith Resources Centre Association: Annual Report

Council requested that the LRCA Executive Director be invited to a future meeting of Council to answer questions related to their annual report.

**CS 2020-140**

That Council receive for information the Ladysmith Resources Centre Association annual report for 2019.

*Motion Carried*

### 11.2 Building Capacity and Partnerships for Restorative Justice Practices in Ladysmith

**CS 2020-141**

That Council receive for information the March 2020 report by the Ladysmith Resources Centre Association entitled "Building Capacity and Partnerships for Restorative Justice Practices in Ladysmith".

*Motion Carried*

### 11.3 Paul Manly, Member of Parliament for Nanaimo-Ladysmith

**CS 2020-142**
That Council receive for information the correspondence dated April 28, 2020 from Paul Manly, Member of Parliament for Nanaimo-Ladysmith.
*Motion Carried*

## 12. NEW BUSINESS

### 12.1 Citizens on Patrol

**CS 2020-143**
That Council send a letter of appreciation to the Ladysmith Citizens On Patrol, thanking them for continuing to provide excellent and invaluable service to the residents of Ladysmith through their regular patrols throughout the Town.
*Motion Carried*

### 12.2 Opening Transfer Beach and Holland Creek Parking Lots

Council discussed the merits and risks of opening the parking lots at Transfer Beach and Holland Creek trail, particularly in light of the upcoming Mother's Day and Victoria Day weekends. This operational decision was left with the CAO.

### 12.3 Island Corridor Foundation

**CS 2020-144**
That Council request that staff bring forward to the next Council meeting, the previous report from Island Corridor Foundation.
*Motion Carried*
OPPOSED: Councillor Jacobson

## 13. QUESTION PERIOD

Council expressed profound appreciation, respect and admiration for Guillermo Ferrero, CAO, as he prepares to take a position with the City of Whiterock. They commended him for his stewardship, support, leadership and guidance and wished him well. The CAO thanked Council and expressed his appreciation for the team that supports him and Council.

There were no questions from the public.

## 14. MOTION TO RECESS

**CS 2020-145**
That Council recess at 8:33 p.m. for a five minute break before reconvening the Closed Session.
*Motion Carried*

## 15. RISE AND REPORT- Items from Closed Session

Council rose from Closed Session at 9:02 p.m. with report on the following item:

- Resolution CE 2020-064

  That Council approve the Request for Proposal for the Chief Administrative Officer Executive Search/Recruitment and direct staff to post it on the Town's website, CivicInfo and BC Bid.

## 16. ADJOURNMENT

**CS 2020-146**
That this Special Meeting of Council adjourn at 9:03 p.m.
*Motion Carried*

| | |
|---|---|
| Mayor (A. Stone) | Corporate Officer (D. Smith) |

LADYSMITH

## MINUTES OF A SPECIAL MEETING OF COUNCIL

**Tuesday, May 12, 2020**
**5:00 P.M.**
**This meeting was held electronically**

**Council Members Present:**

Mayor Aaron Stone
Councillor Duck Paterson
Councillor Amanda Jacobson
Councillor Rob Johnson
Councillor Tricia McKay
Councillor Marsh Stevens
Councillor Jeff Virtanen

**Staff Present:**

Guillermo Ferrero
Erin Anderson
Chris Barfoot
Jake Belobaba
Geoff Goodall
Donna Smith
Joanna Winter
Mike Gregory
Sue Bouma

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### 1. CALL TO ORDER

Mayor Stone called this Special Meeting of Council to order at 5:00 p.m., in order to retire immediately into Closed Session.

### 2. CLOSED SESSION

**CS 2020-147**
That, in accordance with section 90(1) of the *Community Charter,* Council retire into closed session in order to consider items related to the following:

- Negotiations regarding the provision of a municipal service - Section 90(1)(k)

*Motion Carried*

### 3. RISE AND REPORT- Items from Closed Session

Council rose from Closed Session at 7:06 p.m. without report.

## 4. ADJOURNMENT

This Special Meeting of Council was adjourned by unanimous consent at 7:08 p.m.

Mayor (A. Stone)

Corporate Officer (D. Smith)

LADYSMITH

TOWN OF LADYSMITH

# PROCLAMATION

## **LOCAL GOVERNMENT AWARENESS WEEK**

*WHEREAS* *a Local Government Awareness Week will increase public awareness and understanding of local government roles and responsibilities, and*

*WHEREAS* *local governments have the most direct impact on the day-to-day lives of people in communities through the provision of essential infrastructure, public services, community amenities and emergency response, and*

*WHEREAS* *local governments play a pivotal role in serving, supporting and uniting people during extraordinary and difficult times, and*

*WHEREAS* *local governments and the Province of British Columbia work together for the common good of all people, and*

*WHEREAS* *local government awareness is sponsored and supported collaboratively by the Union of British Columbia Municipalities, local government partner agencies and the Province of British Columbia;*

***THEREFORE,*** *I, Aaron Stone, Mayor of the Town of Ladysmith, do hereby proclaim May 17 -23, 2020 as "Local Government Awareness Week" in the Town of Ladysmith, British Columbia.*

Mayor A. Stone

May 12, 2020

TOWN OF LADYSMITH

# PROCLAMATION

## INTERGENERATIONAL DAY

***WHEREAS***: *Intergenerational Day Canada is meant to raise awareness about the power of making simple, respectful intergenerational connections; and*

***WHEREAS***: *It is a day to focus on the profound positive influence intergenerational connecting has on eliminating isolation and loneliness, moving towards healthy, all-age friendly communities; and*

***WHEREAS***: *Intergenerational Day Canada is a day to celebrate all of the good things presently taking place between generations in local community; and*

***WHEREAS***: *Intergenerational Day Canada encourages simple and fun intergenerational sharing; and*

***WHEREAS***: *Intergenerational Day Canada will be an official reminder and yearly invitation for every citizen to take one small step to bridge generations within his or her local community.*

***THEREFORE,*** *I, Aaron Stone, Mayor of the Town of Ladysmith, do hereby proclaim June 1, 2020 as "Intergenerational Day Canada" in the Town of Ladysmith, British Columbia.*

Mayor A. Stone

May 12, 2020

STAFF REPORT TO COUNCIL

**Report Prepared By**: Jake Belobaba, Director of Development Services
**Meeting Date:** May 19, 2020
**File No:** **0400-60-30**
**RE:** **RDN REFERRAL: REZONING AND OCP AMENDMENT NANAIMO AIRPORT LANDS**

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**RECOMMENDATION:**
That Council endorse the response to the referral from the Regional District of Nanaimo related to proposed OCP and Zoning Bylaw amendments for the Nanaimo Airport, attached as Appendix A to the report prepared by the Director of Development Services dated May 19, 2020.

**EXECUTIVE SUMMARY:**
The Regional District of Nanaimo (RDN) has sent a referral (Appendix B) to the Town related to a rezoning and OCP amendment for the Nanaimo Airport lands. Staff have reviewed the referral and have provided a proposed response (Appendix A) for Council's consideration. The proposed response is supportive of the bylaw amendments, with a recommendation that efforts to expand and improve regional transit service continue and coincide with further development at the airport, so as to mitigate the impacts on the regional highway system. The RDN has requested a response to the referral by May 28, 2020.

**PREVIOUS COUNCIL DIRECTION:**

| Resolution Number | Resolution Date | Resolution |
|---|---|---|
| CS 2015-074 | 03/02/2015 | That the correspondence from the Nanaimo Airport Authority requesting a letter of support for the Nanaimo Airport Expansion Project be received and staff be directed to prepare a letter of support for the grant application for the Nanaimo Airport Expansion Project through the Building Canada Fund. |

**INTRODUCTION/BACKGROUND:**
The Nanaimo Airport Commission recently adopted an Airport Land Use Plan to guide development of the airport lands. The plan's Land Use Development Plan includes five land use zones, a conceptual transportation network, and a set of objectives and general policies. The plan designates areas for: "Airside Commercial"; "Air Terminal Reserve"; "The Runway"; "Future Aviation"; and "Groundside Commercial" (commercial development adjacent to the Trans Canada Highway).

The RDN has tabled zoning and OCP amendments that will align these bylaws with the Airport Land Use Plan. The first phase of public, First Nations and stakeholder engagement has been completed, and the amendment bylaws received first and second reading on April 14, 2020.

*Proposed Bylaws*

RDN Official Community Plan Amendment Bylaw 1620.06 will amend Section 8.8 of the Electoral Area A, OCP to change background text and add objectives and policies to reflect current and proposed uses on the airport lands.

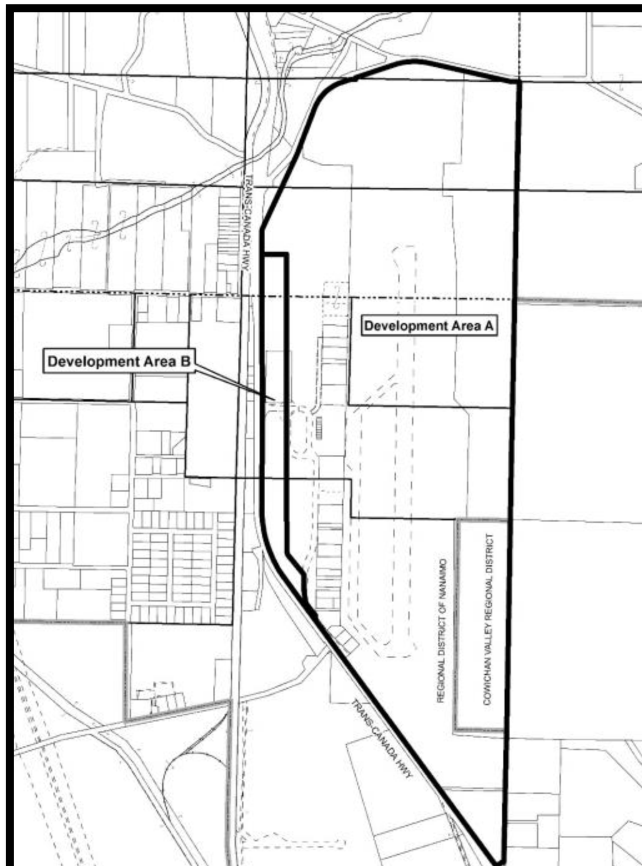



Figure 1: Development Areas A & B

Bylaw 500.429 will amend the RDN Zoning Bylaw to change the zoning for three parcels south of Haslam Road from RU4 and AG1 to a new zone called 'Nanaimo Airport 1'. The new zone includes two sub areas:

1. Development Area A would include the area identified in the Airport Land Use Plan as Airside, Airside Commercial, and Air Terminal Reserve. Only "airport" and "agriculture" will be permitted in this sub area.

2. Development Area B is adjacent to the Trans Canada Highway and would include the area identified in the Airport Land Use Plan as Groundside Commercial but would exclude parking areas. This sub area allows uses that are related to aeronautics (e.g. "airport") and uses that are not necessarily related to aeronautics (e.g. "convenience store", "fast food outlet", "light industry", "retail store" and "gasoline service station").

*Federal/Regional District Jurisdiction*

Aeronautics and airports are generally immune from local government bylaws as they fall exclusively under federal jurisdiction. Lands owned by the federal government are also generally immune from local government bylaws, regardless of use. This latter immunity does not apply to the Nanaimo Airport lands, as they are now owned by the Nanaimo Airport Commission and not the federal government. Staff's review of the available legal literature and cursory legal advice suggest that, in general, the proposed RDN bylaws *will not* apply to aeronautics operations of the airport (e.g. location of runways, terminal buildings etc.) but *will* apply to land uses unrelated to aeronautics, such as certain commercial uses alongside the Trans Canada highway.

For these reasons, staff's review and the proposed response focus on land uses more likely to be unrelated to aeronautics.

**PROPOSED RESPONSE:**

The proposed response is supportive of the bylaw amendments with recommendations that that the RDN consider the proposal in the context of regional transit service and impacts on the regional transportation system. This is consistent with work that is already under way and with aspects of the Airport Land Use Plan (e.g. the plan includes a "transit hub". Specifically, the proposed response recommends transit connections between the airport and communities to the south, with the aim of having this service up and running prior to full build out of the airport and in-particular full build out of the commercial component along the highway.

**DISCUSSION:**

The Nanaimo Airport is a major employment, economic and transportation center for Ladysmith and the Town has previously supported expansion of the Airport (see 'Previous Council Direction').

The proposed development of the airport includes a substantial commercial component and list of permitted uses along the highway, many of which may not be directly related to the operational needs of the airport. Development of this scale will create traffic impacts on the Trans Canada highway—which is Ladysmith's only highway connection to communities to the north. It will also generate additional transportation demands between the airport and Ladysmith and the airport for travel, shopping and employment.

Transit service and infrastructure have a positive impact on traffic volumes, vehicle trips and greenhouse gas emissions. Transit convenience and connectivity to airports and shopping centers also influences tourism and travel choices, which has positive economic impacts—i.e. convenient, affordable transportation choices will make people more likely to use the airport or shop there, thereby increasing its economic impact. For these reasons, it would be prudent to ensure that full build out of the proposed commercial development does not precede more robust transit service.

The RDN recently expanded transit service from Nanaimo to the airport. Discussions are under way regarding bus service between the airport and communities to the south, and development plans for the Airport Plan include a transit hub; meaning the recommendation in the proposed response is aligned with existing development plans and transit objectives. Given the importance of these projects to Ladysmith, it is in the Town's best interest to request that further development of the airport lands coincide with planned transit improvements. Staff are confident that southbound transit service can be established before further development of the airport occurs and demand will be adequate to justify and maintain the service in perpetuity.

**ALTERNATIVES:**

Council can choose to:

1. Not endorse the proposed response and direct staff not to comment on the proposed referral.
2. Amend the proposed response, and endorse the response as amended.

**FINANCIAL IMPLICATIONS:**
None.

**LEGAL IMPLICATIONS:**
The Town is not a party to the RDN Regional Growth Strategy and therefore the RDN is not legally bound to implement the recommendations in the proposed response.

**CITIZEN/PUBLIC RELATIONS IMPLICATIONS:**
The Town is not required to undertake any public consultation related to this referral. The RDN is responsible for ensuring public consultation requirements under the *Local Government Act* are met.

**INTERDEPARTMENTAL INVOLVEMENT/IMPLICATIONS:**
The referral was circulated amongst Town departments for review and comment and the proposed response is reflective of feedback received.

**ALIGNMENT WITH SUSTAINABILITY VISIONING REPORT:**
☐Complete Community Land Use ☒ Low Impact Transportation
☐Green Buildings ☐ Multi-Use Landscapes
☐Innovative Infrastructure ☐ Local Food Systems
☐Healthy Community ☒ Local, Diverse Economy
☐ Not Applicable

**ALIGNMENT WITH STRATEGIC PRIORITIES:**
☒Infrastructure ☒ Economy
☐Community ☐ Not Applicable
☐Waterfront

***I approve the report and recommendation(s).***

**Erin Anderson, Acting Chief Administrative Officer**

**ATTACHMENT(S):**

Appendix A: Proposed Town of Ladysmith Response
Appendix B: RDN Referral

May 20, 2020

Chair Ian Thorpe and Board
Regional District of Nanaimo
6300 Hammond Bay Road,
Nanaimo, BC V9T 6N2

Dear Chair Thorpe and Board:

**RE: Proposed Amendment Bylaws 1620.06 and 500.429 for the Nanaimo Airport Lands**

On behalf of the Town of Ladysmith, I thank you for providing the Town with an opportunity to comment on the above-noted bylaws. Council reviewed the referral on May 19, 2020 and the staff report and Council resolution are attached for your consideration. A recording of the Council meeting is available at: https://www.ladysmith.ca/city-hall/mayor-council/council-video-archive. The Town supports adoption of the proposed bylaws, with the recommendation that transit oriented development principles be factored into further expansion of the airport and that efforts to expand regional transit connections continue. Specifically, the Town recommends that the RDN continue its efforts to expand regional bus service connecting the airport and communities to the south, with the aim of having this service up and running prior to full build out of the proposed commercial developments along the highway.

Addressing these considerations would be consistent with airport development and transit plans that are already proposed or under discussion. Improved transit is necessary to mitigate impacts on regional highway infrastructure, combat climate change, support the Island's economy, optimize integrated transportation systems, and ensure the long-term success of the airport.

Again, thank you for providing the opportunity to comment on this proposal.

Sincerely,

Mayor Aaron Stone

REGIONAL DISTRICT OF NANAIMO

April 29, 2020

Jake Belobaba
Director of Development Services
Town of Ladysmith
PO Box 220
Ladysmith, BC V9G 1A2

**Re: Proposed Amendment Bylaws 1620.06 and 500.429 for the Nanaimo Airport Lands**

Dear Jake Belobaba:

The Regional District of Nanaimo is proposing to change the Official Community Plan and the Zoning Bylaw for the Nanaimo Airport Lands both to recognize the existing airport operations and to facilitate future commercial development on the portion of the property adjacent to the Trans-Canada Highway.

On April 28, 2020, the RDN Board gave first and second reading to amendment bylaws 1620.06 and 500.429. These bylaws are attached for your review. They make changes to the Regional District of Nanaimo Electoral Area A Official Community Plan Bylaw No. 1620, 2011 (OCP) and the Regional District of Nanaimo Land Use and Subdivision Bylaw 500, 1987 (Zoning Bylaw). Additional background information can be found at the project website at www.getinvolved.rdn.ca/airport or by contacting me at (250) 390-6563 or at csimpson@rdn.bc.ca.

Below is a summary of the bylaw amendments:

- ***Official Community Plan*** – Amend the background text and add objectives and policies in Section 8.8 – Nanaimo Airport to reflect current and proposed uses of the airport as shown in the NAC Land Use Plan.

- ***Zoning Bylaw*** – For the three parcels south of Haslam Road, change the current zoning from RU4 and AG1 to a new zone called 'Nanaimo Airport 1' and include two sub-areas based on the Nanaimo Airport Land Use Plan. Development Area A would include the area identified in the NAC Land Development Site Masterplan map as Airside, Airside Commercial, and Air Terminal Reserve. Development Area B is adjacent to the Trans-Canada Highway and would include the area identified in the NAC Land Development Site Masterplan as Groundside Commercial but exclude parking areas.

We are requesting comments on the proposed bylaws as they relate to your agency's responsibilities. Please send your comments to the email address below or by mail to the Regional District of Nanaimo Planning Department located at 6300 Hammond Bay Road, Nanaimo, BC, V9T 6N2 no later than **May 28, 2020**. If we do not receive your comments by this date, we will assume that your agency has no objections to the proposed bylaw amendments.

If you have any questions or require clarification, please do not hesitate to contact me by telephone or by email at csimpson@rdn.bc.ca.

Sincerely,

Courtney Simpson
Senior Planner, Strategic and Community Development
T: 250-390-6563 | Email: csimpson@rdn.bc.ca

Encl. "Regional District of Nanaimo Electoral Area A Official Community Plan Amendment Bylaw No. 1620.06, 2020"
"Regional District of Nanaimo Land Use and Subdivision Amendment Bylaw No. 500.429, 2020"

**REGIONAL DISTRICT OF NANAIMO**
**BYLAW NO. 500.429**

**A BYLAW TO AMEND THE REGIONAL DISTRICT OF NANAIMO LAND USE AND SUBDIVISION BYLAW NO. 500, 1987**

The Board of the Regional District of Nanaimo, in open meeting, enacts as follows:

A. This bylaw may be cited as “Regional District of Nanaimo Land Use and Subdivision Amendment Bylaw No. 500.429, 2020”.

B. Regional District of Nanaimo Land Use and Subdivision Bylaw No. 500, 1987 is hereby amended as follows:

1. Under **PART 3 LAND USE REGULATIONS, Section 3.1 Zones** by adding the following zone classification and corresponding short title after the Agriculture 2 zone:

   Nanaimo Airport (AR1)

2. By adding Section 3.4.3 NANAIMO AIRPORT (AR1)

   as shown on Schedule ‘1’ which is attached to and forms part of this bylaw.

3. By rezoning the lands shown on Schedule ‘2’ and legally described as

   Lot 2 of Section 1 & 2 Range 8, Cranberry District and of District Lots 2 & 15 Bright District Plan VIP68713;

   from Rural 4 (RU4), Subdivision District D, to Nanaimo Airport (AR1), Subdivision District D.

4. By rezoning the lands shown on Schedule ‘2’ and legally described as

   Lot 3, District Lot 15, Bright District, Plan VIP687113;

   from Agriculture 1 (AG1), Subdivision District D, to Nanaimo Airport (AR1), Subdivision District D.

5. By rezoning the lands shown on Schedule ‘2’ and legally described as

   Lot 1 of Sections 1, 2 & 3, Range 8, Cranberry District and Section 20, Range 8, Bright District and District Lots 2 & 15, Bright District and District Lot 8, Oyster District, Plan VIP68713;

   from Agriculture 1 (AG1), Subdivision District D, to Nanaimo Airport (AR1), Subdivision District D.

Introduced and read two times this 28th day of April, 2020.

Public hearing held pursuant to Section 464 of the *Local Government Act* this ____ day of ____, 20XX.

Read a third time this ____ day of ____, 20XX.

Approved by the Minister of Transportation and Infrastructure pursuant to the *Transportation Act* this ____ day of ____, 20XX.

Adopted this ____ day of ____, 20XX.

| | |
|---|---|
| ______________________________ | ______________________________ |
| CHAIR | CORPORATE OFFICER |

## 3.4.3 NANAIMO AIRPORT AR1

### 3.4.3.1 Permitted Principal Uses

For clarity, by describing "airport" as a permitted use in this zone, the RDN does not intend to imply that it has the constitutional jurisdiction to regulate the location or operation of airports or the construction of airport buildings and structures. The listing of "airport" as a permitted use is also not intended to imply that the RDN is "allowing" a non-farm use on the portion of the lands that are in the Agricultural Land Reserve. Instead, "airport" is listed as a permitted use in this zone in recognition that the Nanaimo Airport Commission operates an airport on the lands and to give context to the provisions below relating to site coverage that require the coverage by airport buildings and structures to be taken into account in determining whether additional buildings and structures for uses other than airport use are permitted.

**Development Area A - Airport**

a) airport
b) agriculture

**Development Area B - Airport Commercial**

a) airport
b) convenience store
c) fast food outlet
d) gas bar
e) gasoline service station
f) hotel
g) light industry
h) neighbourhood pub
i) office
j) parking
k) restaurant
l) retail store
m) tourist store
n) tourist information booth
o) transit exchange

### 3.4.3.2 Maximum Height of Buildings and Structures

Height:

hotel use: 15.0 m or 4 storeys, whichever is less

all other uses: 10.0 m or 3 storeys, whichever is less

### 3.4.3.3 Maximum Parcel Coverage

Parcel coverage: 60% including impervious surfaces.

A building or structure (including impervious surfaces) that is not intended to be used for airport purposes must not be constructed or placed on a parcel if the parcel coverage of all buildings and structures (including impervious surfaces) on that parcel, including those used or intended to be used for airport purposes, already exceeds 60% or if the addition of that building or structure would cause the parcel coverage of all buildings and structures (including impervious surfaces) on the parcel, including those used or intended to be used for airport purposes, to exceed 60%.

### 3.4.3.4 Minimum Setback Requirements

| | |
|---|---|
| Front lot lines | 10 metres |
| All other lot lines | 5 metres |

except where any part of a parcel is adjacent to or contains a watercourse, then the regulations in Section 3.3.8 shall apply.

### 3.4.3.5 Off Street Parking Requirements

Parking shall be provided as set out under Schedule ‘3B’ Off-Street Parking & Loading Spaces.

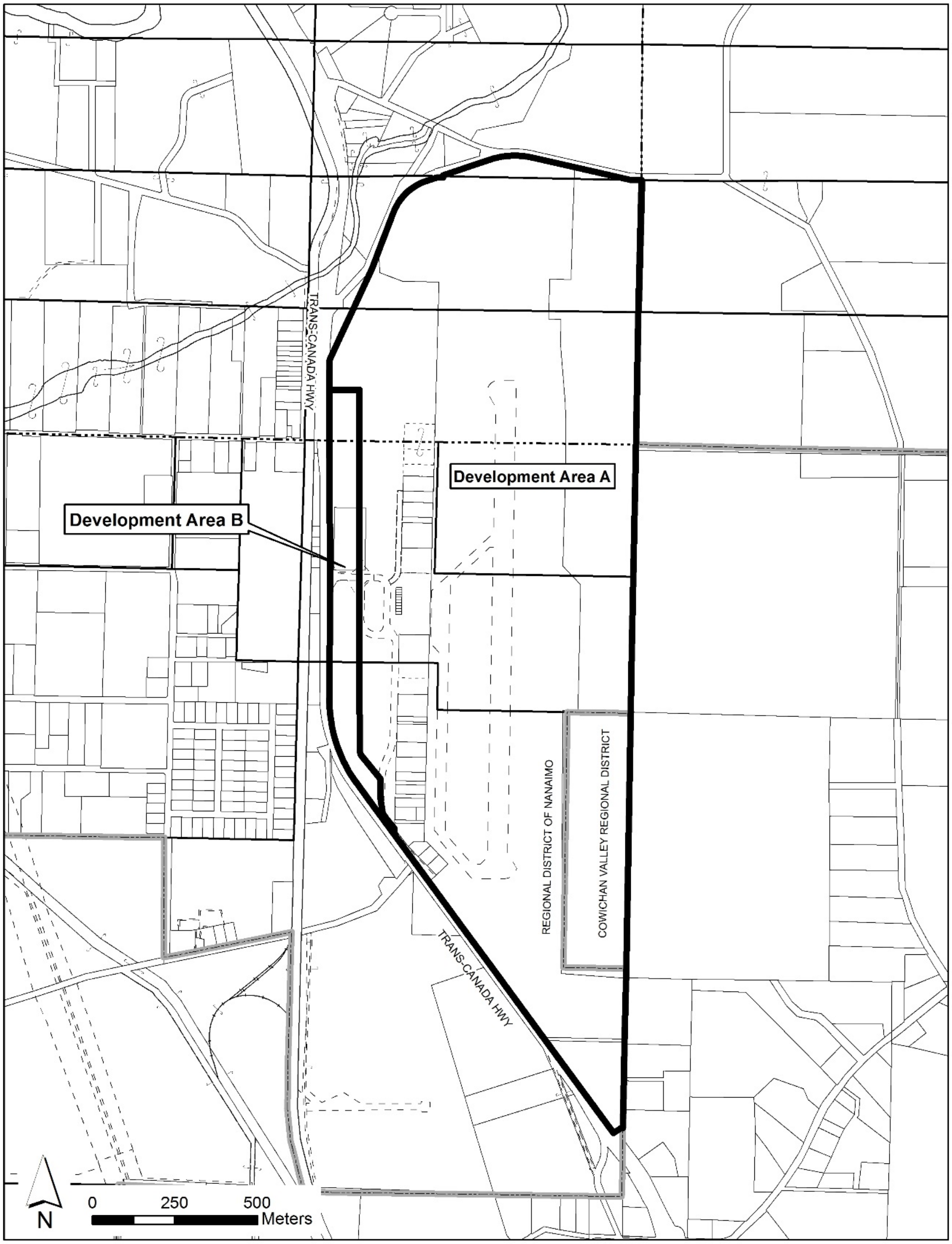
In addition to the requirements of Schedule ‘3B’ Off-Street Parking & Loading Spaces, the following bicycle parking is required:

a) 1 space per 475 $m^2$ commercial floor area adjacent to primary building entrances.

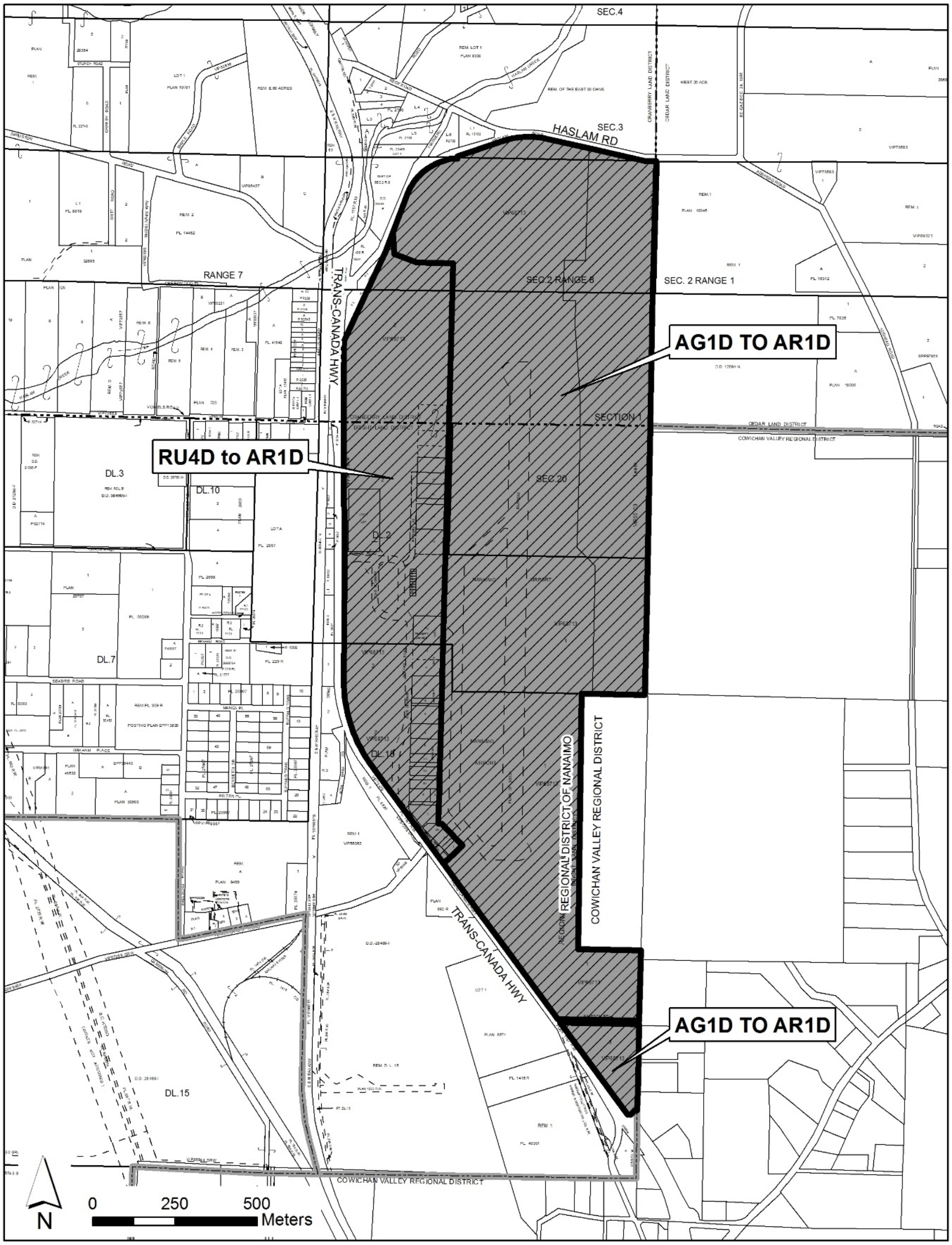
### 3.4.3. Other

Except as provided above for the purposes of calculating parcel coverage limits for the construction of a building or structure not intended to be used for airport purposes, the above restrictions in this zone on height, parcel coverage, minimum setbacks and off-street parking do not apply to buildings or structures that are used or intended to be used for airport purposes.

**Nanaimo Airport 1 Zone**
**Schedule 1**
**Development Areas A and B**



## Schedule '2'



AG1D TO AR1D
RU4D to AR1D
AG1D TO AR1D
HASLAM RD
SEC.4
SEC.3
SEC.2 RANGE 8
SEC. 2 RANGE 1
RANGE 7
SECTION 1
SEC.20
TRANS-CANADA HWY
TRANS-CANADA HWY
DL.3
DL.10
DL.7
DL.15
DL.15
REGIONAL DISTRICT OF NANAIMO
COWICHAN VALLEY REGIONAL DISTRICT
COWICHAN VALLEY REGIONAL DISTRICT
N
0
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**REGIONAL DISTRICT OF NANAIMO**
**BYLAW NO. 1620.06**

**A BYLAW TO AMEND THE REGIONAL DISTRICT OF NANAIMO ELECTORAL AREA ‘A’ OFFICIAL COMMUNITY PLAN BYLAW NO. 1620, 2011**

The Regional District of Nanaimo, in open meeting assembled, enacts as follows:

A. This bylaw may be cited as “Regional District of Nanaimo Electoral Area A Official Community Plan Amendment Bylaw No. 1620.06, 2020”.
B. The “Regional District of Nanaimo Electoral Area ‘A’ Official Community Plan Bylaw No. 1620, 2011” is hereby amended as set out in Schedule ‘A’ of this Bylaw.

Introduced and read two times this 28th day of April, 2020.

Considered in conjunction with the Regional District of Nanaimo Financial Plan and any applicable Waste Management Plans this ____ day of ____, 20XX.

Public hearing held pursuant to Section 464 of the *Local Government Act* this ____ day of ____, 20XX.

Read a third time this ____ day of ____, 20XX.

Adopted this ____ day of ____, 20XX.

| | |
|---|---|
| ______________________________ | ______________________________ |
| CHAIR | CORPORATE OFFICER |

**REGIONAL DISTRICT OF NANAIMO**

**BYLAW NO. 1620.06**

Schedule 'A'

Regional District of Nanaimo Electoral Area 'A' Official Community Plan Bylaw No. 1620, 2011, Schedule A, is hereby amended by deleting Section 8.8 Nanaimo Airport and replacing with the following:

## Section 8.8 Nanaimo Airport

The Nanaimo Airport is comprised of three parcels of land on 211 ha owned by the Nanaimo Airport Commission, a federal not-for-profit corporation. A fourth, 33 ha parcel north of Haslam Road is also owned by the Nanaimo Airport Commission and within the OCP Nanaimo Airport designation, but not within the federally designated Airport. An approximately 15 ha area of the airport at the eastern boundary is located within the Cowichan Valley Regional District.

The Nanaimo Airport Commission's Nanaimo Airport Land Use Plan, 2019 establishes objectives, policies, development principals, and land use zones to guide development of the airport lands in support of the economic and environmental viability of airport, and the region, and support the airport's role as a regional transportation facility.

The airport lands are located above the Cassidy Aquifer, which is highly vulnerable to surface contamination. Aquifer protection is of utmost importance.

### Objectives and Policies

| **Section 8.8** | **Policy/Objective** |
|---|---|
| **Objective 8.8.1** | **Recognize the importance of the Nanaimo Airport as an economic and transportation hub for the Regional District of Nanaimo and Vancouver Island.** |
| Policy 8.8.1 | The Lands owned by the Nanaimo Airport Commission that are shown on Map No. 3 shall be designated as Nanaimo Airport Lands. |
| Policy 8.8.2 | On Nanaimo Airport Lands outside the ALR, the RDN supports airport use, including airport use described in the Nanaimo Airport Land Use Plan contained within Schedule C of this OCP. The RDN also contemplates that a portion of the non-ALR lands within the Nanaimo Airport Lands designation may be zoned to allow other uses the RDN determines are compatible with the operation of an airport on the Nanaimo Airport Lands. |
| Policy 8.8.3 | On the Nanaimo Airport Lands within the ALR, Agriculture use is supported. |
| Policy 8.8.4 | The RDN encourages the NAC to consult with the community and the RDN to address specific issues related to airport expansion and development of light industrial and commercial uses including the following:<br>a. establishing and regulating flight paths and hours of usage to minimize disturbance to nearby residents;<br>b. communication process for addressing noise complaints; |

| | |
|---|---|
| | c. mitigating impact of development on groundwater, surface water and storm water management.<br>d. traffic impacts; and<br>e. visual character. |
| Policy 8.8.5 | Continued operation of the Cottonwood Golf Course within the ALR in this designation is supported. |

| **Section 8.8** | **Policy/Objective** |
|---|---|
| **Objective 8.8.2** | **Protect the Cassidy aquifer, acknowledge the sensitivities associated with adjacent ALR lands, streams, and surrounding residential areas, and avoid or mitigate any negative impacts from development.** |
| Policy 8.8.6 | The NAC is encouraged to provide a high standard of wastewater and storm water management and treatment to protect the sensitive aquifer. |
| Policy 8.8.7 | The NAC is encouraged to consider options for coordinating shared wastewater treatment with the Cassidy Village Centre, including consideration of connection to DPPCC. |
| Policy 8.8.8 | The NAC is encouraged to continue its groundwater monitoring program for both water levels and water quality, to share groundwater monitoring data with the Province and the RDN and ensure that new development does not negatively impact the aquifer. |

STAFF REPORT TO COUNCIL

**Report Prepared By**: Jake Belobaba, Director of Development Services
**Report Reviewed By:** **Erin Anderson, Acting CAO**
**Meeting Date:** May 19, 2020
**File No:** 6740-20
**RE:** **Waterfront Area Plan Implementation: Uplands Remediation Process**

---

**RECOMMENDATION:**

That Council:

1. Receive the Regulatory Path to Closure and Stage 1 Preliminary Site Investigation prepared by Golder Associates provided in Appendix A of the staff report from the Director of Development Services dated May 19, 2020;

2. Direct Staff to amend the 2020-2024 Financial Plan to include up to $400,000 from general surplus and development reserves to cover the cost of a detailed site investigation over the course of 2020-2021; and

3. Direct staff to:
   a. submit an application on behalf of the Town to the Federation of Canadian Municipalities to obtain funding for a detailed site investigation of the uplands and to obtain the services of a consultant, if required, to prepare the grant application; and
   b. seek the services of a qualified environmental engineering firm to complete a detailed site investigation of the uplands.

**EXECUTIVE SUMMARY:**

This report provides a summary of the updated findings of Golder Associates related to the nature of contamination on the "uplands" and a preliminary roadmap and funding strategy for remediation and provincial approval. Staff are recommending expediting further assessments and remediation and pursuing grant funding to cover further assessment costs.

**PREVIOUS COUNCIL DIRECTION**

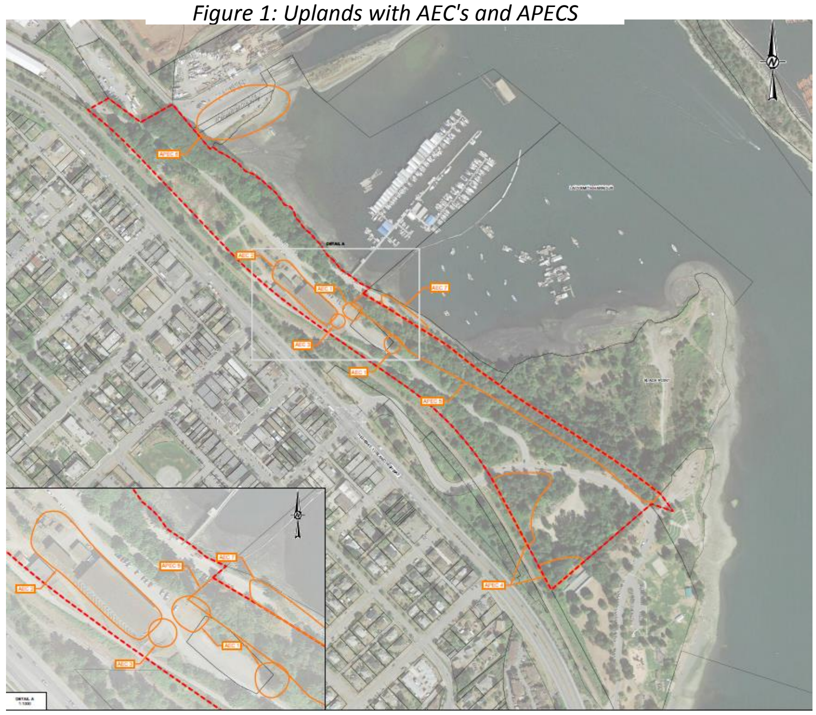
| Resolution Number | Date | Resolution |
|---|---|---|
| CS 2013-103 | 04/02/2013 | It was moved, seconded and carried that the following comments be provided to the Province of British Columbia regarding Crown land referrals 1413402 and 1413408: |

| | | |
|---|---|---|
| | | • The Town has an interest in the clean-up of the Ladysmith Harbour to its original natural state.<br><br>• In November 2012, the Province and the Town released a report on the environmental conditions of the Ladysmith waterfront outlining the extent of the contamination and a range of costs for alternatives to address remediation. These costs are significant.<br><br>• Consideration of a Crown grant or Crown lease should be subject to the applicant's financial commitment to appropriately addressing the environmental condition of the land consistent with Ladysmith's land use vision.<br>… |

**INTRODUCTION/BACKGROUND:**

Town-owned parcels of land comprising areas referred to as the "uplands" in the Waterfront Area Plan are contaminated (Figure 1). In 2011, Golder Associates was hired to undertake a Stage 1 site investigation of the waterfront lands. In addition to identifying contamination on the Crown-owned water lots and foreshore, the study (available here https://www.ladysmith.ca/city-hall/reports-publications) revealed a number of Areas of Environmental Concern (AEC's) and Areas of Potential Environmental Concern (APEC's) on the Town-owned uplands. In late 2019, Golder Associates was again hired to prepare an updated Stage I investigation and remediation cost estimate focusing entirely on the uplands. The second study was needed to reflect the newly adopted Waterfront Area Plan, changes to provincial remediation standards and changes in remediation costs.

*Figure 1: Uplands with AEC's and APECS*



*The Golder Reports*

The Golder reports, attached as Appendix A, include: 1) an updated Stage I investigation; and 2) a regulatory "path to closure" which includes a preliminary estimate of remediation costs. The site investigation has confirmed a number AEC's and APEC's still exist on or near the uplands. Golder's preliminary remediation costs are estimated at $480,000-$700,000, excluding taxes and certain provincial fees. Completing a detailed site investigation would account for approximately $200,000-$400,000 of the total remediation cost. The timeframe to complete a detailed site investigation is estimated to be 4-12 months and is influenced by factors such as soil conditions and provincial testing standards. Golder has also provided a number of "paths" to regulatory closure (i.e. provincial approvals), some of which may allow the Town to develop the land in phases—i.e. develop and sell uncontaminated or remediated portions of the uplands while contaminated portions are remediated. All remediation paths require a detailed site investigation. At this point, it is not necessary to decide on a preferred path, as such a decision is largely dependent on the results of a detailed site investigation and is ultimately approved by the Province.

**RECOMMENDATION**

*Detailed Site Investigation*
Staff are recommending that the detailed site investigation recommended in the Golder Report proceed as soon as possible. A detailed site investigation is a prerequisite for some types of redevelopment, all remediation options and a final decision on which remediation option is the most practical. Once complete, the Town can develop a remediation plan for provincial approval which may allow the Town to begin generating revenues from the uplands (e.g. through subdivision and sale or other forms of development) to offset remediation costs. If a phasing option is not approved by the Province, the Town can completely remediate the site prior to development. In this case, the remediation costs are likely to be recovered from future land sales of land, however, the timeframe to realize the revenues may be longer.

*Funding*
The FCM site remediation/ risk management study program, reimburses up to 50% of costs for a site investigation study to a maximum of $175,000, potentially reducing the Town's $200,000-$400,000 detailed site investigation cost to approximately $100,000-$225,000. Staff are recommending $400,000 be budgeted to cover the full cost of the site investigation, but if FCM funding is received, not all of this money will be used.

Staff note that consulting fees for preparing the FCM grant application are eligible expenses under the grant program. FCM funding is only available for site investigation work that has not occurred, so using a consultant to expedite the grant application accelerates the start of the detailed site investigation process, which accelerates the remediation process, which accelerates the development process and realization of the Waterfront Area Plan.

**LONG TERM CONSIDERATIONS**

*Remediation and Provincial Approvals*
Once a detailed site investigation is complete, the Town can develop and implement a formal remediation plan and commence the Provincial approval process. As noted above, options may be available to remediate the uplands in phases, possibly allowing revenue-generating activities like subdivision and sale to occur while remediation is underway. All remediation options require provincial approval, which can be expected to include a "freeze" on some or all development, a binding remediation plan and schedule, and bonding. The Province makes these decisions based on the information gathered in the detailed site investigation and provincial standards. In all scenarios, the process starts with a detailed site investigation and ends with provincially certified remediation.

Revenue from the sale of uncontaminated or remediated land is expected to more than cover the cost of uplands remediation, consistent with the "pay as you go" approach in the Waterfront Area Plan.

**DISCUSSION**
The estimated cost of further site investigations and remediation of the uplands is significantly lower than costs to remediate the Crown owned water lots and foreshore. As the owner of the uplands, the Town

has the ability initiate the remediation process at any time and it is prudent to do so as soon as possible. To successfully implement the Waterfront Area Plan further development is required and, to obtain approvals for further development remediation is required, the next step of which is a detailed site investigation. Seeking funding for remediation work will reduce the Town's costs, leaving more funds available for other aspects of the Waterfront Area Plan.

**ALTERNATIVES:**

Council can choose to:

1. Not proceed with further assessment and remediation of the uplands at this time and address site contamination as the need arises.

**FINANCIAL IMPLICATIONS:**

The upfront cost of a detailed site investigation and later remediation, even with FCM funding is significant. However, the eventual return on this investment in the form of development revenue is likely to be significantly higher. At this juncture, remediating and developing the uplands is expected to be economically viable, with substantial future revenues for the Town. It is a sound financial decision to remediate the uplands.

The funding for up to $400,000 can come from prior year surplus and other reserves.

**LEGAL IMPLICATIONS:**

The Town has a number of obligations under the *Environmental Management Act* related to contamination on the uplands. The proposed course of action is not in conflict with these obligations.

**CITIZEN/PUBLIC RELATIONS IMPLICATIONS:**

The Waterfront Area Plan involved extensive stakeholder and public engagement. The development plans for the uplands are based on the results of the Waterfront Area Planning process and remediation is a necessary step to implementing the community's vision for the waterfront.

**INTERDEPARTMENTAL INVOLVEMENT/IMPLICATIONS:**

N/A

**ALIGNMENT WITH SUSTAINABILITY VISIONING REPORT:**

☒Complete Community Land Use
☐Green Buildings
☒Innovative Infrastructure
☒Healthy Community
☐ Not Applicable
☐ Low Impact Transportation
☒ Multi-Use Landscapes
☐ Local Food Systems
☒ Local, Diverse Economy

**ALIGNMENT WITH STRATEGIC PRIORITIES:**

☐Infrastructure
☐Community
☒Waterfront
☒ Economy
☐ Not Applicable

***I approve the report and recommendation(s).***

**Guillermo Ferrero, Chief Administrative Officer**

**ATTACHMENT(S):**
Appendix A: Golder Report

**REPORT**

# Stage 1 Preliminary Site Investigation

*Lots 1, 4 and 5 Adjacent to Ladysmith Harbour*

Submitted to:

**Town of Ladysmith**
132C Roberts St
Mail PO Box 220
Ladysmith, BC V9G 1A2

Attention: Jake Belobaba, Director of Development Services


Submitted by:

**Golder Associates Ltd.**
2nd floor, 3795 Carey Road, Victoria, British Columbia, V8Z 6T8, Canada

+1 250 881 7372


18109842-001-R-Rev0

28 February 2020

# Distribution List

eCopy - Town of Ladysmith

eCopy - Golder Associates Ltd.

# Executive Summary

Golder Associates Ltd. (“Golder”) was retained by the Town of Ladysmith (“TOL”) to conduct a Stage 1 Preliminary Site Investigation (“Stage 1 PSI”) of Lots 1, 4, and 5 adjacent to Ladysmith Harbour, in the Town of Ladysmith, on Vancouver Island, British Columbia (the “Site”).

The Site is currently owned by the Town of Ladysmith. The Site is predominantly vacant, but is occupied by several structures in the central area of Lot 4.

Environmental site assessments have been conducted at the Site since the early 1990s. In 2011, Golder was retained by the Crown Lands Opportunities and Restoration Branch (CLORB) of the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) to conduct a Stage 1 PSI, Detailed Site Investigation (DSI), sediment investigation and preliminary geotechnical investigation at Ladysmith Harbour. The primary objectives of the investigation activities were to refine remedial and geotechnical costs and options for the Site. This investigation included Lots 1 and 4 of the Site, as well as the adjacent Slack Point and two water lots within Ladysmith Harbour (which are considered off-Site for the current investigation).

The primary objective of this Stage 1 PSI was to update the historical finding for the Site and identify, insofar as possible based on readily available information and without an intrusive investigation, former or current practices at the Site that may represent issues of actual or potential environmental concern. The scope of work included review of available analytical data and rescreening to current regulatory standards. Golder understands that the TOL is considering development of the Site and requires information concerning management of contaminated land. The Stage 1 PSI will be used to review the regulatory path to closure and update the environmental liabilities associated with the site. These tasks are completed under separate cover.

Authorization to proceed with this investigation was received by email from Mr. Jake Belobaba, Director of Development Services, on behalf of the Town of Ladysmith on 22 November 2019. This Stage 1 PSI report has been prepared for the use of the Town of Ladysmith and may not be relied upon by others without written consent from Golder.

## Summary of Issues of Environmental Concern

The issues of environmental concern identified in this Stage 1 ESA are outlined in the following table:

| AEC or APEC | Summary | PCOC, COC |
|---|---|---|
| On-Site | | |
| AEC 1 - Former fuel pump islands, ASTs and possible PCB Storage. | Owing to the presence of soil and groundwater contamination, this area is considered an AEC. The extent of the contamination in this area of the Site is generally shallow in nature, to depths up to approximately 2.4 m below ground surface, and is estimated to have an approximate volume of 1,000 $m^3$ | Soil: BTEX, VPH, LEPH, HEPH<br>Groundwater: BTEC, VPH, LEPH<br>Soil Vapour: VPHv, xylene, naphthalene |
| AEC 2 - Former Maintenance Area and Current Boat Repair and Construction Operations. | This area is considered an AEC. The extent of soil contamination in this area is generally shallow, to depths up to 4 metres. The volume of contaminated soils in the area to the northwest of the former maintenance building is estimated to be 2,000 $m^3$ | Soil: BTEX, VPH, LEPH, HEPH, styrene, |
| AEC 3 - Former Waste Oil Storage Area and Compressor Storage Area. | The area is confirmed to be an AEC as soil contamination has been identified. However, based on the soil sampling results in the shallow soils, and the absence of groundwater contamination, the area of soil contamination is likely limited in area. The volume of contaminated soils is estimated to be 20 $m^3$ | Soil: LEPH |
| APEC 4 – Stockpile of material from around sewage treatment plant | Fill of unknown quality was placed on-site, removed from the ground at the Ladysmith sewage treatment plant to facilitate expansion of the plant. While the fill is not known to be contaminated, it has been retained as an APEC, and further investigation of the material is recommended. | Soil: LEPH, HEPH, PAH, metals |
| APEC 5 – Fill of unknown quality on Lot 5 | Lot 5 is adjacent to Slack Point, where coal fill and surficial fill were previously identified with concentrations of LEPH, HEPH, metals, and PAHs above CSR standards. Since previous intrusive investigations did not include Lot 5, there is a potential for fill material of similar quality to Slack Point to be located on Lot 5. It has been retained as an APEC, and further investigation of the soil quality is recommended. | Soil: LEPH, HEPH, metals, PAHs |

| AEC or APEC | Summary | PCOC, COC |
|---|---|---|
| Off-Site | | |
| APEC 6 – Fill Material at Block B and D of DL 2016 (former Location of the Shingle Mill / Sawmill) | No soil or groundwater contamination identified during previous site investigations, as such, this area is not considered an AEC. However, the sampling program was limited in area, and additional sample collection along the filled area may be warranted, therefore, remains an APEC. | Soil: LEPH/HEPH, PAH, and metals<br>Groundwater: LEPH/HEPH, PAH, metals<br>Soil Vapour: VPHv, BTEX, naphthalene |
| AEC 7 - Former Log Dump (Lot 17G). | Contamination was identified during previous site investigations, but appears to be limited to a particular range of depth and may be associated with the log dump or filling activities. The extent of the contamination in this area of the Site was observed to be between 2.5 and 5.5 m below ground surface. The contamination is estimated to have an approximate volume of 5,800 $m^3$ | Soil: VPH, LEPH<br>Groundwater: PAH<br>Soil Vapour: VPHv |

Based on all the information obtained as part of this Stage 1 PSI, the following other Special Attention Items were identified on the Site:

- asbestos
- PCBs
- Lead

These Special Attention Items are not considered to represent an issue of potential environmental concern provided they are managed in accordance with applicable environmental, health, and safety legislation.

To address the issue(s) of potential environmental concern identified, Golder recommends the following:

- Conducting a Detailed Site Investigation to further investigate soil, groundwater and soil vapour quality at identified AECs.

# Study Limitations

This report (the “Report”) was prepared for the exclusive use of the Town of Ladysmith for the express purpose of providing advice with respect to the environmental condition of the Site. In evaluating the site, Golder Associates Ltd. has relied in good faith on information provided by others as noted in the Report. We have assumed that the information provided is factual and accurate. We accept no responsibility for any deficiency, misstatement or inaccuracy contained in this report as a result of omissions, misinterpretations or fraudulent acts of persons interviewed or contacted.

Any use which a third party makes of this Report, or any reliance on or decisions to be made based on it, are the sole responsibility of the third parties. If a third party require reliance on this Report, written authorization from Golder is required. Golder disclaims responsibility of consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

The scope and the period of Golder’s assessment are described in this Report, and are subject to restrictions, assumptions and limitations. Except as noted herein, the work was conducted in accordance with the scope of work and terms and conditions within Golder’s proposal. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Report. Conditions may therefore exist which were not detected given the limited nature of the assessment Golder was retained to undertake with respect to the Site and additional environmental studies and actions may be required. In addition, it is recognized that the passage of time affects the information provided in the Report. Golder’s opinions are based upon information considered at the time of the writing of the Report. It is understood that the services provided for in the scope of work allowed Golder to form no more than an opinion of the actual conditions at the Site at the time the site was visited, and cannot be used to assess the effect of any subsequent changes in any laws, regulations, the environmental quality of the site or its surroundings. Asbestos and mould surveys were not performed. If a service is not expressly indicated, do not assume it has been provided.

The results of an assessment of this nature should in no way be construed as a warranty that the Site is free from any and all contamination from past or current practices.

# Table of Contents

**TABLES**



**FIGURES**

**APPENDICES**

# 1.0 INTRODUCTION

## 1.1 Background and Objective

Golder Associates Ltd. ("Golder") was retained by the Town of Ladysmith ("TOL") to conduct a Stage 1 Preliminary Site Investigation ("Stage 1 PSI") of Lots 1, 4, and 5 adjacent to Ladysmith Harbour, in the Town of Ladysmith, on Vancouver Island, British Columbia (the "Site"). The location, surroundings, and layout of the Site are shown in Figure 1 and Figure 2.

The Site is currently owned by the Town of Ladysmith. The Site is predominantly vacant, but is occupied by several structures in the central area of Lot 4.

Environmental site assessments have been conducted at the Site since the early 1990s. In 2011, Golder was retained by the Crown Lands Opportunities and Restoration Branch (CLORB) of the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) to conduct a Stage 1 PSI, DSI, sediment investigation and preliminary geotechnical investigation at Ladysmith Harbour. The primary objectives of the investigation activities were to refine remedial and geotechnical costs and options for the Site. This investigation included Lots 1 and 4 of the Site, as well as the adjacent Slack Point and two water lots within Ladysmith Harbour (which are considered off-Site for the current investigation).

The primary objective of this Stage 1 PSI was to update the historical finding for the Site and identify, insofar as possible based on readily available information and without an intrusive investigation, former or current practices at the Site that may represent issues of actual or potential environmental concern. Golder understands that the TOL is considering development of the Site and requires information concerning management of contaminated land. The Stage 1 PSI will be used to review the regulatory path to closure and update the environmental liabilities associated with the site. These tasks are completed under separate cover.

Authorization to proceed with this investigation was received by email from Mr. Jake Belobaba, Director of Development Services, on behalf of the Town of Ladysmith on 22 November 2019. This Stage 1 PSI report has been prepared for the use of the Town of Ladysmith and may not be relied upon by others without written consent from Golder.

## 1.2 Site Uses and Structures

Based on the TOL zoning bylaw (shown in Figure 3), the Site is zoned as a mix of park, residential, commercial and industrial land. The Site is largely vacant and covered by gravel roads, low-lying vegetation, shrubs and grass. Some buildings are present on the Site (e.g., former railway repair building, washroom, car shop, cable splicing shed and storage sheds).

## 1.3 Scope of Work

Golder's assessment was carried out in accordance with the British Columbia Ministry of Environment ("BC ENV") Technical Guidance on Contaminated Sites #10, *Guidance for a Stage 1 Preliminary Site Investigation* (dated August 2016), as well as in general accordance with Canadian Standards Association ("CSA") Standard Z768-01, *Phase I Environmental Site Assessment* (reaffirmed 2016), and involved the following scope of work:

- Reviewing readily available records to collect data on past and present activities on the Site.
- Visiting the Site to observe current Site conditions and operations and further assess any potential environmental concerns identified in the records review.
- Interviewing knowledgeable individual(s), to corroborate or augment the information gathered from the records review and Site visit.
- Collecting soil samples inside the former railway repair building. Excavations were open at the time of the Site visit for installation of new footings in the building.
- Evaluating the information from the records review, Site visit, and interviews.
- Rescreening of available historical analytical data.
- Preparing a Stage 1 PSI report.

For the purposes of this Stage 1 PSI, the assessment area included the Site and surrounding properties within 500 m of the Site.

In preparing this Stage 1 PSI, Golder has applied professional judgement in considering readily available information and has relied in good faith on information provided by others. This level of effort is a method of risk reduction rather than risk elimination. This assessment included a cursory overview of the neighbouring land uses and does not constitute a complete assessment of neighbouring land uses. Further reductions in risk can be achieved through a program of intrusive testing at the Site, including sample collection and analysis.

# 2.0 SITE DESCRIPTION

## 2.1 Site Location and Setting

The Site consists of a rectangular parcel of land approximately 10.5 hectares in area that is located at Ladysmith Harbour, Ladysmith, BC (Figure 1). The Site comprises several legal lots, which are identified with other relevant property information in Table 1 below.

**Table 1: Property Information Summary**

| | |
|---|---|
| **Civic Addresses** | Civic addresses are available for the following buildings located at the Site:<br>■ The main repair shop (610 Oyster Bay Drive)<br>■ The washroom building (612 Oyster Bay Drive)<br>■ The roundhouse (614 Oyster Bay Drive)<br>■ The car shop (616 Oyster Bay Drive)<br>■ The cable splicing shed (840 Oyster Bay Drive)<br>(building locations are shown on Figures 4a and 4b) |
| **Legal District** | Oyster District, Ladysmith. |
| **Legal Description** | ■ Lot 1 District Lots 24 and 56, Oyster District Plan VIP64405<br>■ Lot 4 District Lots (DL) 8G, 11G, 24 and 56, Oyster District, Plan 45800, except part in plans VIP64405, VIP71943 and VIP72131<br>■ Lot 5 District Lots 24 and 56, Oyster District Plan 45800 |
| **Parcel Identifier** | ■ Lot 1: 023-652-926<br>■ Lot 4: 010-208-828<br>■ Lot 5: 010-208-861 |
| **Latitude/Longitude** | 48º 59’ 44” North, 123º 48’ 54” West (approximate centre of the Site). |

Each lot comprising the Site is illustrated on Figure 2.

## 2.2 Topographic, Geologic, and Hydrogeologic Setting

The topography of the Site is typically flat with terraces separated from the shoreline areas by steep rock bluffs along the northeast. The nearest surface water body is Ladysmith Harbour, located adjacent to the east of the Site.

Surficial Geology of Nanaimo, British Columbia Map 27-1963, Sheet 92 G4 and 92 F-1 East (1:63,360) indicates that the surficial geology of the Site is composed of marine deposits of gravel, sand and mainly marine veneer commonly less than 1.5 metres thick and overlain by ground moraine deposits of till, lenses of gravel, sand and silt. Bedrock composed of volcanic and sedimentary rock outcrops along the foreshore.

Materials encountered at the Site during previous investigations (Hardy BBT 1990b; Levelton 2000b, Golder 2011) generally consisted of fill soils of variable thickness overlying native silt, sand and gravel overlying sedimentary bedrock. Historical industrial activities took place on the Site for many years. During these activities, fill soils of variable thickness and composition were placed throughout the area. The fill materials generally consisted of silt, sand and gravel, cobbles and boulders. In addition, organic material (roots and woody debris), isolated coal waste, and anthropogenic materials including concrete and metal, were encountered in the fill layers.

During the Golder 2011 field investigation, it was found that the thickness of the fill ranges overall from about 0.1 m to 3.4 m, and on average is about 1.3 m. In the area south of the bluff and along Oyster Bay Drive, the fill layer typically ranged in thickness from about 0.1 m to 1.6 m, and on average was about 0.7 m. The composition of the fill material encountered in this area consisted of silty sand with minor gravel to sand and gravel. Also included in this layer is cobbles, boulders and concrete, metal and wood debris.

Underlying the fill materials, native deposits of silts, sands and gravels were encountered overlying, in some locations, glacial till-like deposits. The depths to which these deposits extended ranged broadly from about 0.4 m to 5.9 metres below ground surface (m bgs), but were generally in the range of about 1 m to 4 m bgs.

Underlying the native soil deposits, sedimentary bedrock was encountered in approximately half of the test pits and monitoring wells/boreholes drilled on-site (Golder 2011). Where encountered, the depth to bedrock ranged widely among the boreholes and test pits, from 0.6 m to 8.1 m bgs; however, at most locations it was generally between 1 m and 4 m bgs. The rock consisted of sedimentary sandstone and mudstone (argillite).

Regional groundwater flow in the underlying aquifers is typically to the northeast towards Ladysmith Harbour. In previous field investigations, it was found that groundwater flow is directed toward the shoreline, despite some tidal influences (Golder 2011). Buried utilities, underground structures, and septic systems can affect local (shallow) groundwater flow conditions.

An online search of the iMapBC database was performed on 6 December 2019, to identify groundwater usage and water wells at the Site and in the immediate surrounding areas. According to iMapBC, the aquifer underlying the Ladysmith area, including the Site, is labelled Aquifer 168. Aquifer 168 is classified as IIIA under the BC Aquifer Classification System, indicating low demand relative to the aquifer’s low productivity and high vulnerability of the aquifer to contamination from surface sources. The aquifer material is listed as bedrock.

The online search of the iMapBC database identified the nearest well was located approximately 475 metres (m) to the west of the Site, on the west side of the Island Highway. The detailed well record indicates that the well was constructed in 2007 and is 120 metres deep. A figure showing the results of the water well search of iMapBC can be found in Appendix A. In addition to current water use, the BC ENV requires that future drinking water use is considered when assessing potential threats to groundwater quality

# 3.0 PROPERTY USE INFORMATION REVIEW

## 3.1 Aerial Photos

Aerial photos of the Site and vicinity for the years 1952, 1957, 1962, 1968, 1975, 1984, 1988, 1993, 1998, and 2007, as well as Google Earth Images from 2017, were reviewed by Golder. The presence and absence of structures on the Site and on neighbouring properties were noted (Table 2).

**Table 2: Aerial Photos**

| Date | Site Description | Surrounding Area |
|---|---|---|
| 1952 | A log dump is observed at Lot 4 DL11G.<br>Several roads and rail spurs are present on the Site and along the foreshore.<br>Buildings, in the configuration as they are currently known, are present at the Site, including the main repair shop, car shop, roundhouse, washroom and cable splicing shed.<br>To the northeast of the main repair building, a clearing is observed, and a structure is visible in the approximate area of Lot 1. | Logging activities are present through-out the water adjacent to the northeast of the Site, including several log booms and sorting pockets.<br>There appear to be several roadways through the area and a building appears on the western portion of Slack Point, approximately 100m east of Site. Several small structures appear on the north side of Slack Point. A parking area is noted on the east side of Slack Point.<br>The current day government wharf (to the northwest of the Site) is not visible. The land adjoining the wharf, Blocks B and D of DL 2016 have not yet been filled. The shingle mill referred to in previous reports is visible (on a wharf) in the area of Block B.<br>The area further to the north west of the Site has been filled and appears to have a hook-like pattern similar to the 1902 map of Ladysmith (Golder 2011; Appendix I).<br>To the southwest of the Site, the railway and major highway are visible and several residential housing plots are observed occupying the Town of Ladysmith.<br>To the southeast of the Site, the Loading Wharf and Transfer Wharf, as described on the 1902 map of Ladysmith (Golder 2011; Appendix I) are also visible. |
| 1957 | The Site appears similar to the 1952 aerial photograph; however, the photograph quality and scale of photograph prevent identification of specific Site features. | The Site appears similar to the 1952 aerial photograph; however, the photograph quality and scale of photograph prevent identification of specific Site features. |
| 1962 | The building structure southeast of the main repair building appears to have been removed and a new structure is observed in the area inferred to be the location of the former pump islands. | To the northwest of the Site the Government wharf has been constructed. A square shaped filled area has been constructed immediately adjacent to Blocks B and D, which is connected to the Government wharf. The shingle mill has been removed.<br>The area to the southwest of the Site appears similar to 1952, with the exception of increased housing development to the southwest of the Site.The Loading Wharf to the southeast of the Site is no longer evident<br>The northern tip of Slack Point (northeast of Site) has been expanded slightly and includes the distinctive hook-shaped point.<br>There appears to be less evidence of logging activities; at least half of the sorting pockets have been removed in the water area. |

| Date | Site Description | Surrounding Area |
|---|---|---|
| 1968 | The Site appears generally unchanged. | There appears to have been more filling to the northwest of the Site and the former hook-like pattern observed in the 1952 photograph appears to have been completely filled in. A long breakwater has been constructed extending from Block B and D of DL 2016 into Ladysmith Harbour, and more fill appears to have been added in the area of Block B and D.<br>The Transfer Wharf to the southeast of the Site is no longer evident.<br>It appears that more fill has been added to the northern portion of Slack Point (northeast of the Site) and fewer logs, machinery and buildings are visible. Some areas of Slack Point are observed to be vegetated (trees are observed). |
| 1975 | The Site appears generally unchanged. | More filling has occurred northwest of the Site. Two large areas appear to have been paved and are utilized for industrial activity. Log sorting is observed along the water adjacent these areas.<br>A wide road extends through Slack Point (northeast of Site) from Lot 4. |
| 1984 | The Site appears generally unchanged. | To the northwest of the Site, the two paved areas identified in 1975 were expanded and more fill added to this area.<br>A hydraulic crane used for loading barges is visible in water lot DL 651.<br>A large stockpile of material is present in the central portion of Slack Point. The road through Slack Point observed in 1975 is less prominent in the 1984 aerial photograph. |
| 1988 | The Site appears generally unchanged. | In the harbour adjacent to the Site, the majority of the logging operations have ceased, and a small marina has been constructed in the harbour. A few scattered log booms remain, and all of the sorting pockets have been removed.<br>To the northwest of the Site extensive infilling is again observed and appears to connect the two paved areas observed in the 1975 aerial photograph.<br>The area around the base of the Government Wharf and including Blocks B and D of DL 2016 has been further infilled and appears similar to the current configuration; it appears to be paved and utilized as a storage area.<br>Slack Point is further vegetated and the building in the western area is no longer visible. The northern tip of Slack Point has been further expanded and appears slightly rounded. |
| 1993 | The Site appears generally unchanged. | The large stockpile of material on Slack Point remains present and is now covered in vegetation. |
| 1998 | The Site appears generally unchanged. The cable splicing shed is not visible, likely owing to tree cover. | The small marina in the harbour adjacent to the Site has been expanded and includes a narrow breakwater area and several boats are visible.<br>The large stockpile of material on Slack Point is no longer visible. |

| Date | Site Description | Surrounding Area |
|---|---|---|
| 2007 | A road from the main highway leading into the area southwest of Slack Point has been constructed (Transfer Beach Boulevard).<br>The structure to the southeast of the main repair building (inferred to be the location of the former pump islands) has been removed. | The marina has expanded to include at least two docks; the breakwater has been removed.<br>Park-like features are observed on the southeast portion of Slack Point, including a baseball field and amphitheatre. Immediately east of the Site there is another residential development (what is now 63B Avenue).<br>The hydraulic crane piles are no longer visible on DL 651; however, many boats and other structures are visible in the water northwest of Slack Point. |
| 2017 (Google Earth Image) | Similar to the 2007 photograph. | Similar to the 2007 photograph, except a breakwater has been constructed to the North of the Site, adjacent to the Government Wharf, and Slack Point (northeast of site) is increasingly vegetated. |

## 3.2 Fire Insurance Records

SCM Risk Management Services Inc (SCM) was contacted on 4 September 2009 for fire insurance information pertaining to the Site. Although a 1954 fire insurance map was available for the Town of Ladysmith, the map did not include the Site itself. Fire insurance maps were therefore not obtained during this investigation.

The 1999 Revelop report contained a 1911 fire insurance map. The map also did not have any details for the site. The map showed that the railway was present along the shoreline of Ladysmith in 1911. The map also includes information on the former Tyee Copper Smelter northwest of and cross gradient to the Site.

## 3.3 City Directories

On 4 September 2009, Golder contacted Vancouver Public Library's (VPL) Information and Research Centre to request city directories for the Town of Ladysmith. A representative from VPL indicated that there were no city directories with street indexes for Ladysmith. The response is included in Appendix E.

Revelop (1999) conducted a search of city directories for the Site; they reported that the Comox Logging Company and Railway Co. was listed at the Site on the city directories from 1950 to 1957 (not available for review by Golder). In addition, Revelop obtained an early 1900 microfiche business directory information (not reviewed by Golder) that included a description of Ladysmith Harbour in the 1902-1910 directories. The description was as follows:

> *"Ladysmith in the Nanaimo district.... is the shipping point for the Wellington Collieries where the largest ships afloat can come alongside and tie up to the capacious wharves. Here you will find the latest and most up-to-date improved machinery on the Pacific Coast for the quick dispatch of colliers. The wharves are substantially built on copper covered pile. Here also is the transfer wharf for the Canadian Pacific Railway. ..."* (Revelop 1999).

It was reported by Revelop that the directory indicated that the wharves may have been built on copper covered piles, potentially affecting the quality of sediments in the vicinity.

## 3.4 Land Title Information

Golder performed a current and historic land title search of the Site using the Land Title and Survey Authority (LTSA) of British Columbia. Historical searches and land lease agreements from previous reports were also reviewed.

Currently, the Site (Lots 1, 4, and 5) is owned by the Town of Ladysmith. For Lot 1, TOL has held the title since at least November 1996. For Lot 4, TOL has held the title since at least March 2001. Lot 5 has been owned by TOL since April 2019. Prior to this, several companies held the title for Lot 5 between March 1988 and April 2019. Notable owners include logging companies (TimberWest Forest Ltd., Elk Falls Wood Products Ltd., Crown Forest Industries Ltd.) and Sea Vision Resorts Development Ltd. Prior to March 1988, TOL held the title of Lot 5.

Copies of the land titles are included in Appendix B.

## 3.5 Agreement of Purchase and Sale

Golder was not provided with an agreement of purchase and sale.

## 3.6 Previous Environmental Reports

The following environmental reports related to the Site were obtained by Golder. Environmental site assessments have been conducted at the Site and in the surrounding area since the early 1990s. Reports are ordered from oldest to most recent. Golder consulted these reports to develop an understanding of issues previously identified for the Site and surrounding properties.

- Norecol Environmental Consultants Ltd. 1989. "Habitat Compensation Plan Ladysmith Waterfront Development Plan". Dated August 1989.
- Dames & Moore. 1990a. "Fletcher Challenge Canada Environmental Inspection Report on Leases 101501, 101502 & 101503, Ladysmith Harbour". Dated 24 August 1990.
- Dames & Moore. 1990b. "Fletcher Challenge Canada Decommissioning Investigations – Leases 101501, 101502 & 101503 Ladysmith Harbour". Dated December 1990.
- Hardy BBT Limited. 1990a. "Preliminary Geotechnical Assessment for Ladysmith Waterfront Development Ladysmith, BC". Dated October 1990.
- Hardy BBT Limited. 1990b. "Environmental Review for Town of Ladysmith Waterfront Development Slack Point Area, Ladysmith, BC". Dated October 1990.
- Subsea Enterprises Inc. 1993. "Summary Report of an Underwater Video Survey of Fletcher Challenge Lease (Lot 651) in Ladysmith Harbour, BC". Dated 30 September 1993.
- EBA Environmental Ltd. 1994a. "Elk Falls Forest Industries Limited Phase II Environmental Assessment Ladysmith Harbour Leases Project Ladysmith, BC". Dated January 1994.
- EBA Environmental Ltd. 1994b. "Elk Falls Forest Industries Limited Supplemental Information Ladysmith Harbour Leases Project Ladysmith, BC". Dated 4 February 1994.

- Triton Environmental Consultants Ltd., "Slack Point Biophysical Inventory and Fish Habitat Compensation Plan". Dated May 1996.
- Town of Ladysmith, "Waterfront Area Plan", January 1997.
- New Pacific Ventures, "Environmental Assessment of Proposed Developments at Burleith Log Sort Ladysmith Harbour". Dated May 1998.
- The Revelop Group. 1999. "Stage 1 Preliminary Site Investigation Ladysmith Waterfront Development Ladysmith, BC". Dated 10 August 1999.
- Phoenix Environmental Services Ltd. 1999. "Environmental Impact Assessment Report Proposed Ladysmith Marina and Waterfront Development Project Ladysmith, BC." Dated December 1999.
- Levelton Engineering Ltd. 2000a. "Preliminary Site Investigation Stage I and Stage II Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, BC". Dated 25 August 2000.
- Levelton Engineering Ltd. 2000b. "Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, BC". Dated 25 October 2000.
- Levelton Engineering Ltd. 2000c. "Remediation Plan Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District Ladysmith, BC". Dated 1 December 2000.
- Westmar Consultants Inc. 2001. "Town of Ladysmith, Report for Waterfront Redevelopment". Dated June 2001.
- Baker & Osland Appraisals Ltd. 2002. "Property Appraisal Report, Private and Crown Lands Front and Within Ladysmith Harbour Ladysmith, British Columbia". Dated 4 April 2002.
- Phoenix Environmental Services Ltd. 2002. "Sediment Chemistry Investigation Report Ladysmith Harbour Proposed Waterfront Re-Development Ladysmith, BC". Dated September 2002.
- W.R. Colclough & Associates Ltd. and D.F. Brown. 2004. "Review of Existing Environmental Reports Relating to Ladysmith Harbour and Uplands Proposed Waterfront Re-Development Ladysmith, BC". Dated November 2004.
- EBA Engineering Consultants Ltd. "Stage 1 Preliminary Site Investigation Lot 5, Plan 45800, DL 24 and 56, Ladysmith, BC". Dated February 2005.
- G3 Consulting Ltd. 2005. "Report on Ladysmith Harbour Foreshore Fill Sampling & Analysis". Dated March 2005.
- Golder Associates Ltd. 2005. "Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC". Dated 19 July 2005.
- Golder Associates Ltd. 2011. "Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation, Ladysmith Harbour Ladysmith BC". Dated 21 December 2011.

While technical peer reviews of the reports were not completed, noteworthy findings are summarized below. Note that the current site under investigation is sometimes referred to as the "Uplands Area" in previous reports, to distinguish from surrounding properties including Slack Point that were previously under investigation.

### 3.6.1 Norecol Environmental Consultants Ltd. 1989 Habitat Compensation Plan

In 1989, Norecol Environmental Consultants Ltd. (Norecol) prepared a habitat compensation plan for a waterfront development plan. Details were documented in the report entitled "*Habitat Compensation Plan Ladysmith Waterfront Development Plan*" (Norecol 1989). As part of its environmental liability assessment in 2005, Golder was provided the sediment composition section of the report by the Town of Ladysmith. The section indicated that three sediment samples were collected from three locations within the Site. Sampling location details were not provided. Of the samples, one contained a mercury concentration exceeding both the BC *Contaminated Sites Regulation* (CSR) sediment criteria and ocean disposal limits applicable at the time of the assessment, and cadmium exceeding the ocean disposal limits only. The report stated that the only indication from the Site history that would suggest a possible source of mercury and cadmium was the previous discharge of sewage into Ladysmith Harbour.

### 3.6.2 Dames & Moore 1990 Environmental Inspection

In 1990, Dames & Moore (D&M) conducted an environmental inspection of three leased properties including 1) Slack Point, 2) the former Log Dump at Lot 17G, and 3) DL 651 (water lot) (Leases 101501, 101502 and 101503 respectively). Details were documented in the report entitled "*Fletcher Challenge Canada Environmental Inspection Report on Leases 101501, 101502 & 101503, Ladysmith Harbour",* dated 24 August 1990 (D&M 1990a). The environmental inspection consisted of a field inspection and a review of available information. The purpose of the investigation was to determine the potential environmental impacts related to the occupancy of Fletcher Challenge Canada prior to the surrender of the leases back to the Crown.

D&M's review of historical information indicated that coal mining and forestry operations had been the primary industrial activity in Ladysmith Harbour over the past century. A coal smelter, ore smelter, shingle mill and iron foundry had been established in the port by 1899. According to D&M's report, the fill used to create Slack Point was composed of coal, which was derived from the washing of coal mine and coal smelter wastes.

During the global economic depression in the 1930s, the coal industry began to decline, and the logging industry began its rise. Between 1935 and 1953, the leased area was occupied by the Comox Logging and Railway Company. From 1953 to 1988, Crown Zellerbach Building Materials Ltd. (Crown Zellerbach) occupied the area. Fletcher Challenge assumed the lease in 1988. During logging operations, the railroad was extended out onto Slack Point. Logging activities in the area included the off-loading of logs from the railway to Ladysmith Harbour, where log dumping, sorting, storing, and shipping took place. In 1979, a hydraulic crane was installed on piles and was used to load barges.

The report stated that no treatment of wood reportedly occurred at the Site. D&M indicated that pressure treated piles were used for the dolphins associated with the wharfs on Slack Point. According to a former employee of Fletcher Challenge, interviewed by D&M, waste bark materials and other debris from the operations were burned on Slack Point.

Diesel engines replaced steam in the leased area around 1958. Diesel, gasoline and bunker fuels were reported to have been used over the years for various purposes related to the logging and railway operations in Ladysmith Harbour. Fuel was initially delivered to the tanks by barge, until the 1960s when fuel was delivered by trucks. Fuelling operations occurred on the Uplands portion of the Site, including operations near the former rail yard, where fuels from above-ground tanks were used to fuel trains and boats. Boats at the shore were fuelled by a gravity-fed pipeline. The pipeline system was in place at the time of D&M's inspection; however, their report did not indicate if the pipelines were above or below ground surface. Trains bringing logs to Site were fuelled at the main fuelling facility (presumably by the former pump islands shown on Figure 5a).

In 1981, three diesel fuel tanks were installed in a concrete containment, and were described as being located "on the upslope side of the lower track". For the purpose of this current PSI, the location has been interpreted as being in the vicinity of the present-day Ladysmith Maritime Society Marina parking lot (located at the base of the Ladysmith Maritime Society Marina and Wharf, shown on Figure 4). Pipelines from these tanks transferred fuel to a fuelling dock for the boats. Interviews conducted by D&M indicated that a leak was historically from one of the pipes from the upper aboveground storage tanks (ASTs), and the soil around a lower track ballast was subsequently removed. The area was replaced with clean fill, and the leaking pipe replaced. The time and precise location of the spill was not provided in the report.

No other historical spills were reported during the interview conducted by D&M. Small gasoline tanks (above ground) were used at various times and locations (including Slack Point) for fuelling gasoline-powered equipment. The report by D&M does not provide specific details about the usage of fuel or fuel storage locations at Slack Point.

During their occupancy (from approximately 1935), Comox Logging and Railway Company established a small boat yard in the west corner of Slack Point where wooden and steel vessels were built (shown on Figure 4). In the 1970s, the boat yard was used as a boat repair and service shop until it burned down in 1987.

According to D&M, an untreated sewage pipe extended to the inner harbour area through a short outfall immediately north of the Government Wharf (off-Site) between 1905 and 1965. After 1965, the pipe became a storm water outfall, although the outfall acted as an overflow for sewage until 1985 when all sewage was directed to Holland point. The report indicated that the sewage outfall may be of considerable concern for the sediments in the area with regard to heavy metals and organic compounds that may have originated from industrial and domestic sources in Ladysmith.

D&M commented that the harbour was previously known for its shellfish but water quality concerns, including sewage discharge, recreational boaters and the forest industry, were indicated as likely major sources of the disappearance of a viable shellfish market. It was thought that the diversion of the raw sewage outfall (between 1965 and 1985) may have increased the potential for shellfish in the vicinity of Slack Point.

D&M did not identify any potential for residual chemicals on the lease areas originating from Fletcher Challenge Canada's activities. The report states that the marine log sort area would have deposited bark and other debris; however, D&M reported that there was no requirement to remove the debris from the lease area. The report did indicate, however, that given the extended past use of the area for coal washing and smelting and a raw sewage and storm water outfall into the harbour (occurring before occupancy by Fletcher), the quality of the sediments in the area would be a concern.

### 3.6.3 Dames & Moore 1990 Proposed Decommissioning

Following the report by D&M in 1990, the Ministry of Crown Lands requested that Fletcher Challenge Canada's leased area be "environmentally clean and suitable for residential development" prior to the surrender of the land back to the Crown. In a letter regarding "*Your Files: 1403254, 140255, 1403256 Lease # 101501, 101502, 101503 – Ladysmith*" dated 5 September 1990 (Fletcher Challenge 1990), Fletcher Challenge Canada responded to the ministry and outlined a proposed clean up of the area, as described in the document entitled "*Fletcher Challenge Canada Decommissioning Investigations – Leases 101501, 101502 & 101503 Ladysmith Harbour*", dated December 1990 (D&M 1990b).

Proposed activities included the removal of the following: steel cables and coils along the waterfront; three oil tanks, bases, piping and pump house; loose logs, floats, and sunken buildings; miscellaneous machinery, equipment and metal objects; railroad ties and tracks on Slack Point; boat ways and a burned boat haul; miscellaneous garbage; and boom shack, floats, stairways and piers.

### 3.6.4 Hardy BBT Limited 1990 Geotechnical and Environmental Assessments

In 1990, Hardy BBT Limited (Hardy BBT) conducted a geotechnical assessment and an environmental review of the Site and Slack Point for the Town of Ladysmith. Details were documented in the reports entitled "*Preliminary Geotechnical Assessment for Ladysmith Waterfront Development Ladysmith, BC*", dated October 1990 (Hardy BBT 1990a), and "*Environmental Review for Town of Ladysmith Waterfront Development Slack Point Area, Ladysmith, BC*", dated October 1990 (Hardy BBT 1990b).

The Town of Ladysmith requested the work to assess the possibility of future development of the area. The objective of the environmental assessment was to determine if significant soil contamination was present in the proposed development area. The purpose of the geotechnical investigation was to identify any significant foundation problems for the potential future development of residential and/or commercial buildings.

Hardy BBT's reports indicated that historical activities in Ladysmith Harbour included the shipping and handling of coal from rail cars onto ships. The waste materials from coal washing operations were discharged into the harbour to form Slack Point. Hardy BBT indicated that after the coal mining industry ceased, the area was used by forest product companies, and Slack Point was generally used as a dry land sort for logs and as a storage/disposal area for waste material and other debris from the harbour bottom.

On-site, Hardy BBT observed the following:

- One 500-gallon (approximately 1,900 L) underground storage tank (UST) in the vicinity of the washroom building that was reported to have been installed in the mid 1960s and was reported to have contained both heating oil and diesel fuel[1].
- Three above-ground fuel tanks (ASTs) (size was not reported) described as being located, "adjacent to a disused railway spur line along the shoreline downslope of the Railway Museum" (interpreted as being in the vicinity of the present-day Maritime Society Marina parking lot).

[1] During the 2011 Stage 1 PSI, Golder concluded that the UST was installed as a component of a sewage pump-out facility connected to the Town of Ladysmith's municipal sewage system, and was not used for fuel storage. Therefore, it is not considered an area of potential environmental concern

- A pump island located approximately 100 m to the southeast of the main repair building, supplied by nearby ASTs.
- Storage of electrical transformers, likely containing polychlorinated biphenyls (PCBs) approximately 100 m southeast of the main repair building.
- A waste oil storage area adjacent to the southeast of the main repair shop.

The inferred locations of historical features are shown on Figures 4a and 4b.

At Slack Point, adjacent to the east of the Site, Hardy BBT observed the following:

- An approximately 4 m high stockpile of wood debris (with an estimated volume of 4,200 $m^3$) was observed in the central portion of Slack Point (shown on Figure 4), near the end of a former railroad track. Communications with the Site representative at the time of the Hardy BBT report suggested that the material was dredged from the log dump area and transported via rail.
- The presence of a timber bulkhead and log-hauling ramp at the north end of Slack Point.
- The burned remains of the former boat maintenance facility at the west corner of Slack Point.
- A drainage ditch at the south eastern perimeter of Slack Point.
- Midway along the northern side of Slack Point, in the intertidal zone, the remains of a pile of dredged coal waste from the harbour.
- A small landfill associated with the former logging activities was also identified on Slack Point; however, the exact location was not described.

The inferred locations of historical features on Slack Point are shown on Figure 4.

A total of 25 test pits were advanced during Hardy BBT's geotechnical and environmental assessments. Fifteen of the test pits were installed for geotechnical assessment purposes; ten were installed for environmental assessment purposes. Samples from select locations during the environmental assessment were analysed for potential contaminants of concern, including metals and petroleum hydrocarbons.

The test pits were excavated to total depths ranging from 1.4 m and 4.0 m bgs (depth was limited due to a high-water table and sloughing conditions). The report indicated that test pits installed for environmental assessment purposes were advanced in the vicinity of the pump islands, the UST, the railway siding used for railcar and engine maintenance, the scrap metal storage area (inferred to be located to the northwest of the main repair building in the rail yard area), the concrete bunker containing the three ASTs, the main repair building in the rail yard area, the former cable slicing shed, the stockpiled area of unknown fill on Slack Point, and the small landfill identified at Slack Point.

Soil samples showed exceedances of standards applicable at the time of the assessment. Exceedances of various metals standards (arsenic, nickel, zinc, and copper) corresponded to test pits installed at Slack Point, in the area that was understood to be the abandoned landfill. Exceedances of petroleum hydrocarbons, including LEPH, xylenes, ethylbenzene, and toluene, corresponded to test pits installed on-site near the former fuel pump island and the main repair building, as well as off-site on Slack Point.

### 3.6.5 EBA Environmental Ltd. 1994 Phase II ESA and Supplemental Investigation

#### *3.6.5.1 Overview and Purpose*

In 1994, a Phase II ESA was conducted at the Site by EBA Environmental Ltd. (EBA) on behalf of Elk Falls Forest Industries Limited (Elk Falls). A subsequent supplemental investigation was conducted to obtain additional information as requested of BC ENV. The investigations were conducted over the entire Site, as well as Slack Point and the adjacent water lots. Elk Falls was the lease holder of the investigated properties at the time of the investigations. The purpose of the investigations was to further characterize soil and groundwater such that the land leases could be returned to the Crown. Details of the investigations were documented in the reports entitled "*Elk Falls Forest Industries Limited Phase II Environmental Assessment Ladysmith Harbour Leases Project Ladysmith, BC*, dated January 1994 (EBA 1994a), and "*Elk Falls Forest Industries Limited Supplemental Information Ladysmith Harbour Leases Project Ladysmith, BC*", dated 4 February 1994 (EBA 1994b).

#### *3.6.5.2 Historical Information*

According to EBA, the area was used for log handing and sorting between 1935 and 1987. The operations involved transferring logs into the harbour. The boat repair facility located on the western portion of Slack Point burned down in the late 1980s and the burned debris was removed in 1992. The three ASTs located at the shoreline near DL 17G (shown on Figure 4) had been removed by 1994, and there was no evidence of surficial staining or distressed vegetation. The log dump area had been removed and backfilled and the railway tracks had been removed.

According to EBA, extensive clean-up activities were reported to have been completed in 1992 and included the removal of "piles, dolphins, wharfs and piers, floats, boom shacks, buildings, equipment, cable, burned boat-repair ways, miscellaneous dumped garbage, and other scattered debris" (EBA 1994a). No further documentation of the decommissioning activities at the Site was available for Golder's review.

#### *3.6.5.3 Scope of Investigation*

EBA's intrusive investigation consisted of the excavation of seventeen test pits, to a maximum depth of approximately 4.5 m bgs. Thirteen test pits were advanced off-Site around Slack Point; specifically, five were advanced near the former boar repair area, two were advanced in the vicinity of the landfill, and the remainder were advanced through-out Slack Point. Four additional test pits were hand excavated using a shovel on-site.

#### *3.6.5.4 Observations*

During the investigation, shallow groundwater was observed in some of the test pits at 1.5 m to 2 m below grade. Subsurface stratigraphy encountered at Slack Point was similar to that observed by Hardy BBT, which consisted of up to 3.5 m of wood waste, with other debris in some locations, underlain by coal waste. No visual evidence of contaminants or buried hazardous materials was noted at the former boat repair area, and no significant garbage or other debris was uncovered from the test pits near the inferred location of the former landfill (shown on Figure 4). EBA inferred that the area was potentially associated with unauthorized dumping.

#### *3.6.5.5 Analytical Results*

Chemical analysis of select soil samples collected from the test pits included mineral oil and grease (MOG), sulphur, metals (two samples only), and chlorinated phenols (one sample only). Results of the analysis were compared to CSR standards applicable at the time of the assessment, for commercial land-use (CL), industrial land-use (IL), residential land-use (RL) and park land-use (PL). Soil samples showed exceedances of MOG and sulfur, based on the BC ENV standards applicable at the time of the assessment.

EBA also collected groundwater from four of the test pits. These samples were reported to contain high amounts of suspended coal sediment. Chemical analysis of the groundwater samples included MOG, salinity, total metals, chloride, sulphate, and sulphur. Groundwater samples contained concentrations of several metals (copper, chromium, barium, mercury, nickel, and lead) and MOG exceeding the BC ENV standards applicable at the time of assessment.

#### *3.6.5.6 Ministry of Environment Correspondence*

Appended to EBA's supplemental investigation report (EBA 1994b) is a letter of correspondence from BC ENV (referred to as the Ministry of Environment Lands and Parks at the time of the report) to EBA providing a summary of the reports reviewed by BC ENV. One document identified in the letter was a proposal for an environmental assessment of Leases 101501, 101502, & 101503 (Norecol Environmental Consultants Ltd., titled "*Proposed Methodology for Environmental Site Assessment Leases 101501, 101502, & 101503, Ladysmith Harbour, BC*.", dated 12 August 1991). This document was not available to Golder for review. Additional information provided in the letter indicates that smelter waste (slag), originating from the former Tyee Copper Company in Ladysmith, may also have also been used as (deep) fill material at Slack Point. BC ENV concluded that Fletcher Challenge's responsibility for clean-up at the Site is limited to the wood waste and dredged materials dumped on the Site (estimated to have a total volume of 20,000 m$^3$), and to any soil and groundwater impacts related to the boat repair operations.

### 3.6.6 Town of Ladysmith 1997 Waterfront Area Plan

In 1997, a waterfront area plan (WAP) was developed by the Town of Ladysmith (Town of Ladysmith 1997) to provide guidance for future land use of the Ladysmith waterfront. The Site was planned for multi-family residential, mixed-use residential/commercial land use. The WAP illustrated the planned use of Slack Point as a mixture of park and residential/commercial properties.

The WAP did not identify areas or activities of environmental concern or potential environmental concern.

### 3.6.7 New Pacific Ventures 1998 Environmental Assessment at Burleith Log Sort

In 1998, New Pacific Ventures (New Pacific) conducted an Environmental Assessment at the Burleith Log Sort on Ladysmith Harbour, located north of the Site and across Ladysmith Harbour (off-Site), for the Burleith Log Sort. Details were documented in "*Environmental Assessment of Proposed Developments at Burleith Log Sort Ladysmith Harbour*", dated May 1998 (New Pacific 1998). The report indicated that the Burleith Log Sort area has been substantially altered from the natural condition by logs and wood debris associated with the log sorting activity, as well as the ongoing activity of boom boats. A thick layer of wood debris was observed in the intertidal and subtidal regions of the area.

### 3.6.8 The Revelop Group 1999 Stage 1 PSI

A Stage 1 PSI of the Site, Slack Point, and surrounding areas was conducted by the Revelop Group (Revelop) on behalf of Concept Bank Corporation and SVR Acquisitions Limited, who were reported to be the lease holder at the time. Details were documented in the report, "*Stage 1 Preliminary Site Investigation Ladysmith Waterfront Development Ladysmith, BC*", dated 10 August 1999 (ReVelop 1999).

The investigation included the Site, Slack Point, and the water lots adjacent to the Site. The general description of the investigation area was described as extending towards the Harbour shoreline from the rail lines to the waterfront shoreline, and from Transfer Beach Park to the Government Wharf. Information contained in the Stage 1 PSI conducted by Revelop (i.e., historical fire insurance plans, city directories, site inspection details, etc.) is referenced, where applicable, in the current investigation.

The report identified 15 Areas of Potential Environmental Concern (APECs) including:

- The abandoned fuel pump island southeast of main repair shop (location of historical Site features is shown on Figures 4a and 4b).
- Former electrical transformer storage area near pump island.
- Railway siding formerly used for railcar and engine maintenance.
- Former waste oil disposal area at southeast end of the main repair shop.
- Underground storage tank behind the washroom building (inferred by Golder to be the sewage pump-out facility connected to the Town of Ladysmith's municipal sewage system).
- Cable splicing shed.
- Coal waste material at Slack Point.
- Former landfill at Slack Point.
- Former logging building on Slack Point.
- Former log dump area (DL 17G).
- Former above ground storage tank at the shoreline.
- Sewage disposal outfalls in the harbour area.
- Off-site copper smelter.
- Areas surrounding railway buildings formerly used for maintenance.
- Railway buildings including:
  - The main repair building used for machining, welding and major mechanical repair of locomotives. The building was also leased by a small boat building companies and a wood pellet company.
  - The roundhouse that was used for short term maintenance on the locomotives; this building contained below-ground maintenance pits, which were reported to have been filled in.
  - Car shop located west of the roundhouse.

### 3.6.9 Phoenix Environmental 1999 Environmental Impact Assessment and 2002 Sediment Chemistry Investigation

In 1999, Phoenix Environmental Services Ltd. (Phoenix) was retained by the Town of Ladysmith to conduct an environmental impact assessment of the proposed marina and waterfront development project. Details were documented in the report, "*Environmental Impact Assessment Report Proposed Ladysmith Marina and Waterfront Development Project Ladysmith, BC*", dated December 1999 (Phoenix 1999). The project area assessed in this report included the Site, as well as the filled foreshore areas DL 2016 Blocks B, C and D. For the proposed development, an approximate area of 3.8 ha of existing intertidal and subtidal mudflats was proposed to be dredged to a minimum depth of 2 m bgs. Dredged material was anticipated to be deposited offshore at Porlier Pass, in accordance with Environment Canada's Ocean Disposal Limits (ODL).

Historical information provided in the report indicated that the Township of Ladysmith discharged untreated sewage through an outfall into the water lots in the vicinity of the Log Dump in DL 17G. A small sawmill was reported to have been historically located in the northwest corner of the Site near the boat launch adjacent the government wharf[2]. During their investigation, a timber cribbing retaining wall was observed along the shoreline of DL 11 and a small spit was observed "near the north edge at the former location of one of the former mills". The location of the spit was not clearly described in the report. Discarded batteries and other refuse in the water were visible from the small marina located in the centre of the Site. In addition, it was reported that onboard repairs, painting, and other marina related activities could have resulted in sediment contamination around the marina.

As part of their assessment, sediment samples were collected and analysed for metals, organic carbon and AVS/SEM ratio. The purpose of the sampling was to determine sediment quality with respect to the aquatic habitat and to determine the suitability of the sediments for ocean or upland disposal. A total of six samples were collected using a Ponar dredge. Results of the analysis indicated that none of the six samples had concentrations of metals above the standards applicable at the time of the assessment. However, Phoenix indicated that concentrations of cadmium were higher than the ODLs in sediment samples from four locations.

In 2002, additional sediment sampling was conducted by Phoenix on behalf of Water and Land British Columbia Inc. Details were documented in the report entitled, "*Sediment Chemistry Investigation Report Ladysmith Harbour Proposed Waterfront Re-Development Ladysmith, BC*", dated September 2002 (Phoenix 2002). During the sediment investigation, Phoenix identified five areas of potential environmental concern including:

- Former log booming, storage and barge loading areas.
- Former sawmill near to the northwest corner of the Site (Golder infers this area to comprise the former shingle mill on Block B and D of DL 2016 shown on Figure 4).
- Former coal trans-shipment area (Slack Point).
- Former sewage effluent pipe (south of Ladysmith Maritime Society Marina and Wharf).
- Existing small boat moorage.

[2] There has been no other reference to or evidence of a sawmill at this location, and Golder infers this area to be the location of the former shingle mill.

The sediment investigation included the collection of 58 surface sediment samples (40 grab samples, 4 core samples, plus duplicate samples) at 42 locations, which were analyzed for trace metals (55 samples), polycyclic aromatic hydrocarbons (PAHs) (22 samples), PCBs (7 samples), particle size (47 samples), and/or total organic carbon (TOC; 55 samples).

Of the 55 samples analysed for metals in sediment, none had concentrations above the CSR sediment standards applicable at the time of the assessment. Twenty of the samples contained concentrations of cadmium that were greater than the ODL for cadmium.

Of the 22 samples analysed for PAHs, 19 contained concentrations of total PAHs that were greater than the ODL for total PAHs, and 18 contained concentrations of one or more PAHs that were above the CSR sediment standards applicable at the time of the assessment.

Based on the results of the investigation, Phoenix concluded that ocean disposal appeared to be an unlikely candidate for disposal because cadmium concentrations were greater than the applicable criteria, with some concentrations that were more than double the ODLs. In addition, PAH contamination was widespread, with concentrations up to five times the ODLs in some locations. Phoenix also concluded that the source of the metals and/or PAHs in sediment could be attributed to past coal transhipment, log handling activities or sewage disposal, as well as small boat moorage uses.

### 3.6.10 Levelton Engineering 2000 Stage I and II PSI, DSI, and Remediation Plan

#### *3.6.10.1 Overview*

Levelton Engineering Ltd. (Levelton) was retained by the Town of Ladysmith in 2000 to carry out a Stage I and II PSI, a DSI, and a Remediation Plan for the Site. The purpose of the work was to identify potential environmental liabilities and prepare the area for the potential sale of the property. Details were documented in the following reports: "*Preliminary Site Investigation Stage I and Stage II Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, BC*", dated 25 August 2000 (Levelton 2000a); "*Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, BC*", dated 25 October 2000 (Levelton 2000b); and, "*Remediation Plan Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District Ladysmith, BC*", dated 1 December 2000 (Levelton 2000c). Note that these reports did not include Lot 5, which is considered as part of the Site for the current investigation.

#### *3.6.10.2 Areas of Potential Environmental Concern*

The Stage I identified both on-site and off-site areas of potential environmental concern. Additional information contained in the Stage I PSI is referenced, where applicable, in the current investigation. On-site areas of environmental concern included:

- Fill from copper smelting operations, located at the northwest edge of site.
- Cable splicing shed (locations of historical Site features are shown on Figures 4a and 4b).
- Railway maintenance area.
- Transformer and shop area.

- Former waste oil area.
- Former AST and fuel island area.
- Former scale pit, where polychlorinated biphenyls (PCB) containing transformers were suspected to exist.
- Waterfront area above the high tide mark.

Levelton also used ground penetrating radar to identify a UST by the washroom building (Levelton 2000c); however, Golder infers this to be the sewage pump out facility connected to the Town of Ladysmith's municipal sewage system.

Off-site areas of environmental concern included two gas service stations within 50 metres of the property boundary along the west side of Esplanade Avenue (currently a Petro Canada located at 435 Esplanade Avenue, and a Shell Canada located at 728 Esplanade Avenue).

Levelton also reported that a truck repair and salvage business was located northwest of the Site; however, the business was not considered an area of potential concern.

#### 3.6.10.3 Stage II Test Pit Investigation

The Stage II PSI included the excavation of eleven test pits to a maximum depth of 4 m in areas of suspected contamination around the Site. Soil samples were analysed for metals, benzene, toluene, ethylbenzene and xylene (BTEX), EPH10-19, and EPH19-32, and PCBs. Two sediment samples were also collected using a hand auger and analysed for metals.

One soil sample had a concentration of EPH10-19 that exceeded the CSR CL, RL, and PL standards applicable at the time of the assessment. This test pit was located near the maintenance railway buildings (see Figure 4).

One sediment sample had concentrations of copper and lead that exceeded the CSR AW Level I standard applicable at the time of the assessment. This sample was taken at the base of the Ladysmith Maritime Society Marina and Wharf.

#### 3.6.10.4 DSI Sampling Program

The DSI included the drilling of fourteen boreholes; five of the boreholes were completed as monitoring wells. The DSI also included the collection of four foreshore sediment samples, the collection of four groundwater samples, and the collection of one surface soil sample.

Two soil samples had concentrations of EPH10-19 or EPH19-32 that exceeded the CSR standards applicable at the time of the assessment. These samples were taken from the former waste oil disposal area located at the southeast end of the main shops building.

One groundwater sample, also located near the former waste oil disposal area at the southeast end of the main shops building, had a concentration of EPH10-19 that exceeded the CSR AW standards applicable at the time of the assessment.

#### *3.6.10.5 Remediation Plan*

Details of Levelton's Remediation Plan (Levelton 2000c) were not considered relevant to the current investigation.

### 3.6.11 Westmar Consultants Inc. 2001 Cost Estimate for Redevelopment

In 2001, Westmar Consultants Inc. (Westmar) was retained by the Town of Ladysmith to prepare an order-of-magnitude cost estimate for proposed redevelopment of the Ladysmith harbour. Proposed works included dredging, filing, slope protection, removal of wood waste, soil improvement at Slack Point, and a provision for basic site infrastructure. Details were documented in the report, *"Town of Ladysmith Report for: Waterfront Redevelopment,"* dated June 2001.

The report did not identify areas or activities of environmental concern or potential environmental concern.

### 3.6.12 Baker & Osland 2002 Property Appraisal

In 2002, Baker & Osland Appraisals Ltd. (Baker & Osland) prepared an appraisal report for the Site, including Slack Point, and the water lots adjacent to Site (not investigated in this report), to determine a total market value for the Site. Details were documented in the report entitled, "P*roperty Appraisal Report, Private and Crown Lands Front and Within Ladysmith Harbour Ladysmith, British Columbia*", dated 4 April 2002.

The report contained photographs, building and area descriptions, sizes and construction details as of 2002 (the Site in the 2002 photographs appeared similar to the current Site configuration). In addition, the report supplied civic addresses for the buildings on Lot 4 including: the main repair shop (610 Oyster Bay Drive), the washroom building (612 Oyster Bay Drive), the roundhouse (614 Oyster Bay Drive), the car shop (616 Oyster Bay Drive) and the cable splicing shed (840 Oyster Bay Drive).

The report did not identify areas or activities of environmental concern or potential environmental concern.

### 3.6.13 W.R. Colclough & Associated Ltd. 2004 Report Review

In 2004, W.R. Colclough & Associated Ltd. (Colclough) was retained by Land and Water British Columbia Inc. (now Integrated Land Management Bureau) to review existing environment reports relating to Ladysmith Harbour, and to identify areas where additional investigation was required. Details were documented in the report entitled, *"Review of Existing Environmental Reports Relating to Ladysmith Harbour and Uplands Proposed Waterfront Re-Development Ladysmith, British Columbia,"* dated November 2004.

The report reviewed 16 reports that were also reviewed by Golder. In addition, the Colclough review also included a review of a 1990 report entitled *"Yearly Mine Reports for Ore and Coal Processing,"* prepared for by the Ministry of Energy, Mines and Petroleum Resources, which provided information relating to the Tyee copper smelter. The report indicated that the smelter operated from 1902 to 1913 and that copper ore was received from various mines operating on the west coast and as far away as Mexico.

Based on their review, Colclough summarised that:

- The water lots adjacent to the Site contain coal and wood wastes on the bottom.

- Contamination levels vary across the harbour.
- Some samples indicated levels of cadmium exceeding the ODLs.
- Some samples indicated levels of total PAHs exceeding the ODLs.
- Cadmium and PAH contamination may not be bioavailable.
- Lot 16G and Lot 17G (Slack Point; considered off-Site for the current investigation) are contaminated.

#### 3.6.14 EBA Engineering Consultants Ltd. 2005 Stage 1 PSI

In 2005, EBA conducted a Stage 1 PSI for Lot 5, Plan 45800, DL 24 and 56, of Ladysmith, BC on behalf of Land and Water British Columbia (now Integrated Land Management Bureau). Details of the investigation were documented in "Stage 1 Preliminary Site Investigation Lot 5, Plan 45800, DL 24 and 56, Ladysmith, BC", dated February 2005.

The investigation identified two areas of potential environmental concern on adjacent properties as follows:

- The former pump island and railway maintenance building.
- Coal fill on Slack Point.

No areas of potential environmental concern were identified on Lot 5.

#### 3.6.15 Golder Associates Ltd. 2005 Stage 1 PSI and DSI

In 2005, Golder was retained by the Crown Contaminated Sites Branch to conduct a Supplemental PSI and a DSI on Slack Point. Details were documented in the report entitled, *"Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC,"* dated 19 July 2005. This report only pertains to Slack Point, which is considered off-site for this investigation.

The DSI investigated six APECs on Slack Point identified during the Supplemental PSI. The APECs included:

- Coal Fill.
- Surficial wood waste fill.
- Buried refuse and possible landfills.
- Former boat repair shop.
- Former wood waste and dredgeate stockpile (that was present on the site between 1984 and 1994).
- A stockpile of imported material of unknown quality observed during the 2005 site reconnaissance (not observed during the Site reconnaissance associated with this current report).

The investigation consisted of a geophysical survey, test pitting, borehole drilling and subsequent groundwater monitoring well installation, soil and groundwater sampling, seepage water sampling, and soil vapour sampling.

Following the investigation of the soil, groundwater, and seepage water at Slack Point, three of the six APECs were considered Areas of Environmental Concern (AECs). These included:

- **Coal Fill** – Hydrogen sulphide odours were observed in the coal fill at depths below 12 metres at Slack Point, well below the surface of the groundwater table (generally 2 m to 3 m below ground surface). Light Extractable Petroleum Hydrocarbons (LEPH), Heavy Extractable Petroleum Hydrocarbons (HEPH), and PAH in soils were present at concentrations greater than the CSR RL/PL standards (applicable at the time of the assessment) throughout Slack Point. Elevated concentrations of sulphur were present in the coal fill. Groundwater samples collected during the DSI did not contain concentrations of potential contaminants of concern (PCOCs) at concentrations greater than the CSR AW standards. Of the non-regulated parameters, elevated concentrations of dissolved calcium, iron, manganese, magnesium and sodium were detected at several monitoring wells at the Site. These concentrations were suspected to be caused by leachate or saltwater intrusion (i.e., sea water). No other indications of leachate from the coal (i.e., low pH, elevated metal concentrations) were measured on Slack Point. A seepage water sample collected from the western foreshore area (near the former boat yard) indicated concentrations of LEPHw and a numerous PAHs that were greater than one-tenth of the CSR AW standards. It was suspected that the elevated concentrations of these parameters were a result of suspended coal particles (sediment) in the water, suggesting that PAHs associated with the coal may be transported via surface water and other modes of particulate transport.
- **Surficial wood waste fill** – LEPH, HEPH and metals were detected at concentrations greater than CSR RL/PL standards, and concentrations of zinc were greater than the CSR CL/IL standard. Of the hydrocarbons, HEPH was thought to be naturally occurring in wood that may have been entrained in the samples. The volume of the surface fill materials at Slack Point was estimated to be between about 34,000 $m^3$ and 67,000 $m^3$. The contamination identified appeared to be related to the quality of materials used as surface fill at the Site. Some of these materials may have included sediments historically dredged from Ladysmith Harbour.
- Buried **refuse and possible land filling** – The investigation identified areas containing metal debris and refuse along the northwest portion of the Slack Point. Concentrations of PCOCs in groundwater were below the CSR AW standards in this area; however, the area contained concentrations of LEPH, HEPH and metals above the CSR CL/IL and/or the CSR RL/PL soil standards applicable at the time of assessment.

The other APECs (including the former boat repair shop) identified in the supplemental PSI were investigated and no concentrations of PCOCs were found that exceeded the applicable standards. These APECS were not considered AECs for Slack Point and are not considered AECs for this current report.

During the investigation, two surface water samples were collected and analysed from a drainage ditch located on the eastern perimeter of Slack Point. It is inferred that the ditch carries storm water to the Harbour and that the water in the ditch is not associated with Slack Point. As such, the chemistry results for water samples collected from the ditch in 2005 have not been included in the current investigation.

### 3.6.16 Golder Associates Ltd. 2011 Supplemental Stage 1 PSI and DSI

Golder was retained by the Crown Lands Opportunities and Restoration Branch (CLORB) of the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) to conduct a Stage 1 PSI, DSI, sediment investigation and preliminary geotechnical investigation at Ladysmith Harbour. The primary objectives of the investigation activities were to refine remedial and geotechnical costs and options for the Site. This report presented the results of the Stage 1 PSI and DSI. Results of the sediment and preliminary geotechnical investigations were presented under separate covers. This report considered the current Site, as well as Slack Point and two water lots within Ladysmith Harbour (considered off-Site for the current investigation).

#### *3.6.16.1 Stage 1 PSI*

The Stage 1 PSI scope of work included a review of available historical reports. During the Stage 1 PSI, 21 on-site and 4 off-site likely APECs or AECs were identified, including the following:

**Table 3: Summary of APECs and AECs identified as part of the 2011 Golder Stage 1 PSI**

| Information Obtained by Historic Review and Stage 1 PSI |
|---|
| **Slack Point** |
| Coal Fill at Slack Point. |
| Surficial Fill from Non-Coal sources at Slack Point. |
| Former Wood Waste and Dredgeate Stockpile. |
| Former Boat Repair Shop on Slack Point. |
| Buried Refuse and Possible Abandoned Landfill. |
| Stockpiles of Imported Sand and Gravel. |
| Former Buildings Associated with Logging Activities. |
| **Upland Areas** |
| Fill Material in the Uplands (Lot 1 and Lot 4). |
| Former Scale Pit and Possible PCB Storage (Lot 4). |
| Former Pump Islands, ASTs, Pump House and Possible PCB Storage (Lot 1). |
| Historic Fuel Pipelines from Uplands to the Harbour (Lot 1 and Lot 5). |
| Former Maintenance Area and Current Boat Repair and Construction Operations (Lot 4). |
| Former Waste Oil Storage Area and Compressor Storage Location (Lot 4). |
| Former Location of Oil Drum, Scrap Metal Storage, and Stockpiles of Unknown Quality (Lot 4). |
| Former Cable Splicing Shed (Lot 4). |
| Suspect UST Adjacent the Washroom Building (Lot 4). |

| Information Obtained by Historic Review and Stage 1 PSI |
|---|
| **Filled Foreshore** |
| Fill Material at Block B and D of DL 2016 (former Location of the Shingle Mill). |
| Small Sawmill. |
| Former Log Dump (DL17G). |
| Former Location of ASTs at the Foreshore. |
| **Sediments** |
| Foreshore Sediments – Quality of Sediment, Marina Activities, Sewage Outfall and Pressure Treated Piles. |
| **Off-Site** |
| Off-Site Service Stations at 435 and 728 Esplanade. |
| Copper Smelter. |
| Burleith Log Sort Facility. |
| Iron Foundry. |

At the conclusion of the Stage 1 PSI, some of the APECs were eliminated based on historical information available, and as such, were not retained for further investigation. A total of eight AECs and nine APECS were retained for further investigation and or delineation. A scope of work was developed for the DSI to investigate and delineate the retained APECs and/or AECs. Nine of the APECs/AECs identified in this investigation are located in the Uplands area, which corresponds to the Site currently under investigation. Furthermore, several APECs/AECs are located adjacent to the current Site, and have the potential to impact the Site. Slack Point and the Former Log Dump (Filled Foreshore) are located adjacent to Lot 5; APECs/AECs identified in those areas could potentially cause impacts on Lot 5. Other areas in the Filled Foreshore (such as the former shingle mill and sawmill) are adjacent to Lot 4. Similarly, APECs/AECs identified in the Filled Foreshore areas could impact the Site currently under investigation.

#### *3.6.16.2 DSI*

The objectives for the DSI were to:

i) Assess soil, soil vapour, and groundwater quality in each of the APECs identified at the Site.

ii) Determine if the APECs should be considered areas of environmental concern (AEC).

iii) Characterize and delineate the extent of soil and/or groundwater contamination at the Site associated with the AECs.

iv) Provide supporting information for a risk assessment and remedial plan for the Site. The objective of the sediment investigation was to obtain data to refine remedial costs and options, including an assessment of whether ocean disposal is a viable option, for potential developers of the Site.

The remedial costs and options were presented under separate cover.

The DSI activities were conducted between November 2009 and February 2011 and included surface soil sampling, test pitting, drilling of boreholes and installation of monitoring wells, and soil and groundwater sampling.

Following the completion of the DSI, the following APECs/AEC, and their respective contamination of concern, were identified. Note that only the “Uplands” is located on the current Site, and the remaining areas are located adjacent to Site.

**Table 4: Summary of AECs and APECs identified as part of the 2011 Golder DSI**

| AEC or APEC | Summary | Contaminant of Concern (COC) |
|---|---|---|
| **Slack Point** | | |
| Coal Fill. | Coal fill material contains concentrations of PAHs, LEPH, and HEPH at concentrations above PL/RL standards. | Soil: naphthalene LEPH and HEPH<br>Soil vapour: naphthalene |
| Surface Fill. | Samples collected form surface fill (non-coal) contained concentrations of LEPH, HEPH and metals exceeding the CSR PL/RL standards and zinc concentrations exceeding the CL/IL standards. | Soil: LEPH, HEPH, metals |
| Buried Refuse. | Samples collected from the area of the buried refuse contained concentrations of LEPH, HEPH and metals exceeding the CSR CL/IL standard and/or the CSR RL/PL standards. | Soil: LEPH, HEPH, metals |
| **Uplands** | | |
| Former fuel pump islands, ASTs and possible PCB Storage. | Volatile Petroleum Hydrocarbon (VPH) contamination exceeding the CSR CL/IL standard was identified in the southern areas of AEC 10. Xylene and naphthalene were detected in soils but were below standards.<br>In the northern area of AEC 10, surficial soil samples contained HEPH concentrations over the CSR RL/PL or CL/IL standards. The HEPH appears to be limited to a surficial area adjacent to a concrete slab; and is not adjoining the VPH contamination located in the southern area of AEC 10.<br>One groundwater sample, in the southern area of AEC 10, contained VPH concentrations exceeding the CSR standards. While the groundwater contamination has not been delineated horizontally or vertically, groundwater contamination is expected to be limited to the area of soil contamination. | Soil: VPH, HEPH<br>Groundwater: VPH<br>Soil Vapour: VPHv, xylene, naphthalene |
| Former Maintenance Area and Current Boat Repair and Construction Operations. | LEPH contamination was observed in the area of AEC 12. Contamination appeared to be patchy, and not associated with one contiguous source/activity. In addition, styrene was observed at concentrations exceeding the PL/RL standards.<br>LEPH contamination was historically observed in groundwater; however, subsequent sampling did not indicate the presence of groundwater contamination. | Soil: LEPH, styrene |
| Former Waste Oil Storage Area and Compressor Storage Area. | Near-surface soil contamination of LEPH and HEPH concentrations exceeding the CSR PL/RL standards.<br>LEPH contamination was historically observed in the groundwater; however, subsequent sampling did not indicate the presence of groundwater contamination. | Soil: LEPH |

| AEC or APEC | Summary | Contaminant of Concern (COC) |
|---|---|---|
| **Filled Foreshore** | | |
| Fill Material at Block B and D of DL 2016 (former Location of the Shingle Mill), Small Sawmill, Tyee Copper Smelter, and Iron Foundry | No soil or groundwater contamination identified during the DSI, as such, this area is not considered an APEC. However, the sampling program was limited in area, and additional sample collection along the filled area may be warranted, therefore, remains an APEC. | Potential COC:<br>Soil: LEPH/HEPH, PAH, and metals<br>Groundwater: LEPH/HEPH, PAH, metals<br>Soil Vapour: VPHv, BTEX, naphthalene |
| Former Log Dump (Lot 17G). | Presence of NAPL was observed during drilling boreholes along the shoreline in the vicinity of the former log dump. VPH, LEPH and HEPH concentrations exceeding CSR CL/IL standards in soil, and PAH constituents exceeding. NAPL was not observed in monitoring wells during monitoring events.<br>Contamination appears to be limited to a particular range of depth and may be associated with the log dump or filling activities. Contamination in this area does not appear to be related to migration of contamination from areas where railway maintenance activities occurred. | Soil: VPH, LEPH<br>Groundwater: PAH<br>Soil Vapour: VPHv |
| **Sediments** | | |
| – Foreshore sediments. | Reported under separate cover. | |

The COCs identified in these tables are based on the standards applicable at the time of the 2011 assessments. Historical data associated with the Site has been rescreened to current CSR standards, and is summarized in Section 8.0.

# 4.0 REGULATORY INFORMATION REVIEW

## 4.1 BC ENV Contaminated Site Registry

An on-line search of the BC ENV Site Registry for registered properties within 500 m of the centre of the Site was conducted on 10 December 2019 by Golder. Twelve Site IDs were found within 500 m from the Site boundaries and are listed in Table 5 below. The results of the search are presented in Appendix C.

**Table 5: BC Site Registry Summary**

| Property ID# | Site Address | Description | Location Relative to the Site | Status |
|---|---|---|---|---|
| 1700 | Slack Point | Last updated: 13 October 2005. The details listed the entire Site as well as Slack Point (not assessed during this investigation). | Includes the Site area and areas adjacent to the East of the Site, and downgradient of Site. | Details indicated that the Site was Active and Under Assessment and included multiple suspected land uses: coal, dry docks, landfill, petroleum storage, bulk freight handling, and logging activities. |
| 3034 | 209 Symonds Street | Last updated 7 October 1997. Appears to be a residential property on Google Street View. | 360m southwest of Site, across the highway, up- to cross-gradient of Site. | Details indicate that the site was used for petroleum production, produce water storage, and had an aboveground or underground tank. On 11 July 1995, the site was remediated to commercial/industrial levels. |
| 5352 | Foot of Oyster Cove Road | Last updated: 14 March 2001. | Unclear: point on map places it adjacent to the northwest. Address shows the property is approximately 850 m southeast of and cross gradient to the Site. | Details suggested that a Phase I and 2 Environmental Site Assessment was performed on a harbour or port in 1997 and 1999 respectively, initiated by Transport Canada. It appears that the reports were submitted for external review in 1998. Currently registered inactive and no further action is required. |
| 5775 | 840 First Avenue | Last updated: 17 March 2000 (currently occupied by a retail business adjacent a Big O Tire Shop). | Approximately 200 m southwest and upgradient of the Site. | The details did not indicate previous activities at the Site or the reason for the Site profile. A notice of independent remediation was filed in 1999. Currently registered inactive and no further action is required. |
| 6836 | 728 Esplanade Avenue | Last updated: 10 August 2015 (currently occupied by a Shell Service Station). | Approximately 50 m southwest and upgradient of the Site. | A notice of independent remediation was filed in 2000. The most recent update lists that a Site Risk Classification Report is required. The Site is listed as active and under remediation. |
| 9349 | Forward Road (at the intersection of Dogwood Drive) | Last updated: 2 June 2005. Currently occupied by an automotive repair shop “Dalby’s Service” | 235 m southwest and upgradient of Site, across the highway | A spill was reported on 20 January 2005. No other updates are available. |

| Property ID# | Site Address | Description | Location Relative to the Site | Status |
|---|---|---|---|---|
| 11634 | 1111 First Avenue | Last updated: 23 April 2015. Currently occupied by a Save On Gas petrol station | 230 m west of Site, across the highway, up- to cross-gradient of Site. | On 21 August 2009, a notice of independent remediation completion was submitted. |
| 12891 | 1030 Oyster Bay Drive | Last updated: 3 March 2017. Currently occupied by Ladysmith Motorsports | 260 m northwest and cross-gradient of Site | The most recent notations on file date to November 2011, when an independent remediation was conducted as part of a development permit application. |
| 21424 | 422 First Avenue | Last updated: 15 March 2018. Based on an August 2014 Google Earth image, it was occupied by the Travellers Hotel, and for sale at the time. | 250m southwest and upgradient of Site, across the highway | A notice of independent remediation was completed on 4 March 2018, and the site was classified as non-high risk. No information regarding the site use is available. |
| 21774 | 941 Oyster Bay Drive and 930 Ludlow Road | Last updated: 24 June 2019.<br>930 Ludlow Road is currently occupied by “Wash me on Ludlow”.<br>941 Oyster Bay Drive is occupied by multiple businesses including an overhead crane business and bottle depot. | Adjacent to the northwest of Site, cross-gradient from Site. | Notations on the file indicate the site was classified as non-high risk in June 2018. A release letter was granted July 2018 for development; however, conditions are noted such that an annual statement must be submitted by an approved professional, and that a remediation must be completed within five years. |
| 22253 | 205 Bayview Avenue | Last updated: 22 March 2019. Based on a 2014 Google Earth Image, the site was previously used as a martial arts school. | 300m south of Site, up- to cross-gradient from Site. | A notice of independent remediation was complete in March 2019. A notation on the file indicates it was for a commercial underground storage tank. |
| 3687 | 610 First Avenue | Last updated:<br>30 December 2003 (currently occupied by a commercial business including a Canada Post Outlet). | Approximately 200 m southwest of and upgradient from the Site. | Described as “Tombstone data only for site registry” – Federal.<br>Land. Currently registered inactive and no further action was required. |

Site ID 1700 included the site and much of the surrounding area. Based on the review of the location of the registered sites, two properties were located within 100 metres of the Site and may have the potential to impact site soil or groundwater. The remainder of the 9 registered sites were located at distances greater than 200 metres and not considered to be of potential environmental concern. The three registered sites (ID 1700, 6836, 21774) are further discussed below.

### 4.1.1 Property ID 1700

Property ID #1700 is located at Slack Point, adjacent to the east of the Site. The property status remains active and under assessment. Suspected land uses listed in the details were coal, dry docks, landfill, petroleum storage, bulk freight handling, and logging practices. These indicate several CSR Schedule 2 activities. It is not known what triggered the Site Profile for the property; however, after the logging activities had ceased in the area, several investigations were performed, the likely basis for the site profile.

### 4.1.2 Property ID 6836

Property ID #6836 is currently a Shell Service Station. This property was listed as active and under remediation. The property is located approximately 50 metres upgradient from the Site, and therefore may have the potential to impact the quality of the soil and/or groundwater at the Site.

### 4.1.3 Property ID 21774

Property ID #21774 is listed with two different addresses, for 930 Ludlow Road, and 941 Oyster Bay Drive. 930 Ludlow Road is currently occupied by “Wash me on Ludlow”. 941 Oyster Bay Drive is occupied by multiple businesses including an overhead crane business and bottle depot. Property uses are listed as vehicle repair/salvage/wrecking, and construction/demolition of material including concrete and asphalt. Notations on the file indicate the property was classified as non-high risk in June 2018. A release letter was granted July 2018 for development; however, conditions are noted such that an annual statement must be submitted by an approved professional, and that a remediation must be completed within five years. The registry lists contaminated fill an issue for this property. The property is located adjacent to the northwest of the Site, and therefore may have the potential to impact the quality of the soil and/or groundwater at the Site.

## 4.2 Federal Contaminated Sites Inventory

An on-line search of the Federal Contaminated Sites Inventory (FCSI), on the Site and surrounding area, was conducted on 10 December 2019 by Golder. A summary of the search results is provided in Appendix D.

Three Federal Real Property (FRP) locations were found adjacent to the Site, with six associated FSCI Identifier number (or “Contaminated Sites”). The Identifier numbers indicated a Site Name, Contaminant Type, and Media Type. The details provided are summarised in Table 8, below.

**Table 8: Details from FSCI Database for the surrounding area**

| FSCI Identifier | Site Name | Contaminant Type | Media Type | Site Status |
|---|---|---|---|---|
| 00020503 | Ladysmith Boat Basin No. 1 | N/A | N/A | Closed: Historical review not required. |
| 00021349 | Ladysmith (Waste Oil ASTs) | PAHs, PHCs (petroleum hydrocarbons) | Sediment | Active: Initial testing completed. Detailed testing underway. |

| FSCI Identifier | Site Name | Contaminant Type | Media Type | Site Status |
|---|---|---|---|---|
| 00021350 | Ladysmith (Nearshore Sediment and surface water) | PAHs, PHCs | Sediment | Suspected: Historical review completed. Initial testing underway. |
| 00021352 | Ladysmith (Boat Grid) | Metal<br>metalloid<br>organometallic<br>PAHs<br>PHCs | Surface water | Closed: Initial testing completed. No Further action required. |
| 00021353 | Ladysmith (Fill Material) | Metal<br>metalloid<br>organometallic | Soil | Closed: Initial testing completed. No Further action required. |
| 00021354 | Ladysmith (Stormwater Discharge) | Metal<br>metalloid<br>organometallic | Sediment | Closed: Initial testing completed. No Further action required. |

The inventory indicated several CSR Schedule 2 activities associated with these sites. Exact locations of the activities were not identified on the FCSI; however, the majority of the activities have been identified during the previously described historical investigations.

## 4.3 Town of Ladysmith

### 4.3.1 Historic Town of Ladysmith Map and Photographs

A copy of a 1902 Town of Ladysmith map was obtained from the archives (Ladysmith Archives 1902) and is included in Appendix E. The map illustrates the Site as of 1902.

On-site, a washer and scales are observed, which appear to be associated with the operations off-site on Slack Point. Railway tracks and a depot are also observed. In the northwestern portion of the Site, a shingle mill extends off-Site near the present-day Government wharf.

Off-Site, it appears that Slack Point does not extend as far into the Harbour as in current conditions. There are three wharfs visible in the area of Slack Point including: the loading wharf, the transfer wharf, and a T-shaped wharf. The area below the T-shaped wharf is labelled “Dirt Dump". To the northwest of the shingle mill is the Tyee Copper Company smelter and foundry, located off-Site and cross gradient to the Site.

### 4.3.2 Placement of Material from Sewage Treatment Plant

Following a kick-off call for this project, Jake Belobaba from the Town of Ladysmith raised a question regarding potential disposal of material from the sewage treatment plant on Lot 4.

Geoff Goodall, the Director of Infrastructure Service for the Town of Ladysmith, was contacted and he explained that the material taken to the site was native material that was removed from the ground at the sewage treatment plant site, to facilitate expansion of the plant. The material was not known to be contaminated, and he attached a figure showing the locations where the material was placed.

A copy of this communication is provided in Appendix E.

# 5.0 INTERVIEW AND SITE VISIT

## 5.1 Interview

Golder conducted an interview and a Site visit with Mr. Quentin Goodbody, the President of the Ladysmith and District Historical Society, on 16 December 2019. Mr. Goodbody has volunteered at the Site for two years. During the interview, Golder obtained information regarding the past land use at, and near, the Site. The following information presented in Table 6 was obtained from the interview.

**Table 6: Past Uses of the Site and Neighbouring Properties**

| Reported Use | Details |
|---|---|
| Dry cleaner | None reported on-site or surrounding properties. |
| Industrial metal finishing, including painting or electroplating | Metal finishing and electroplating was not reported to have occurred on-site or surrounding properties; however, the Site Representative reported that some painting of trains in the main repair building was likely to have occurred. |
| Other industry | The Site Representative reported that logging activities and a railway yard were present at the Site. Tyee Copper Smelter was historically located approximately 400 m to the north of the Site. |
| Fuel storage | The Site Representative reported that two ASTs were historically present to the southeast of the of the main repair building. Fuel was gravity-fed from the ASTs downgradient to the southeast to the area of the former log dump for fuelling activities. The approximately location of these ASTs is shown on Figure 4. |
| Retail fuel outlet or vehicle service garage | Retail fuel outlets or service garages were not present on-site; however, fuelling activities took place on-site as reported above and industrial vehicle and locomotive repair and maintenance took place on-site in the main repair building. Retail fuel outlets are currently located off-site and within 100 m of the Site. |
| Landfilling or placement of fill | The Site Representative noted that fill material was placed along the west boundary of the Site in the 1980s during upgrades to the highway. |
| Wastewater impoundments | None reported. |
| Solid or liquid waste storage or disposal | None reported. |
| Environmental sampling, wells, or evidence of drilling | Previous environmental investigations have been conducted at the Site, as described in Section 3.6 and presented in Section 8.0. |
| Other activities that may have affected the environmental condition of the Site or neighbouring properties | None reported. |

## 5.2 Site Visit

During the Site visit, the Site Assessor walked through and observed accessible areas of the interior and exterior of the Site, observed neighbouring properties, interviewed the Site Representative, and photographed representative Site features (Appendix F). The following table provides an overview of the Site visit (Table 7).

**Table 7: Details of Site Visit**

| Item | Information |
|---|---|
| Weather | Overcast, raining |
| Restrictions on access or photography | Golder did not enter the first aid building and washroom building in the railway yard area on-site. |

### 5.2.1 Present Site Uses

The Site includes Lot 1, Lot 4, and Lot 5 near the Ladysmith Harbour. There are currently six buildings on-site including the former railway repair building, washroom, car shop, roundhouse, first aid shed, and cable splicing shed. The locations of the buildings are shown on Figure 4.

The former railway repair building is approximately 62 m long by 23 m wide and 12 m high, with galvanized iron reinforced walls. This building was historically used for logging truck maintenance at the southeast end of the building and steam and diesel locomotive repair at the northwest end. The Site representative noted that during the time the building was used for logging truck and steam/diesel locomotive repair, there were pits present in the floor of the building for accessing the underside of trucks and locomotives. The front (east) portion of the building was partitioned into several compartments and storage. Until late 2019, the building was fronted by the Maritime Society office building, Liquid Gold Art Studios, and the Arts Council of Ladysmith and District. The rear of the building (or the northwest end) was occupied by two tenant operations including Atlantis Kayaks and Southwood Products. During the Site Visit, the building was vacant, and the concrete floor of the building was cut to excavate and install new footings for the building.

According to the Site representatives, a compressor house was historically located immediately adjacent to the southwest side of the former railway repair building. The location of the former compressor house is shown on Figure 4. The compressor was used for the air lines associated with the locomotives. During Golder's Site Visit for the 2011 Supplemental Stage 1 PSI, the Site representatives commented that the compressor leaked on a steady basis; they were unsure when the compressor had been removed. In addition to the compressor, a waste oil tank car was stored in this area. Oil from locomotive and truck maintenance was generally stored in the waste oil tank car and used by surrounding municipalities to irrigate the roads to keep the dust down. During the 2011 Site visit, the Site representatives mentioned that oil was frequently discarded onto the ground as opposed to disposal in the waste oil tank car. This area also contained buckets of pyrene used for washing metal parts. The use of the waste oil area likely ceased when the logging operations halted in the mid 1980s. Currently this area is paved with asphalt and concrete stairs are located on the slope to the west.

According to the Site representatives interviewed by Golder in 2011, the washroom building was historically used as the electrical shop for the logging activities and railway (Golder 2011). The building currently consists of two washrooms, showers and a changing area. The building was not entered during the Site visit.

The roundhouse building is approximately 23 m by 8 m and is similar in construction to the main repair shop. It is currently used by the Ladysmith Maritime Society for restoration of a locomotive. Several 4 litre cans of paint and 20 litre pails of grease were stored on workbenches inside the building. According to the Site representative, locomotive maintenance was historically performed in this area (i.e., oil changes, small engine repair). The area was historically used by the logging industry to store the locomotives. A rail spur was visible in the building. During the 2011 Site Visit conducted by Golder for the Supplemental Stage 1 PSI, the Site representative noted that there was a maintenance pit located under plywood between the rail spur and the pit appeared to have been infilled and covered over.

The former car shop is approximately 25 m by 12 m and is located southwest of the roundhouse. It is currently used by the Ladysmith Maritime Society for vessel restoration products and storage. Historically, the car shop was used as a repair facility for train wheels and axles.

The first aid building is located north of the roundhouse and is generally used as a storage shed.

Two smaller sheds were observed in the vicinity of the car shops and were used for storage.

The former cable splicing shed is located in the northwest portion of Lot 4. According to the Site representatives, the building has been used for wood and galvanized steel siding construction, wood manufacturing, storage of explosives and streetlights, and used for cable splicing. The building is not currently in use.

A railyard area is located adjacent to the north of the Site buildings, it is currently used as a display area for several railcars and historical equipment. The Site representative noted that the area to the west of the rail spurs in the railyard area was historically used as a boneyard for derelict equipment. This boneyard is identified on Figure 4.

### 5.2.2 Site Buildings and Equipment

At the time of the Site visit, the Site was developed with six buildings as described in Section 5.2.1.

**Table 8: Site Building(s) and Equipment**

| Topic | Findings and Assessor Comments |
|---|---|
| Below-ground floors and uses | None. |
| Frequently occupied rooms in contact with the ground | The former railway repair building, car shop and roundhouse are frequently occupied, and the floor of the building is in contact with the ground. Each of these three buildings has a concrete floor. |
| Number of tenant units | The Ladysmith Maritime Society is currently occupying the Site buildings. |
| Building exterior | Former railway repair building: corrugated steel siding, glass windows with wooden frames, roof material unknown.<br>Car Shop: painted wood and corrugated steel siding, glass windows with wooden frames, roof material unknown.<br>Roundhouse and Washroom: painted wood siding, glass windows with wooden frames, roof material unknown.<br>First aid shed: painted wood siding, glass windows with wooden frames, metal roof.<br>Cable splicing shed: corrugated steel siding, metal roof. |

| Topic | Findings and Assessor Comments |
|---|---|
| Building interior | Former railway repair building: concrete floor, wood and drywall interior walls, wood ceiling.<br>Car Shop, washroom, first aid shed, cable splicing shed: did not enter interior of these buildings.<br>Roundhouse: wood walls and ceiling, concrete floor. |
| Heating/Cooling system | At the time of the Site visit there were no heating or cooling systems for the on-site buildings. |
| Backup power supply | At the time of the Site visit there was no backup power supply on-site. |
| Potable water supply | Municipal water. |
| Other services | The Site is serviced with electricity from the municipal grid. The wastewater is pumped on-site into the municipal sewer line. |
| Hydraulic lift equipment | No hydraulic lift equipment was noted on-site. |
| Other mechanical equipment | No other mechanical equipment was noted during the Site visit. |
| X-ray equipment | None |

### 5.2.3 Pesticides and Fertilizers

Generally, the use of herbicides and pesticides is a practise around railways and in railway yards. During the Site visit a representative from the Town of Ladysmith working on the footing installations in the former railway repair building noted that soil underneath the office rooms on the east side of the building had been treated with pesticides for termites.

### 5.2.4 Storage Tanks

At the time of the Site reconnaissance, USTs and ASTs were not observed on the Site. Previous reports indicated that trains and boats were fuelled using a pump island located approximately 100 m to the southeast of the former railway repair building. The pump island was reported to be connected to above-ground tanks. Fuel was gravity fed down to the shoreline via pipes and used to fuel boats, locomotives and trucks. A structure was observed in this area on aerial photographs, between 1962 and 1998. According to the Site representatives' interview in Golder 2011, a pump house/shed cantilevered over the cliff to the northeast and was held up by stilts. In Golder 2011, it was noted that the Site representatives said that PCB storage may have been located in this area; however, the contents, locations and size were unknown. This area is currently vacant and covered by gravel.

### 5.2.5 Chemical Storage

At the time of the Site reconnaissance, chemical products were observed in the roundhouse building. Chemical storage was generally limited to several 4 litre cans of paint and 20 L plastic buckets of grease. The containers were all closed and stored on shelves or on the concrete floor of the building. Staining or cracks in the concrete floor were not observed in the roundhouse during the Site visit; however, much of the floor was not visible beneath the locomotive being restored in the building.

### 5.2.6 Waste Generation and Handling

One garbage bin was observed adjacent to the former railway repair building for construction work within the building. No other garbage bins were located on-site. According to Golder 2011, municipal garbage collection is not available at the Ladysmith Harbour and when the Site buildings were occupied by other tenants, bins were present on-site for collection of garbage which were picked up on an as-needed basis.

Coal sorting bins were historically stored along the side of the road southeast of the main repair shop. The number of bins was unknown, and these bins were not observed during the Site reconnaissance (Golder 2011).

### 5.2.7 Surrounding Properties

During the Site reconnaissance, surrounding properties were observed to be commercial, industrial and parkland. The following summarizes land use in the area of the Site:

Southeast (cross-gradient of the Site): Southeast of the Site is Transfer Beach Park. The park includes a playground, basketball and beach volleyball courts, a washroom building, and a building occupied by a kayak rental company.

Southwest (upgradient of the Site): Immediately southwest of the Site is the Trans Canada Highway, followed by a mixture of commercial businesses, residential homes and parkland. Three service stations (a Save On Gas at 1111 1$^{st}$ Avenue, a Petro Canada at 434 Esplanade Avenue, and a Shell at 728 Esplanade Avenue) were observed to be southwest of the Site.

North/northwest (cross-gradient of the Site): To the northwest are industrial activities, including the Government wharf to the north and the Western Forest Products sawmill and sorting facility beyond that, followed by the Town of Ladysmith. A Co-Op Cardlock service station and the “Wash me on Ludlow” carwash is located adjacent to the northwest of and cross gradient to the Site.

Northeast: The area to the northeast generally comprises open water passage and Ladysmith Harbour followed by Burleith Arm.

# 6.0 SPECIAL ATTENTION ITEMS

Information about Special Attention Items was collected during the Site visit and the interview with the Site Representative. The TOL noted that in 2019 a hazardous building material assessment was conducted for the former railway repair building and that lead paint was noted near stairs within the building and no other hazardous building materials (HBMs) were identified. Golder did not review the report as part of this PSI and other HBMs could be present in other buildings on the Site. The following section provide an overview of potential special attention items that may be present on-site.

## 6.1 Polychlorinated Biphenyls

Polychlorinated biphenyls ("PCBs") are a group of organic chemicals that were widely used in caulking and electrical equipment manufactured between the 1950s and 1980. Caulking potentially containing PCBs can found in any building constructed during this period. Electrical equipment potentially containing PCBs is restricted to transformers, capacitors, heat transfer equipment, hydraulic equipment, electromagnets and vapour diffusion pumps manufactured prior to September 1977 and in lamp ballasts manufactured prior to July 1980. The PCB regulations of the Canadian Environmental Protection Act (SOR/2008-273) require that equipment containing more than 50 mg/kg PCBs should be decommissioned, with PCB use to be eliminated by 2025.

Based on the reported age of the Site buildings (built in approximately 1935 [Golder 2011]), PCB-containing electrical caulking and equipment may be present on-site. Fluorescent lights were observed in the roundhouse building; however, lamp ballasts for these fluorescent light fixtures were not inspected. The Site Representative was unaware whether the lamp ballasts contained PCBs. In addition, it was reported that PCB may have been stored near the storage tanks, refer to Section 5.2.4.

## 6.2 Asbestos-Containing Materials

The use of asbestos-containing building materials ("ACMs"), including both friable and non-friable asbestos, in building construction materials significant declined on a voluntarily basis in the mid-1970s. The use of materials containing friable asbestos in Canada was effectively discontinued by 1986 as a result of strict provincial regulation. Typical examples of friable ACMs include thermal, fire-proofing or acoustical insulating materials and can include deteriorated materials containing non-friable ACM (e.g., Transite™ pipe). Typical examples of non-friable ACMs can include packings, gaskets, sealants, resilient flooring, asphalt roofing, mastics, drywall joint compounds, stuccos, cementitious and Transite™ materials (including drains and downspouts), and Transite™ shingles. Buildings constructed prior to 1986 potentially contain both friable and non-friable ACMs. Buildings constructed after 1986 potentially contain non-friable ACMs; however, as a practical matter, the condition of some non-friable ACMs can deteriorate, releasing asbestos fibres if disturbed.

Based on the age of the Site buildings (built in approximately 1935 [Golder 2011]), building materials may contain ACMs. Building materials were observed to be present that potentially contain ACMs including window putty, and drywall joint compound. The TOL noted that in 2019 a hazardous building material assessment was conducted for the former railway repair building and that asbestos containing material was not present.

## 6.3 Lead and Lead-Containing Surface Coatings

Paints manufactured prior to 1960 commonly contained significant lead. In 1976, the Canadian Hazardous Products Act restricted the lead content of paints and other surface coatings on furniture, household products, children's products, and exterior and interior surfaces and since that time lead content of paints has continued to decline. Lead-containing surface coatings in good condition are not typically associated with health risks to building occupants; however, unacceptable lead exposures can occur during building renovations, modifications or demolition activities. Other potential sources of lead in buildings include soldered plumbing joints installed prior to 1986 and lead plumbing pipe (used up until 1975). Lead is present in leaded glass and other type of radiation shielding that are used where radiation sources are present (e.g., medical and dental clinics).

Based on the reported age of the Site buildings (built in approximately 1935 [Golder 2011]), it is likely that interior or exterior surface coatings contain significant lead concentrations. The observed painted surfaces of the Site building were generally noted to be in good condition. The TOL noted that in 2019 a hazardous building material assessment was conducted for the former railway repair building and that lead paint was noted near stairs within the building.

## 6.4 Ozone-Depleting Substances

Refrigeration and air conditioning equipment in service prior to 1998 may contain chlorofluorocarbon refrigerants that are designated as ozone-depleting substances (ODSs). Non-ODS refrigerants have been developed and are available to replace these materials in newer equipment. Other ODSs include halons, methyl chloroform and carbon tetrachloride. Under the Ozone Depleting Substances Regulations 1998 of the Canadian Environmental Protection Act (SOR/99-07), all ODSs are being phased out of use in Canada.

ODS-containing equipment were not observed or reported to be present at the Site.

## 6.5 Urea Formaldehyde Foam Insulation

Urea formaldehyde foam insulation (“UFFI”) is low-density foam that was used as an insulating material in the 1970s until it was banned from use in Canada in 1980. UFFI was commonly injected through walls by drilling injection holes, typically in walls, roof structures, ceilings and overhangs.

The Site Representative was not aware of UFFI having been used at the Site.

## 6.6 Radon and Radioactive Substances

Radon is a radioactive gas formed by the decay of naturally occurring uranium. In 2012 Health Canada released a major study demonstrating that radon concentrations in 7% of Canadian homes exceed the recommended guideline of 200 Becquerels/$m^3$. It is likely that similar proportion of commercial and industrial buildings are also impacted by radon at concentrations exceeding this recommended guideline. Although radon concentrations vary significantly across Canada, no geographic area is radon-free, and Health Canada recommends the completion of long-term radon testing to determine radon concentrations within a building.

Radioactive sources are found within a wide range of testing equipment including lasers, x-ray sources, imaging and radiography equipment, industrial gauges (including density gauges and other materials testing equipment), and smoke detectors. Radioactive products include any uranium containing material and medical isotopes.

The Site Representative was unaware if radon testing was conducted at the Site. No radioactive sources were observed or reported to be present at the Site.

## 6.7 Mercury

Mercury may be present in both mechanical and electrical equipment including thermometers, thermostats, switch gears, barometers, vacuum gauges, gas pressure regulators, electrical switches/relays, batteries and electrolytic manufacturing processes. Small amounts of mercury are present in some fluorescent lights, including mercury vapour, metal halide, and sodium vapour lamps.

During the Site visit, Golder did not observe equipment or products potentially containing mercury.

## 6.8 Mould or Water Damage

Mould can grow on damp building materials such as ceiling tiles, drywall, carpeting, and areas. Mould growth is commonly associated with water leakage.

The Site Representative stated that mould has not been of concern at the Site. Areas of moisture, water ingress and/or suspected mould growth were not observed or reported to be present at the time of the Site reconnaissance.

## 6.9 Noise and Vibration

No major or persistent sources of noise and vibration were observed or reported to be present other than that typical of vehicular traffic on the adjacent roadways.

## 6.10 Non-ionizing Electromagnetic Radiation

Non-ionizing types of electromagnetic radiation include radiofrequency and microwave radiation, which can be associated with tissue damage through heating. Radiofrequency radiation is produced by radio and TV transmitters, induction heaters, and dielectric sealers. Microwave radiation is produced by microwave ovens, parabolic antennas, radar devices, and diathermy applicators. No human health risks are known to be associated with the low-energy electromagnetic radiation from commercial electronics and power transmission lines.

No sources of non-ionizing electromagnetic radiation were observed or reported to be present at the time of the Site reconnaissance.

# 7.0 SURFICIAL SOIL SAMPLING

During the Site visit on 16 December 2019, construction work was taking place inside the former railway repair building to install new footings. As the former railway repair building was retained as an AEC as part of the DSI undertaken by Golder in 2011, there was a potential for contamination under the building. While the footing excavations were open, Golder collected soil samples from the soil beneath the floor of the former railway repair building. Three soil samples and one duplicate soil sample were collected within the former railway repair building. One sample was collected outside the building to the south, as the TOL representative on-site noted that material would also need to be removed from this area during construction activities. The locations of the soil samples collected are presented on Figure 8.

## 7.1 Field Methodology

Prior to the collection of the soil samples, tools used to collect the samples were washed with laboratory grade detergent and rinsed with distilled water. Nitrile gloves were worn when handling sampling equipment and samples and were changed between sample locations.

The soil samples were collected using a shovel. The soil conditions were recorded and logged by Golder staff, including soil descriptions, headspace measurements using a photoionization detector (PID), and observations of potential contamination (if encountered). The soil samples collected within the former railway repair building were taken between 0.3 to 0.6 m below the bottom of the concrete floor and the sample collected on the bank to the south of the building was collected at 0.3 to 0.6 m below the ground surface.

Field-screening of soil samples was completed using the dry headspace method, where plastic headspace bags were filled two-thirds full of soil, then sealed, shaken, and left to stand for several minutes. The headspace over the soil was then monitored for the presence of organic vapours using a MiniRAE 2000 photoionization detector (PID) containing a 10.6 eV ultraviolet lamp calibrated to 100 parts per million ("ppm") isobutylene.

The soil samples were placed in pre-cleaned 125 millilitre (mL) glass jars with Teflon®-lined lids supplied by the laboratory. The samples were submitted for the analysis of metals; extractable petroleum hydrocarbons (EPH); polycyclic aromatic hydrocarbons (PAHs); benzene, toluene, ethylbenzene, and xylenes (BTEX); and methyl t-butyl ether (MTBE). The samples were labelled, registered on a chain-of-custody form, and placed in a cooler with ice packs for transport to the laboratory within the recommended temperatures and hold times.

## 7.2 Applicable Regulatory Standards

In British Columbia, environmental matters pertaining to contaminated sites generally fall under the jurisdiction of the Ministry of Environment & Climate Change Strategy (ENV), pursuant to the Environmental Management Act (EMA, SBC 2003, Chapter 53 assented to 23 October 2003, updated to 16 May 2019. The key regulation under the EMA that relates to the assessment and remediation of contaminated sites is the Contaminated Sites Regulation (CSR; BC Reg. 375/96, O.C. 1480/96 and M271/2004, as updated [includes amendments up to BC Reg. 13/2019, 24 January 2019]).

The CSR provides numerical standards for the evaluation of soil, groundwater, sediment and soil vapour quality. The CSR numerical standards applied to analytical soil data were based on current and potential future land use including urban park (PL), commercial (CL), and industrial (IL) land use. Referenced standards include groundwater flow to surface used by marine aquatic life (AW-M), intake of contaminated soil (I), toxicity to invertebrates and plants (T), drinking water (DW), ecological health protection (EH), and human health protection (HH).

## 7.3 Analytical Results

The soil under the concrete floor of the former railway repair building and on the bank to the south of the building generally consisted of silty sand or silty clay. Wood debris was observed in the soil collected from locations HS19-01 and HS19-05. The organic vapour headspace measurements collected in the field for the soil samples were less than or equal to 0.1 ppm.

ALS of Burnaby, BC performed the chemical analyses of the soil samples. Copies of the analytical reports and the corresponding chain-of-custody form are provided in Appendix G.

The results of the soil sample analyses were compared to applicable BC CSR standards for PL, CL and IL land use and are presented in Table H-1 and H-2 in Appendix H. The concentration of parameters of concern were less than the applicable BC CSR standards in the samples analyzed with the exception of the concentration of copper in sample HS19-04 collected on the bank to the south of the former railway repair building which was greater than the AW-M standard for PL, CL, and IL land use.

## 7.4 Quality Assurance and Quality Control

The target for QA/QC for a field investigation was a minimum of one replicate sample for every ten samples analyzed for a particular compound (i.e., 10 percent field replicates).

The relative percent difference (RPD), the absolute difference between the two values, divided by the mean of replicate analysis was used to evaluate the sample result variability. Where the concentration of a given parameter is less than five times the method detection limit (MDL), the laboratory results are considered to be less precise and the RPD was not calculated. For parameters with concentrations less than five times the MDL, the difference factor (DF) between the sample and its replicate is calculated. For soils, data quality objectives (DQOs) are an RPD value of less than 30% for metals and less than 50% for organic compounds.

A review of the laboratory quality control reports indicated that the laboratory appears to have met their own standards and internal targets with the exception of a laboratory duplicate result outside the laboratory DQO due to sample heterogeneity. Copies of the laboratory analytical reports including laboratory quality control data are provided in Appendix G.

The soil field QA/QC program consisted of one duplicate soil sample pair collected at location HS19-02. The results of the QA/QC program indicated that the calculated RPDs and DFs were within Golder’s DQOs.

Full results of the soil QA/QC program are presented in Table H-3 in Appendix H.

# 8.0 HISTORICAL DATA RESCREENING

The BC CSR and associated guidance have undergone significant revision since the analytical data was last reviewed at the Site as part of Golder 2011. In order to define the work required at the Site going forward, it is important to consider the Site under the current regulatory framework. Based on Golder's understanding of the Project, Golder has rescreened the available data for Lots 1 and 4 and sampling locations located near to and adjacent to Lot 5 to the current applicable CSR standards. The results of the data rescreening are summarized in Table 9 below. Results are included in Appendix I, and are illustrated on Figures 6a, 6b, 7a, and 7b.

**Table 9: Summary of Historical Data Rescreening**

| AEC or APEC | Summary | COC |
|---|---|---|
| **On-Site** | | |
| Former fuel pump islands, ASTs and possible PCB Storage. | In the southern area,<br>■ Historic soil concentrations at CPT 1 (Hardy BBT 1999) exceed current CSR standards for benzene, toluene, and xylene.<br>■ At TP09-02 and TP09-03 (Golder 2011) VPH concentrations in soil exceed the current CSR RL/PL or CL/IL standards. Naphthalene in soil also exceeds CSR RL/PL standards at TP09-03.<br>■ One groundwater sample (MW09-1; Golder 2011) in the southern part had concentrations of benzene, toluene, and MTBE that exceeded CSR-DW standards. This sample also had VPH concentrations exceeding CSR AW-M standards.<br>In the northern area,<br>■ Surficial soil samples (SA6 and SA7; Golder 2011) had HEPH concentrations that exceed current CSR RL/PL or CL/IL standards.<br>■ One groundwater sample and its duplicate (MW09-8; Golder 2011) had concentrations of pyrene, benzo(a)pyrene, and benzo(b)fluoranthene that exceeded CSR standards in 2009. These concentrations decreased after resampling in 2011. | Soil: VPH, HEPH, naphthalene, BTEX<br>Groundwater: VPH, BTEX<br>Soil Vapour: VPH, xylene, naphthalene |
| Former Maintenance Area and Current Boat Repair and Construction Operations. | Rescreened historical data showed the following:<br>■ Historic soil concentrations at CPT 2 and 3 (Hardy BBT 1999) exceed current CSR standards for LEPH and VPH.<br>■ Soil at 3 m bgs in TP6 (Levelton 2002) exceeded the CSR PL/RL and CL/IL standards for barium.<br>■ LEPH concentrations in soil above CSR CL/IL standards were measured at BH00-08 (0.2 m) and at TP4 (2.0 m and 4.0 m) (Levelton 2002).<br>■ Shallow soil samples in two test pits (TP09-6 and TP11-07; Golder 2011) had LEPH concentrations exceeding CSR PL/RL and CL/IL standards, as well as HEPH concentrations exceeding CSR PL/RL standards. Exceedances of volatiles in soil including ethylbenzene, xylene, benzene, and styrene of CSR PL/RL or CL/IL standards were also found in the area. | Soil: LEPH, HEPH, BTEX, styrene |

| AEC or APEC | Summary | COC |
|---|---|---|
| | ■ Soil samples in the area also had concentrations of zinc (MW09-11) and lead (TP09-05) exceeding CSR PL/RL or CL/IL standards (Golder 2011).<br>■ In groundwater, MW09-9 and MW09-11 (Golder 2011) had concentrations of manganese that exceeded CSR-DW standards.<br>■ Downgradient location MW11-02 (Golder 2011) had concentrations of chloroform and arsenic that exceeded CSR standards. | |
| Former Waste Oil Storage Area and Compressor Storage Area. | ■ Historic shallow soil concentrations at BH00-03 (Levelton 2002) were rescreened showing exceedances of CSR PL/RL standards for LEPH and HEPH at 0.2 m bgs. A deeper sample at 0.5m bgs was below CSR PL/RL standards.<br>■ New soil samples taken as part of the 2011 DSI showed no exceedance of LEPH/HEPH standards.<br>■ In groundwater, MW11-02 located downgradient had concentrations of arsenic and chloroform exceeding CSR standards. | Soil: LEPH, HEPH |
| **Off-Site** | | |
| Fill Material at Block B and D of DL 2016 (former Location of the Shingle Mill), Small Sawmill; Tyee Copper Smelter, and Iron Foundry | ■ One soil sample at MW09-05 (Golder 2011) showed concentrations of benzene that exceed the current CSR PL/CL standard.<br>■ No other soil or groundwater contamination identified during the 2011 Golder DSI. | Potential COC:<br>Soil: LEPH/HEPH, PAH, and metals<br>Groundwater: LEPH/HEPH, PAH, metals<br>Soil Vapour: VPHv, BTEX, naphthalene |
| Former Log Dump (Lot 17G) located downgradient and adjacent to Lot 5. | In soil,<br>■ Historic investigations found concentrations of Mineral Oil and Grease (MOG) inferred to be above current CSR RL/PL and CL/IL standards for LEPH, at EBA's Test Pit 14 (EBA 1994).<br>■ At Test Pit 11 (EBA 1994), concentrations of MOG are inferred to be above current CSR RL/PL standards for LEPH.<br>■ MW-09-8 (Golder 2011) showed concentrations of VPH, LEPH, and HEPH in exceedance of current CSR RL/PL and CL/IL standards at a depth of 2.9-3.0 m bgs. Concentrations of these parameters were below the standards at a depth of 3.9 – 5.0 m bgs.<br>■ Concentrations of LEPH exceeded the CL/IL standard and concentrations of HEPH exceeded the CSR RL/PL in BH09-13, BH09-14, and BH09-15 (Golder 2011). | Soil: VPH, LEPH, HEPH, BTEX<br>Groundwater: PAH<br>Soil Vapour: VPHv |

| AEC or APEC | Summary | COC |
|---|---|---|
| | ■ Concentrations of benzene also exceeded the CSR RL/PL and CL standards at BH09-13 (Golder 2011).<br><br>In groundwater,<br><br>■ Concentrations of PAH's at MW11-01 (Golder 2011) exceeded CSR standards, for benzo(a)pyrene (CSR AW-M), benzo(b)fluoranthene (CSR DW), and pyrene (CSR AW-M)<br><br>■ One groundwater sample and its duplicate (MW09-8; Golder 2011) had concentrations of pyrene, benzo(a)pyrene, and benzo(b)fluoranthene that exceeded CSR standards in 2009. These concentrations decreased after resampling in 2011.<br><br>■ In groundwater, MW11-02 located upgradient had concentrations of arsenic and chloroform exceeding CSR standards. | |

# 9.0 ISSUES OF ENVIRONMENTAL CONCERN

Based on all the information obtained as part of this Stage 1 PSI, the following issues of potential environmental concern were identified:

## 9.1 AEC 1 – Former Fuel Pump Islands, ASTs and Possible PCB Storage

A former pump island and possible associated ASTs containing bunker fuel, gasoline and/or diesel fuel (D&M 1990a) were historically located approximately 100 m southeast of the main repair building (on Lot 1). Historical investigations identified concentrations of hydrocarbon constituents in soil and groundwater that exceeded the standards applicable at the time of the investigation. Historical data suggested that storage of PCBs may also have taken place in this area.

In the southern area, historic soil concentrations at CPT 1 (Hardy BBT 1999) exceed current CSR standards for benzene, toluene, and xylene. As part of the DSI undertaken by Golder in 2011, this AEC was retained, and investigation to delineate soil and confirm groundwater quality was completed.

In the southern area,

- At TP09-02 and TP09-03 (Golder 2011) VPH concentrations in soil exceed the current CSR RL/PL or CL/IL standards. Naphthalene in soil also exceeds CSR RL/PL standards at TP09-03.
- One groundwater sample (MW09-1; Golder 2011) in the southern part of the AEC had concentrations of benzene, toluene, and MTBE that exceeded CSR-DW standards. This sample also had VPH concentrations exceeding CSR AW-M standards.

In the northern area,

- Surficial soil samples (SA6 and SA7; Golder 2011) had HEPH concentrations that exceed current CSR RL/PL or CL/IL standards.
- One groundwater sample and its duplicate (MW09-8; Golder 2011) had concentrations of pyrene that exceeded CSR AW-M standards in 2009. These concentrations decreased after resampling in 2011.

The HEPH appears to be limited to a surficial area adjacent to a concrete slab; PCBs were not detected. Based on the results of the soil sampling and field observation, the soil contamination has been delineated. While the groundwater contamination has not been delineated horizontally or vertically, groundwater contamination is expected to be limited to the area of soil contamination.

Owing to the presence of soil and groundwater contamination, this area is considered an AEC. The extent of the contamination in this area of the Site is generally shallow in nature, to depths up to approximately 2.4 m below ground surface, and is estimated to have an approximate volume of 1,000 $m^3$.

## 9.2 AEC 2 – Former Maintenance Area and Current Boat Repair and Construction Operations

During historic logging operations, the former railcar and engine maintenance area (rail yard) contained several sub-areas for train and truck repair, including: the main repair shop, car shop and roundhouse. The shops historically used underground pits for maintenance. The current operations in the area include kayak manufacturing, boat construction and repair; specialty wood product construction occurs in the main repair shop and roundhouse. As part of the 2011 Golder site investigation, a chemical storage area containing drums of polyester composites, resins and acetone were present between the buildings. Staining was observed on the floors of the buildings and in the outside general storage area (Golder 2011).

Historical investigations in this area show exceedances of current CSR standards:

- Historic soil concentrations at CPT 2 and 3 (Hardy BBT 1999) exceed current CSR standards for LEPH and VPH.
- Soil at 3 m bgs in TP6 (Levelton 2002) exceeded the CSR PL/RL and CL/IL standards for barium.
- LEPH concentrations in soil above CSR CL/IL standards were measured at BH00-08 (0.2 m) and at TP4 (2.0 m and 4.0 m) (Levelton 2002).

As part of the DSI undertaken by Golder in 2011, this area was retained as an AEC, and investigation to delineate soil and confirm groundwater quality was completed. During this investigation:

- Shallow soil samples in two test pits (TP09-6 and TP11-07; Golder 2011) had LEPH concentrations exceeding CSR PL/RL and CL/IL standards, as well as HEPH concentrations exceeding CSR PL/RL standards. Exceedances of volatiles in soil including ethylbenzene, xylene, benzene, and styrene of CSR PL/RL or CL/IL standards were also found in the area.
- Soil samples in the area also had concentrations of zinc (MW09-11), and lead (TP09-05) exceeding CSR PL/RL or CL/IL standards (Golder 2011).
- In groundwater, MW09-9 and MW09-11 (Golder 2011) had concentrations of manganese that exceeded CSR-DW standards.
- Downgradient at location MW11-02 (Golder 2011) had concentrations of chloroform and arsenic that exceeded CSR standards.

Concentrations in exceedances of standards were found on the northwest side of the former maintenance building. In addition, the contamination appeared to be patchy, and not associated with one contiguous source in the former railway maintenance area. A series of test pits delineated contamination to the northwest and southeast, and a downgradient monitoring well delineates the area of contamination to the northeast. Soil contamination is not delineated towards the west (upgradient); however, based on the review of the data and the heterogeneous nature of the contamination in the soil, the contamination is not expected to be widespread and would be limited in area and depth.

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

## 9.3 AEC 3 – Former Waste Oil Storage Area and Compressor Storage Area

Previous reports indicated that the former waste oil area was located on the southeast side of the main repair shop (currently used as a waste bin storage area). In addition, Site representatives indicated that this area formerly comprised a large compressor that was prone to leaks. Historic LEPH concentrations in a soil sample at BH00-03 at 0.2 m bgs (Levelton 2002) from this area are greater than the current CSR PL/RL standard. Although a deeper sample at 0.5 m bgs was collected and found to be below CSR PL/RL standards, the hydrocarbon contamination in soil was not delineated laterally, or sampled at the water table.

As part of the DSI undertaken by Golder in 2011, the extent of hydrocarbon contamination in groundwater was delineated to confirm the extent of the contamination. As part of the DSI, an additional monitoring well was installed downgradient to the northeast. Additionally, a well was installed to investigate off-Site APECs to the southeast.

New soil samples taken as part of the 2011 DSI showed no exceedance of LEPH/HEPH standards.

In groundwater, MW11-02 located downgradient had concentrations of arsenic and chloroform exceeding CSR standards. Groundwater sampling results indicated that hydrocarbon concentrations met the CSR standards in new and existing wells in the area.

The area is confirmed to be an AEC as soil contamination has been identified. However, based on the soil sampling results in the shallow soils, and the absence of groundwater contamination, the area of soil contamination is likely limited in area. The volume of contaminated soils is estimated to be 20 $m^3$.

## 9.4 APEC 4 – Stockpile of Material from Sewage Treatment Plant

During communication with representatives from the Town of Ladysmith, it was reported that there was disposal of material from the sewage treatment plant on a portion of Lot 4. The TOL representatives confirmed that the material was removed from the ground at the Ladysmith sewage treatment plant to facilitate expansion of the plant. To their knowledge there was no contamination in this material, and that it was a very sandy material. The client provided a sketch showing the general location of the fill placement.

Since this material was placed on-site, and because the exact nature of the material is unknown, it has been retained as an APEC. Further investigation of the material is recommended.

## 9.5 APEC 5 – Fill of Unknown Quality on Lot 5

Previous investigations on-site have not included Lot 5, which is located between Lot 4 and Slack Point. In Golder's previous work (Golder 2005 and Golder 2011), several AEC's were in identified in the area of Slack Point, including the following:

- **Coal fill at Slack Point**: Coal fill material contains concentrations of PAHs, LEPH, and HEPH at concentrations above CSR PL/RL standards applicable at the time of assessment. The observed depth of the coal fill at Slack Point ranged from 6.5 m to 10 m below surface level in the most southwestern (upland) portion of Slack Point, to 16.6 metres below surface in the remainder of Slack Point. It is estimated that the total volume of coal fill present at Slack Point is approximately 725,000 $m^3$ (roughly one million tons), and that an additional 100,000 to 225,000 $m^3$ (140,000 to 300,000 tons) of coal fill likely extends into the harbour (based on an angle of repose of 15° to 30°).

- **Surficial Fill from Non-Coal Sources at Slack Point**: Surface fill materials (not including coal fill) were observed as discontinuous units across Slack Point and ranged in thickness up to a maximum of 3 m. Little to no surface fill materials were observed above the coal fill unit in the south corner of Slack Point. Samples collected from surface fill (non-coal) contained concentrations of LEPH, HEPH and metals exceeding the CSR PL/RL standards and zinc concentrations exceeding the CSR CL/IL standards applicable at the time of assessment. The extent of the surface fill materials at Slack Point, including the concentrated regions of buried metal debris and refuse (summarized below), are estimated to have an approximate volume between 34,000 $m^3$ and 67,000 $m^3$.
- **Buried Refuse and Possible Abandoned Landfill**: Regions of concentrated buried metal debris and refuse are present on Slack Point, but no underground storage tanks were identified. Areas investigated were found to have metal debris, car parts, bricks, wire cable, oil and paint cans, and wood waste. Samples collected from the area of the buried refuse contained concentrations of LEPH, HEPH and metals exceeding the CSR CL/IL standard and/or the CSR RL/PL standards.

Since previous intrusive investigations did not include Lot 5, there is a potential for fill material of similar quality to Slack Point to be located on Lot 5. It has been retained as an APEC, and further investigation of the soil quality is recommended.

## 9.6 APEC 6 – Former Shingle Mill/Sawmill (Off-Site)

Blocks B and D of DL 2016 adjacent to Site were created by infilling the water lot, in the area previously occupied by the shingle mill wharf. Based on the aerial photograph review, filling of this area appeared to take place between 1962 and 1988. The investigation by Phoenix in 1999 indicated that a small sawmill was located near to the northwest corner of the Site on Block B and D of DL 2016, adjacent to the government wharf (there has been no other reference to or evidence of a sawmill at this location). Golder infers this area to be the location of the former shingle mill.

No previous intrusive investigations occurred at Blocks B and D, other than the DSI undertaken by Golder in 2011. The DSI included soil and groundwater sampling at one location (MW09-16), with no soil or groundwater contamination identified. Results of the investigation indicated that the fill soil and groundwater did not contain any other metals or hydrocarbon concentrations exceeding the CSR standards. One sampling location, MW09-05 located on the northeast area of the Site contained benzene exceeding the CSR standard, and may be attributable to this off-Site APEC. It is noted that the sampling program was limited, and additional sample collection along the filled area may be advisable to provide greater certainty. As such, this area is not considered an AEC; however, retained as an off-site APEC.

## 9.7 AEC 7 – Former Log Dump (Lot 17G; Off-Site)

The former log dump on Lot 17G was established in the 1930s and used to transport logs from railcars to the Harbour for bundling and shipping. The area is an extension of the natural foreshore and therefore contains fill materials of unknown quality. The log dump was reported to have been removed in 1992 (EBA 1994).

Historic investigations found concentrations of Mineral Oil and Grease (MOG) inferred to be above current CSR RL/PL and CL/IL standards for LEPH, at EBA's Test Pit 14 (EBA 1994). At Test Pit 11, concentrations of MOG are inferred to be above current CSR RL/PL standards for LEPH.

As part of the DSI undertaken by Golder in 2011, observations of Site soil conditions indicated hydrocarbon like odours, sheet and product droplets, likely indicative of contamination. As such, several boreholes, and subsequent monitoring wells, were completed as step outs along the shoreline to the northwest. Soil and groundwater contamination were confirmed at several of these locations. Based on the results of the DSI and historical investigation activities, the contamination has been delineated along the shoreline. In addition, as part of the sediment sampling program in Ladysmith Harbour, several sediment samples were collected near to the shoreline, adjacent to the log dump area. No indication of hydrocarbon contamination was observed during the sediment sampling program (Golder 2011c), and the contamination is inferred to be limited to the near shore filled area. However, there was uncertainty as to whether this contamination was from former log dump, filling activities, or subsurface migration to the area from the former railway yard activities.

To address this issue, a deep groundwater well was completed in the bedrock, on the bedrock terrace located up gradient from the former log dump, and down gradient of the former maintenance building (MW11-02; Golder 2011). This well was installed at a depth intersecting the elevation of the contamination observed at the log dump. This well had concentrations of arsenic and chloroform exceeding CSR standards, but no hydrocarbon exceedances. Consequently, it was concluded that the contamination at the former log dump appears to be associated with log dump or filling activities in the filled foreshore area, and is not related to the former railway maintenance area. As such, the area is generally delineated to the southwest; however, it is not known whether contamination extends onto Lot 5. The former log dump area has been retained as an AEC.

The extent of the contamination in this area of the Site was observed to be between 2.5 and 5.5 m below ground surface. The contamination is estimated to have an approximate volume of 5,800 $m^3$.

## 9.8 Summary of Issues of Environmental Concern

The issues of environmental concern identified in this Stage 1 ESA are outlined in the following table:

| AEC or APEC | Summary | PCOC, COC |
|---|---|---|
| **On-Site** | | |
| AEC 1 – Former fuel pump islands, ASTs and possible PCB Storage. | Owing to the presence of soil and groundwater contamination, this area is considered an AEC. The extent of the contamination in this area of the Site is generally shallow in nature, to depths up to approximately 2.4 m below ground surface, and is estimated to have an approximate volume of 1,000 $m^3$ | Soil: BTEX, VPH, LEPH, HEPH<br>Groundwater: BTEC, VPH, LEPH<br>Soil Vapour: VPHv, xylene, naphthalene |
| AEC 2 – Former Maintenance Area and Current Boat Repair and Construction Operations. | This area is considered an AEC. The extent of soil contamination in this area is generally shallow, to depths up to 4 metres. The volume of contaminated soils in the area to the northwest of the former maintenance building is estimated to be 2,000 $m^3$ | Soil: BTEX, VPH, LEPH, HEPH, styrene, |
| AEC 3 – Former Waste Oil Storage Area and Compressor Storage Area. | The area is confirmed to be an AEC as soil contamination has been identified. However, based on the soil sampling results in the shallow soils, and the absence of groundwater contamination, the area of soil contamination is likely limited in area. The volume of contaminated soils is estimated to be 20 $m^3$ | Soil: LEPH |
| APEC 4 – Stockpile of material from around sewage treatment plant | Fill of unknown quality was placed on-site, removed from the ground at the Ladysmith sewage treatment plant to facilitate expansion of the plant. While the fill is not known to be contaminated, it has been retained as an APEC, and further investigation of the material is recommended. | Soil: LEPH, HEPH, PAH, metals |
| APEC 5 – Fill of unknown quality on Lot 5 | Lot 5 is adjacent to Slack Point, where coal fill and surficial fill were previously identified with concentrations of LEPH, HEPH, metals, and PAHs above CSR standards. Since previous intrusive investigations did not include Lot 5, there is a potential for fill material of similar quality to Slack Point to be located on Lot 5. It has been retained as an APEC, and further investigation of the soil quality is recommended. | Soil: LEPH, HEPH, metals, PAHs |
| **Off-Site** | | |
| APEC 6 – Fill Material at Block B and D of DL 2016 (former Location of the Shingle Mill / Sawmill) | No soil or groundwater contamination identified during previous site investigations, as such, this area is not considered an AEC. However, the sampling program was limited in area, and additional sample collection along the filled area may be warranted, therefore, remains an APEC. | Soil: LEPH/HEPH, PAH, and metals<br>Groundwater: LEPH/HEPH, PAH, metals<br>Soil Vapour: VPHv, BTEX, naphthalene |
| AEC 7 – Former Log Dump (Lot 17G). | Contamination was identified during previous site investigations, but appears to be limited to a particular range of depth and may be associated with the log dump or filling activities. The extent of the contamination in this area of the Site was observed to be between 2.5 and 5.5 m below ground surface. The contamination is estimated to have an approximate volume of 5,800 $m^3$ | Soil: VPH, LEPH<br>Groundwater: PAH<br>Soil Vapour: VPHv |

Based on all the information obtained as part of this Stage 1 PSI, the following other Special Attention Items were or are likely identified on the Site:

- asbestos
- PCBs
- Lead

These Special Attention Items are not considered to represent an issue of potential environmental concern provided they are managed in accordance with applicable environmental, health, and safety legislation.

# 10.0 RECOMMENDATIONS

To address the issue(s) of potential environmental concern identified, Golder recommends the following:

- Conducting a Detailed Site Investigation to further investigate soil, groundwater and soil vapour quality at identified AECs.

# 11.0 QUALIFICATIONS OF SITE ASSESSOR

Pursuant to Section 63 of the Contaminated Sites Regulation (CSR), Golder confirms that this report has been prepared in accordance with the applicable sections of the CSR (Part 14) and related BC ENV technical guidance (TG) documents.

This report was authored by Robyn Chatwin-Davies, MASc, EIT, and by Dawn Flotten, PEng, CSAP.
Robyn Chatwin-Davies is an environmental engineer-in-training with 2 years experience, and Dawn Flotten is a senior environmental engineer with over 23 years of experience in the assessment of contaminated sites, and is familiar with the assessments carried out at the Ladysmith Harbour.

## 12.0 CLOSURE

We trust that this report meets your immediate requirements. If you have any questions regarding the content of this report, please do not hesitate to contact this office.

**Golder Associates Ltd.**

PROFESSIONAL PROVINCE OF D.M. FLOTTEN 25449 BRITISH COLUMBIA ENGINEER

March 2, 2020

Robyn Chatwin-Davies, MASc, EIT
*Environmental Engineer*

Dawn Flotten, PEng, CSAP
*Principal, Senior Environmental Engineer*

RCD/DF/asd



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LEGEND

SITE BOUNDARY

NOT FOR CONSTRUCTION

0 1,000 2,000

1:50,000 METRES

NOTE(S)

1. LOCATIONS ARE APPROXIMATE.

REFERENCE(S)

1. TOPOGRAPHIC MAP © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED.

COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT
TOWN OF LADYSMITH

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR

TITLE
**KEY PLAN**

CONSULTANT

GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-27 |
| DESIGNED | MN |
| PREPARED | MH/CDAB |
| REVIEWED | MN |
| APPROVED | DF |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | A | 1 |

PATH: N:\Client\Town of Ladysmith\Ladysmith Harbour\99_PROJECTS\18109842\1000\02_PRODUCTION\MXD\Report\18109842_1000_FIG 1_Key_Plan.mxd PRINTED ON: 2020-02-27 AT: 10:45:07 AM

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

25mm


**LEGEND**

- SITE BOUNDARY
- Filled Foreshore
- Uplands
- Water Lot

**NOT FOR CONSTRUCTION**

0 125 250

1:6,000 METRES

**NOTE(S)**

1. LOCATIONS ARE APPROXIMATE.

**REFERENCE(S)**

1. IMAGERY COPYRIGHT © 20191219 ESRI AND ITS LICENSORS. SOURCE: ESRI. USED UNDER LICENSE, ALL RIGHTS RESERVED.
2. OTHER BASEDATA OBTAINED FROM WMS IN THE PROVINCE OF BRITISH COLUMBIA.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT
TOWN OF LADYSMITH

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR

TITLE
**SITE PLAN**

CONSULTANT

GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-27 |
| DESIGNED | MN |
| PREPARED | MH/CDAB |
| REVIEWED | MN |
| APPROVED | DF |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | A | 2 |

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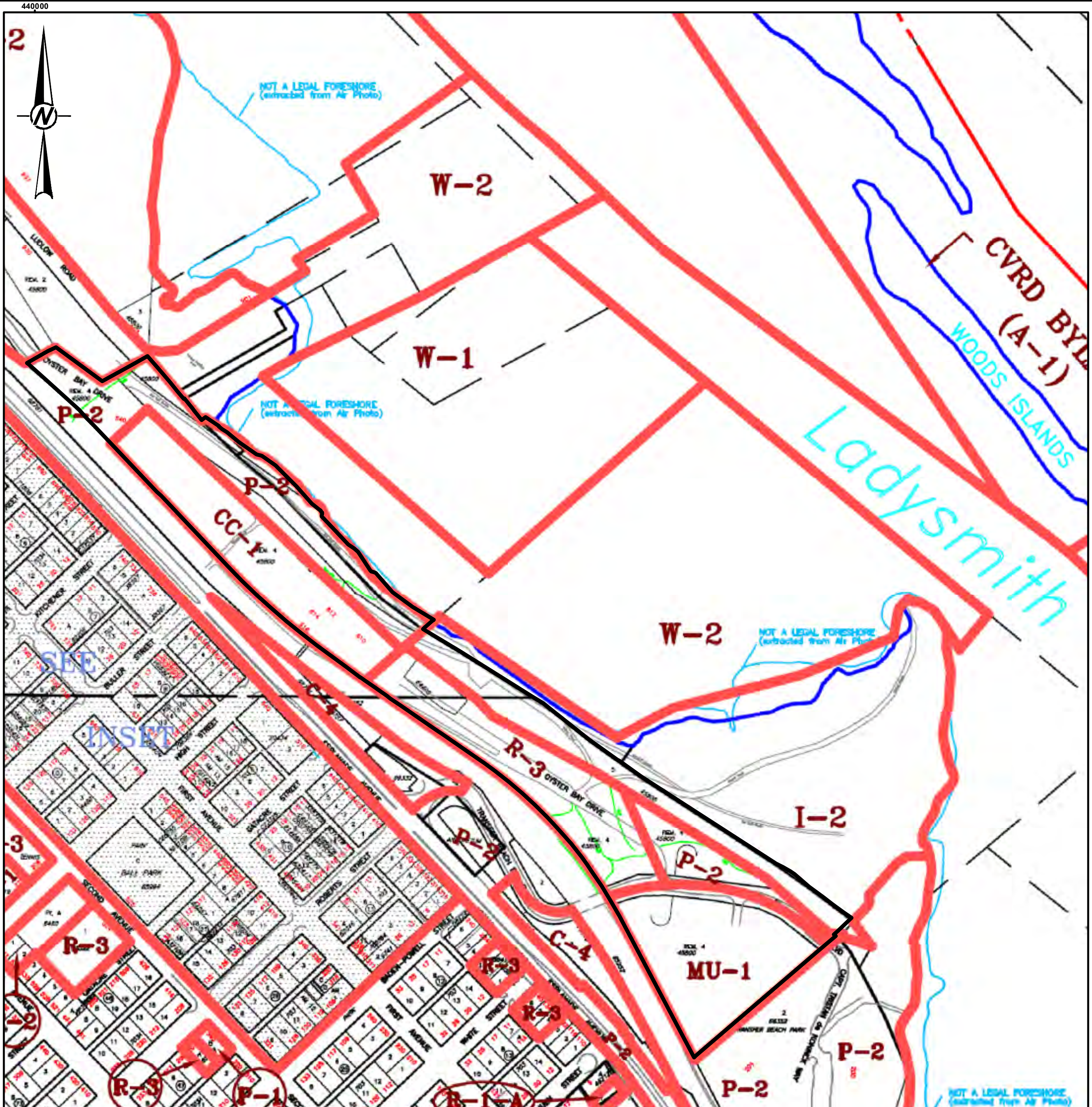
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

25mm




**LEGEND**

SITE BOUNDARY

NOT FOR CONSTRUCTION

0 125 250

1:6,000 METRES

**NOTE(S)**

1. LOCATIONS ARE APPROXIMATE.

**REFERENCE(S)**

1. IMAGE OBTAINED FROM THE TOWN OF LADYSMITH ZONING BYLAW.

COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT
TOWN OF LADYSMITH

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR

TITLE
**SURROUNDING LAND USE**

CONSULTANT

GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-27 |
| DESIGNED | MN |
| PREPARED | MH/CDAB |
| REVIEWED | MN |
| APPROVED | DF |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | A | 3 |


**LEGEND**

- SITE BOUNDARY
- LOT BOUNDARY
- HISTORIC FEATURE

**NOTES**

1. HISTORIC LOCATIONS ARE APPROXIMATE.

**REFERENCES**

AERIAL IMAGE © 2019 GOOGLE OBTAINED FROM GOOGLE EARTH PRO, USED UNDER LICENSE.
IMAGE DATE: 8/18/2016. GOOGLE EARTH IMAGE IS NOT TO SCALE.

LOT BOUNDARIES OBTAINED FROM BC LAND TITLE AND SURVEY ON 2019-12-18

DATUM: NAD83, PROJECTION: UTM ZONE 10

0 25 50
1:1,000 METRES

0 50 100
1:2,000 METRES



CLIENT
TOWN OF LADYSMITH

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
**SITE PLAN WITH HISTORICAL FEATURES**

CONSULTANT

GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-26 |
| DESIGNED | MN |
| PREPARED | RTJ |
| REVIEWED | GG |
| APPROVED | DF |

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | 0 | 4 |

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

Path: \\golder.gds\gal\Kelowna\CAD-GIS\Client\TOWN OF LADYSMITH\Ladysmith Harbour\99_PROJECTS\18109842_Enviro\1000\(Task)\18109842_1000\02_PRODUCTION\DWG\ | File Name: 18109842_1000 - Site.dwg | Last Edited By: ryjames Date: 2020-01-16 Time:12:17:26 PM | Printed By: RYJames Date: 2020-02-26 Time:4:09:31 PM


**LEGEND**
- SITE BOUNDARY
- LOT BOUNDARY
- MONITORING WELL LOCATION
- BOREHOLE LOCATION
- TEST PIT LOCATION
- SURFACE SAMPLE LOCATION

**NOTES**
1. SAMPLING LOCATIONS ARE APPROXIMATE.

**REFERENCES**
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IMAGE DATE: 8/18/2016. GOOGLE EARTH IMAGE IS NOT TO SCALE.

LOT BOUNDARIES OBTAINED FROM BC LAND TITLE AND SURVEY ON 2019-12-18

DATUM: NAD83, PROJECTION: UTM ZONE 10

0 25 50
1:1,000 METRES

0 50 100
1:2,000 METRES



CLIENT
TOWN OF LADYSMITH

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
**SITE PLAN SHOWING INVESTIGATION LOCATIONS**

CONSULTANT
GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-26 |
| DESIGNED | MN |
| PREPARED | RTJ |
| REVIEWED | GG |
| APPROVED | DF |

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | 0 | 5 |


| Location | MW09-1 |
|---|---|
| Date Sampled | 11/10/2009 |
| Depth of Sample (m) | 0.6-0.76 |
| Moisture (%) | 18.5 |
| pH | 5.7 |
| Metals | < |

| Location | MW09-3 |
|---|---|
| Date Sampled | 11/10/2009 |
| Depth of Sample (m) | 0.6-0.76 |
| Moisture (%) | 8.4 |
| pH | 5.7 |
| Metals | < |

| Location | TP09-01 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 0.6-0.8 |
| Moisture (%) | - |
| pH | 5.9 |
| Metals | < |

| Location | TP09-04 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 1-1.2 |
| Moisture (%) | 17.0 |
| pH | 7.2 |
| Arsenic | [illegible] |
| Metals | < |

| Location | MW09-5 | |
|---|---|---|
| Date Sampled | 11/11/2009 | |
| Depth of Sample (m) | 0.6-0.8 | 1.4-1.6 |
| Moisture (%) | 16.8 | - |
| pH | 5.9 | 6.2 |
| Metals | < | < |

| Location | MW09-16 | | |
|---|---|---|---|
| Date Sampled | 14/11/2009 | | |
| Depth of Sample (m) | 1.2-1.37 | 3.35-3.5 | 3.35-3.5 |
| Moisture (%) | 10.3 | 18.7 | 18.1 |
| pH | 6.3 | 7.3 | 7.5 |
| Metals | < | < | < |

| Location | MW09-9 |
|---|---|
| Date Sampled | 13/11/2009 |
| Depth of Sample (m) | 1.5-1.7 |
| Moisture (%) | 12.6 |
| pH | 8.1 |
| Metals | < |

| Location | MW09-10 | |
|---|---|---|
| Date Sampled | 13/11/2009 | |
| Depth of Sample (m) | 0.6-0.76 | 1.5-1.7 |
| Moisture (%) | 8.50 | 15.40 |
| pH | 7.6 | 7.7 |
| Metals | < | < |

| Location | MW09-11 |
|---|---|
| Date Sampled | 13/11/2009 |
| Depth of Sample (m) | 0.3-0.4 |
| Moisture (%) | 21.20 |
| pH | 6.6 |
| Metals | < |
| Zinc | [illegible] |

| Location | KE SA1 |
|---|---|
| Date Sampled | 25/11/2009 |
| Depth of Sample (m) | 0.3-0.4 |
| Moisture (%) | 9.0 |
| pH | 6.2 |
| Metals | < |

| Location | KE SA2 |
|---|---|
| Date Sampled | 25/11/2009 |
| Depth of Sample (m) | 0.2-0.3 |
| Moisture (%) | 10.8 |
| pH | 6 |
| Metals | < |

| Location | KE SA4 |
|---|---|
| Date Sampled | 25/11/2009 |
| Depth of Sample (m) | 0.2-0.3 |
| Moisture (%) | 6.90 |
| pH | 6.1 |
| Metals | < |

| Location | TP09-06 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 0.3-0.5 |
| Moisture (%) | - |
| pH | 7.9 |
| Lead | [illegible] |
| Metals | < |

| Location | MW09-06 |
|---|---|
| Date Sampled | 11/12/2009 |
| Depth of Sample (m) | 2.0-2.2 |
| Moisture (%) | - |
| pH | 6.8 |
| Metals | < |

| Location | TP09-09 | |
|---|---|---|
| Date Sampled | 15/12/2009 | |
| Depth of Sample (m) | 0.4-0.6 | 1.0-1.2 |
| Moisture (%) | 15.9 | 16.3 |
| pH | 7.2 | 7.4 |
| Metals | < | < |

| Location | BH09-13 |
|---|---|
| Date Sampled | 14/11/2009 |
| Depth of Sample (m) | 3.8-4.0 |
| Moisture (%) | 19.3 |
| pH | 7.4 |
| Arsenic | [illegible] |
| Metals | < |

| Location | BH09-14 |
|---|---|
| Date Sampled | 14/11/2009 |
| Depth of Sample (m) | 4.1-4.3 |
| Moisture (%) | 9.5 |
| pH | 8.1 |
| Metals | < |

| Location | MW09-7 |
|---|---|
| Date Sampled | 11/12/2009 |
| Depth of Sample (m) | 0.5-0.7 |
| Moisture (%) | - |
| pH | 6.3 |
| Metals | < |

| Location | MW09-8 | |
|---|---|---|
| Date Sampled | 13/11/2009 | |
| Depth of Sample (m) | 2.9-3.0 | |
| Moisture (%) | 20.0 | 24.3 |
| pH | 8 | 7.9 |
| Metals | < | < |

| Location | TP09-10 | |
|---|---|---|
| Date Sampled | 15/12/2009 | |
| Depth of Sample (m) | 0.3-0.6 | 1.6-1.8 |
| Moisture (%) | 9.0 | 7.2 |
| pH | 7.5 | 6.9 |
| Metals | < | < |

| Location | TP09-11 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 0.2-0.4 |
| Moisture (%) | 13.2 |
| pH | 6.7 |
| Metals | < |

| Location | TP09-12 | | |
|---|---|---|---|
| Date Sampled | 15/12/2009 | | |
| Depth of Sample (m) | 0.1-0.3 | 0.1-0.3 | 1.3-1.5 |
| Moisture (%) | 15.0 | 18.4 | 12.4 |
| pH | 6.8 | 6.8 | 7.3 |
| Metals | < | < | < |

| Location | CPT 1 |
|---|---|
| Date Sampled | 18/09/1990 |
| Depth of Sample (m) | 1.55 |
| pH | 4.87 |
| Metals | < |

| Location | CPT 4 |
|---|---|
| Date Sampled | 18/09/1990 |
| Depth of Sample (m) | 2.5 |
| pH | 7.2 |
| Metals | < |

| Location | CPT 5 |
|---|---|
| Date Sampled | 18/09/1990 |
| Depth of Sample (m) | 0.7 |
| pH | 6.52 |
| Metals | < |

| Location | TP 1 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 1 |
| pH | 6.2 |
| Metals | < |

| Location | TP 2 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 1 |
| pH | 6.5 |
| Metals | < |

| Location | TP 3 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 1 |
| pH | 6.5 |
| Metals | < |

| Location | TP 4 | |
|---|---|---|
| Date Sampled | 18/07/2000 | |
| Depth of Sample (m) | 2.00 | 4.00 |
| pH | 6.8 | 6.3 |
| Metals | < | < |

| Location | TP 6 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 3 |
| pH | 8 |
| Barium | [illegible] |
| Metals | < |

| Location | TP 12 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 3.00 |
| pH | - |
| Metals | < |

| Location | LOT 11G |
|---|---|
| Date Sampled | 21/06/2000 |
| Depth of Sample (m) | 0.5 |
| pH | 6.4 |
| Chromium | [illegible] |
| Metals | < |

**LEGEND**

- SITE BOUNDARY
- LOT BOUNDARY
- MONITORING WELL LOCATION
- BOREHOLE LOCATION
- TEST PIT LOCATION
- SURFACE SAMPLE LOCATION
- SOIL PARAMETER CONCENTRATION MEETS APPLICABLE STANDARDS
- SOIL PARAMETER CONCENTRATION IS GREATER THAN APPLICABLE CSR IL, CSR CL AND CSR PL STANDARDS

**TABLE**

| | |
|---|---|
| 10 | CONCENTRATION IN SOIL EXCEEDS APPLICABLE CSR PL STANDARD |
| 10 | CONCENTRATION IN SOIL EXCEEDS APPLICABLE CSR CL STANDARD |
| 10 | CONCENTRATION IN SOIL EXCEEDS APPLICABLE CSR IL STANDARD |

**ABBREVIATIONS**

| | |
|---|---|
| IL | INDUSTRIAL LAND USE |
| CL | COMMERCIAL LAND USE |
| PL | PARK LAND USE |
| FD | FIELD DUPLICATE |
| FDA | FIELD DUPLICATE AVAILABLE |

**NOTES**

1. ALL VALUES ARE IN MICROGRAMS PER LITRE (μg/g), UNLESS OTHERWISE NOTED.
2. SAMPLING LOCATIONS ARE APPROXIMATE.

**REFERENCES**

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0 25 50
1:1,000 METRES

0 50 100
1:2,000 METRES





CLIENT
TOWN OF LADYSMITH

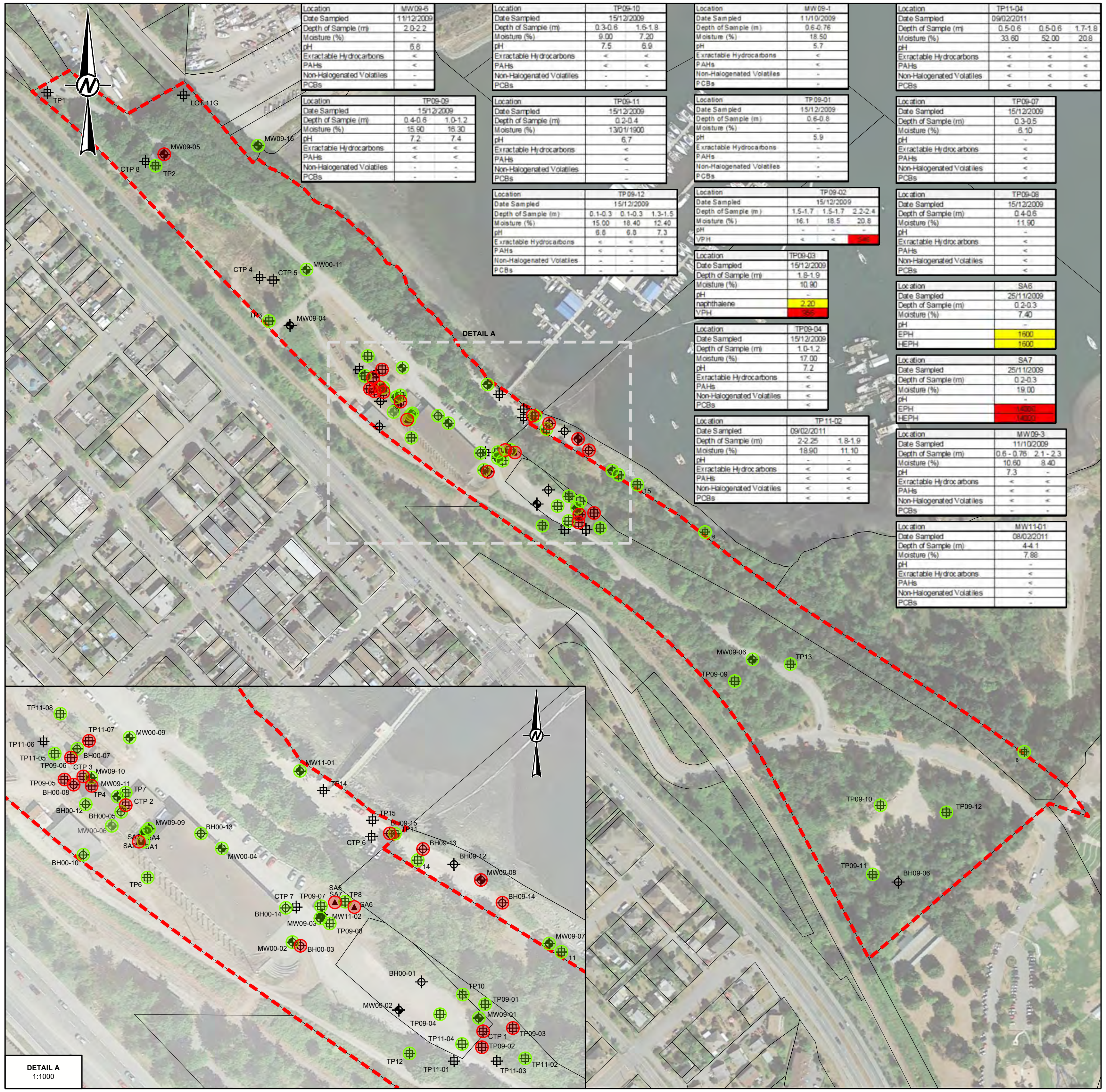
CONSULTANT
GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-26 |
| DESIGNED | MN |
| PREPARED | RTJ |
| REVIEWED | GG |
| APPROVED | DF |

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
**SOIL ANALYTICAL RESULTS - METALS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | 0 | 6A |




| Location | MW09-6 |
|---|---|
| Date Sampled | 11/12/2009 |
| Depth of Sample (m) | 2.0-2.2 |
| Moisture (%) | - |
| pH | 6.8 |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | - |
| PCBs | - |

| Location | TP09-09 | |
|---|---|---|
| Date Sampled | 15/12/2009 | |
| Depth of Sample (m) | 0.4-0.6 | 1.0-1.2 |
| Moisture (%) | 15.90 | 16.30 |
| pH | 7.2 | 7.4 |
| Exractable Hydrocarbons | < | < |
| PAHs | < | < |
| Non-Halogenated Volatiles | - | - |
| PCBs | - | - |

| Location | TP09-10 | |
|---|---|---|
| Date Sampled | 15/12/2009 | |
| Depth of Sample (m) | 0.3-0.6 | 1.6-1.8 |
| Moisture (%) | 9.00 | 7.20 |
| pH | 7.5 | 6.9 |
| Exractable Hydrocarbons | < | < |
| PAHs | < | < |
| Non-Halogenated Volatiles | - | - |
| PCBs | - | - |

| Location | TP09-11 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 0.2-0.4 |
| Moisture (%) | 13/01/1900 |
| pH | 6.7 |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | - |
| PCBs | - |

| Location | TP09-12 | | |
|---|---|---|---|
| Date Sampled | 15/12/2009 | | |
| Depth of Sample (m) | 0.1-0.3 | 0.1-0.3 | 1.3-1.5 |
| Moisture (%) | 15.00 | 18.40 | 12.40 |
| pH | 6.8 | 6.8 | 7.3 |
| Exractable Hydrocarbons | < | < | < |
| PAHs | < | < | < |
| Non-Halogenated Volatiles | - | - | - |
| PCBs | - | - | - |

| Location | MW09-1 |
|---|---|
| Date Sampled | 11/10/2009 |
| Depth of Sample (m) | 0.6-0.76 |
| Moisture (%) | 18.50 |
| pH | 5.7 |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | - |
| PCBs | - |

| Location | TP09-01 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 0.6-0.8 |
| Moisture (%) | - |
| pH | 5.9 |
| Exractable Hydrocarbons | - |
| PAHs | - |
| Non-Halogenated Volatiles | - |
| PCBs | - |

| Location | TP09-02 | | |
|---|---|---|---|
| Date Sampled | 15/12/2009 | | |
| Depth of Sample (m) | 1.5-1.7 | 1.5-1.7 | 2.2-2.4 |
| Moisture (%) | 16.1 | 18.5 | 20.8 |
| pH | - | - | - |
| VPH | < | < | [illegible] |

| Location | TP09-03 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 1.8-1.9 |
| Moisture (%) | 10.90 |
| pH | - |
| naphthalene | 2.20 |
| VPH | [illegible] |

| Location | TP09-04 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 1.0-1.2 |
| Moisture (%) | 17.00 |
| pH | 7.2 |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | < |
| PCBs | < |

| Location | TP11-02 | |
|---|---|---|
| Date Sampled | 09/02/2011 | |
| Depth of Sample (m) | 2-2.25 | 1.8-1.9 |
| Moisture (%) | 18.90 | 11.10 |
| pH | - | - |
| Exractable Hydrocarbons | < | < |
| PAHs | < | < |
| Non-Halogenated Volatiles | < | < |
| PCBs | < | < |

| Location | TP11-04 | | |
|---|---|---|---|
| Date Sampled | 09/02/2011 | | |
| Depth of Sample (m) | 0.5-0.6 | 0.5-0.6 | 1.7-1.8 |
| Moisture (%) | 33.60 | 52.00 | 20.8 |
| pH | - | - | - |
| Exractable Hydrocarbons | < | < | < |
| PAHs | < | < | < |
| Non-Halogenated Volatiles | < | < | < |
| PCBs | < | < | < |

| Location | TP09-07 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 0.3-0.5 |
| Moisture (%) | 6.10 |
| pH | - |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | < |
| PCBs | < |

| Location | TP09-08 |
|---|---|
| Date Sampled | 15/12/2009 |
| Depth of Sample (m) | 0.4-0.6 |
| Moisture (%) | 11.90 |
| pH | - |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | < |
| PCBs | < |

| Location | SA6 |
|---|---|
| Date Sampled | 25/11/2009 |
| Depth of Sample (m) | 0.2-0.3 |
| Moisture (%) | 7.40 |
| pH | - |
| EPH | 1600 |
| HEPH | 1600 |

| Location | SA7 |
|---|---|
| Date Sampled | 25/11/2009 |
| Depth of Sample (m) | 0.2-0.3 |
| Moisture (%) | 19.00 |
| pH | - |
| EPH | 14000 |
| HEPH | 14000 |

| Location | MW09-3 | |
|---|---|---|
| Date Sampled | 11/10/2009 | |
| Depth of Sample (m) | 0.6 - 0.76 | 2.1 - 2.3 |
| Moisture (%) | 10.60 | 8.40 |
| pH | 7.3 | - |
| Exractable Hydrocarbons | < | < |
| PAHs | < | < |
| Non-Halogenated Volatiles | < | < |
| PCBs | - | - |

| Location | MW11-01 |
|---|---|
| Date Sampled | 08/02/2011 |
| Depth of Sample (m) | 4-4.1 |
| Moisture (%) | 7.88 |
| pH | - |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | < |
| PCBs | - |

| Location | MW09-16 | | |
|---|---|---|---|
| Date Sampled | 14/11/2009 | | |
| Depth of Sample (m) | 1.2 - 1.37 | 3.35 - 3.50 | 3.35 - 3.50 |
| Moisture (%) | 10.30 | 18.70 | 18.1 |
| pH | 6.3 | 7.3 | 7.5 |
| Exractable Hydrocarbons | < | < | < |
| PAHs | < | < | < |
| Non-Halogenated Volatiles | - | - | - |
| PCBs | - | - | - |

| Location | MW09-5 | |
|---|---|---|
| Date Sampled | 11/11/2009 | |
| Depth of Sample (m) | 1.4 - 1.6 | 7.1-7.3 |
| Moisture (%) | | 12.90 |
| pH | 6.2 | - |
| Benzene | < | 0.12 |

| Location | MW09-9 |
|---|---|
| Date Sampled | 13/11/2009 |
| Depth of Sample (m) | 1.5-1.7 |
| Moisture (%) | 12.60 |
| pH | 8.1 |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | - |
| PCBs | - |

| Location | MW09-10 | |
|---|---|---|
| Date Sampled | 13/11/2009 | |
| Depth of Sample (m) | 0.6 - 0.76 | 1.5 - 1.7 |
| Moisture (%) | 8.50 | 15.40 |
| pH | 7.6 | 7.7 |
| Exractable Hydrocarbons | < | < |
| PAHs | < | < |
| Non-Halogenated Volatiles | - | - |
| PCBs | - | - |

| Location | MW09-11 |
|---|---|
| Date Sampled | 13/11/2009 |
| Depth of Sample (m) | 0.3-0.4 |
| Moisture (%) | 21.20 |
| pH | 6.6 |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | - |
| PCBs | - |

| Location | SA1 |
|---|---|
| Date Sampled | 25/11/2009 |
| Depth of Sample (m) | 0.2-0.3 |
| Moisture (%) | 9.00 |
| pH | 6.2 |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | < |
| PCBs | - |

| Location | SA2 |
|---|---|
| Date Sampled | 25/11/2009 |
| Depth of Sample (m) | 0.2-0.3 |
| Moisture (%) | 10.80 |
| pH | 6 |
| benzene | 0.08 |
| styrene | 29 |

| Location | SA4 |
|---|---|
| Date Sampled | 25/11/2009 |
| Depth of Sample (m) | 0.2-0.3 |
| Moisture (%) | 6.90 |
| pH | 6.1 |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | < |
| PCBs | - |

| Location | TP09-05 | | |
|---|---|---|---|
| Date Sampled | 15/12/2009 | | |
| Depth of Sample (m) | 0.3-0.5 | 0.7-0.9 | 1.6-1.8 |
| Moisture (%) | - | 22.40 | 17.9 |
| pH | 7.9 | - | - |
| ethylbenzene | [illegible] | < | < |
| Total xylene | [illegible] | < | < |

| Location | TP09-06 | | |
|---|---|---|---|
| Date Sampled | 15/12/2009 | | |
| Depth of Sample (m) | 0.9-1.1 | 0.9-1.1 | 1.7-1.9 |
| Moisture (%) | 19.50 | 19.80 | 19.2 |
| pH | - | - | - |
| EPH10-19 | [illegible] | [illegible] | < |
| EPH19-32 | 1500 | 2000 | < |
| LEPH | [illegible] | [illegible] | < |
| HEPH | 1500 | 2000 | < |

| Location | TP11-05 |
|---|---|
| Date Sampled | 11/02/2009 |
| Depth of Sample (m) | 0.3-0.4 |
| Moisture (%) | 15.50 |
| pH | - |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | < |
| PCBs | - |

| Location | TP11-07 | | |
|---|---|---|---|
| Date Sampled | 15/12/2009 | | |
| Depth of Sample (m) | 1.5-1.6 | 2.8-3.0 | 2.8-3.0 |
| Moisture (%) | 22.80 | 6.71 | 10.5 |
| pH | - | - | - |
| EPH10-19 | [illegible] | < | < |
| EPH19-32 | 1650 | < | < |
| LEPH | [illegible] | < | < |
| HEPH | 1650 | < | < |

| Location | TP11-08 |
|---|---|
| Date Sampled | 11/02/2009 |
| Depth of Sample (m) | 1.4-1.5 |
| Moisture (%) | 16.30 |
| pH | - |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | < |
| PCBs | - |

| Location | MW09-5 |
|---|---|
| Date Sampled | 11/11/2009 |
| Depth of Sample (m) | 0.6-0.8 |
| Moisture (%) | 16.80 |
| pH | 5.9 |
| Exractable Hydrocarbons | < |
| PAHs | < |
| Non-Halogenated Volatiles | < |
| PCBs | - |

| Location | MW09-7 | | |
|---|---|---|---|
| Date Sampled | 11/12/2009 | | |
| Depth of Sample (m) | 1.2 - 1.37 | 3.35 - 3.50 | 3.35 - 3.50 |
| Moisture (%) | - | 16.30 | 15.7 |
| pH | 6.3 | - | - |
| Exractable Hydrocarbons | < | < | < |
| PAHs | < | < | < |
| Non-Halogenated Volatiles | - | - | - |
| PCBs | - | - | - |

| Location | MW09-8 | | |
|---|---|---|---|
| Date Sampled | 13/11/2009 | | |
| Depth of Sample (m) | 2.9 - 3.0 | 2.9 - 3.0 | 3.9 - 5.0 |
| Moisture (%) | 20.00 | 24.30 | 11.4 |
| pH | 8 | 7.9 | - |
| EPH10-19 | 1900 | [illegible] | < |
| EPH19-32 | 2000 | [illegible] | < |
| LEPH | 1900 | [illegible] | < |
| HEPH | 2000 | [illegible] | < |
| VPH | [illegible] | < | < |

| Location | BH09-13 |
|---|---|
| Date Sampled | 14/11/2009 |
| Depth of Sample (m) | 3.8-4.0 |
| Moisture (%) | 19.30 |
| pH | 7.4 |
| EPH10-19 | [illegible] |
| EPH19-32 | [illegible] |
| LEPH | [illegible] |
| HEPH | [illegible] |

| Location | BH09-14 |
|---|---|
| Date Sampled | 14/11/2009 |
| Depth of Sample (m) | 4.1-4.3 |
| Moisture (%) | 9.50 |
| pH | 8.1 |
| EPH10-19 | [illegible] |
| EPH19-32 | 1800 |
| LEPH | [illegible] |
| HEPH | 1800 |

| Location | BH09-15 | |
|---|---|---|
| Date Sampled | 14/11/2009 | |
| Depth of Sample (m) | 3.65-3.8 | |
| Moisture (%) | 14.50 | 11.70 |
| pH | - | - |
| EPH10-19 | [illegible] | [illegible] |
| EPH19-32 | 3100 | 3300 |
| LEPH | [illegible] | [illegible] |
| HEPH | 3100 | 3300 |

| Location | CPT-1 |
|---|---|
| Date Sampled | 18/09/1990 |
| Depth of Sample (m) | 1.55 |
| pH | 4.87 |
| Benzene | 1.02 |
| Toluene | [illegible] |
| Total Xylene | [illegible] |

| Location | CPT-2 |
|---|---|
| Date Sampled | 18/09/1990 |
| Depth of Sample (m) | 1.80 |
| pH | - |
| Total Extractable Hydrocarbons | [illegible] |

| Location | CPT-3 | |
|---|---|---|
| Date Sampled | 18/09/1990 | |
| Depth of Sample (m) | 1 | 1.8 |
| pH | - | - |
| Oil and Grease | [illegible] | [illegible] |
| Total Extractable Hydrocarbons | - | [illegible] |

| Location | TP-2 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 1 |
| pH | 6.5 |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | TP-3 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 3 |
| pH | - |
| Non-Halogenated Volatiles | < |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | TP-4 | |
|---|---|---|
| Date Sampled | 18/07/2000 | |
| Depth of Sample (m) | 2 | 4 |
| pH | 6.8 | 6.3 |
| EPH10-19 | [illegible] | [illegible] |

| Location | TP-6 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 3 |
| pH | 8 |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | TP-7 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 3 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | TP-8 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | - |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | - |
| General | - |

| Location | TP-10 | |
|---|---|---|
| Date Sampled | 18/07/2000 | |
| Depth of Sample (m) | 2 | 2 |
| pH | - | - |
| Non-Halogenated Volatiles | < | < |
| PAHs | - | - |
| Extractable Hydrocarbons | < | < |
| General | - | - |

| Location | TP-11 | |
|---|---|---|
| Date Sampled | 18/07/2000 | |
| Depth of Sample (m) | 1 | 1 |
| pH | - | - |
| Non-Halogenated Volatiles | - | - |
| PAHs | - | - |
| Extractable Hydrocarbons | < | < |
| General | - | - |

| Location | TP-12 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 3 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | TP-13 |
|---|---|
| Date Sampled | 18/07/2000 |
| Depth of Sample (m) | 1 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | MW00-02 |
|---|---|
| Date Sampled | 20/09/2000 |
| Depth of Sample (m) | 1.4 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | BH00-03 | |
|---|---|---|
| Date Sampled | 20/09/2000 | |
| Depth of Sample (m) | 0.2 | 0.5 |
| pH | - | |
| EPH10-19 | 1350 | 875 |
| EPH19-32 | 1450 | 680 |

| Location | MW00-04 |
|---|---|
| Date Sampled | 20/09/2000 |
| Depth of Sample (m) | 1.4 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | BH00-05 |
|---|---|
| Date Sampled | 20/09/2000 |
| Depth of Sample (m) | 2.6 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | MW00-06 |
|---|---|
| Date Sampled | 20/09/2000 |
| Depth of Sample (m) | 1.5 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | BH00-07 | |
|---|---|---|
| Date Sampled | 20/09/2000 | |
| Depth of Sample (m) | 1.5 | 2.9 |
| pH | | |
| Non-Halogenated Volatiles | - | - |
| PAHs | - | - |
| Extractable Hydrocarbons | < | < |
| General | - | - |

| Location | BH00-08 | | |
|---|---|---|---|
| Date Sampled | 20/09/2000 | | |
| Depth of Sample (m) | 0.8 | 1.8 | 2.9 |
| pH | | | |
| EPH10-19 | < | [illegible] | < |

| Location | MW00-09 | |
|---|---|---|
| Date Sampled | 20/09/2000 | |
| Depth of Sample (m) | 2.4 | 2.4 |
| pH | - | - |
| Non-Halogenated Volatiles | - | - |
| PAHs | - | - |
| Extractable Hydrocarbons | < | < |
| General | - | - |

| Location | BH00-10 | |
|---|---|---|
| Date Sampled | 21/09/2000 | |
| Depth of Sample (m) | 1.4 | 3.5 |
| pH | - | - |
| Non-Halogenated Volatiles | - | - |
| PAHs | - | - |
| Extractable Hydrocarbons | < | < |
| General | - | - |

| Location | MW00-11 |
|---|---|
| Date Sampled | 21/09/2000 |
| Depth of Sample (m) | 4.6 |
| pH | - |
| Non-Halogenated Volatiles | < |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | BH00-12 |
|---|---|
| Date Sampled | 21/09/2000 |
| Depth of Sample (m) | 2.1 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | BH00-13 |
|---|---|
| Date Sampled | 21/09/2000 |
| Depth of Sample (m) | 1.2 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | BH00-14 |
|---|---|
| Date Sampled | 21/09/2000 |
| Depth of Sample (m) | 1.2 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | 1 |
|---|---|
| Date Sampled | 07/05/1993 |
| Depth of Sample (m) | 3 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | 11 |
|---|---|
| Date Sampled | 27/06/1993 |
| Depth of Sample (m) | 0.80 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | 14 |
|---|---|
| Date Sampled | 16/07/1993 |
| Depth of Sample (m) | 0.6 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

| Location | 15 |
|---|---|
| Date Sampled | 10/08/1993 |
| Depth of Sample (m) | 0.6 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | - |
| General | < |

| Location | 16 |
|---|---|
| Date Sampled | 10/08/1993 |
| Depth of Sample (m) | 0.6 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | - |
| General | < |

| Location | 6 |
|---|---|
| Date Sampled | 07/05/1993 |
| Depth of Sample (m) | 4.5 |
| pH | - |
| Non-Halogenated Volatiles | - |
| PAHs | - |
| Extractable Hydrocarbons | < |
| General | - |

**LEGEND**
SITE BOUNDARY
LOT BOUNDARY
MONITORING WELL LOCATION
BOREHOLE LOCATION
TEST PIT LOCATION
SURFACE SAMPLE LOCATION
SOIL PARAMETER CONCENTRATION MEETS APPLICABLE STANDARDS
SOIL PARAMETER CONCENTRATION IS GREATER THAN APPLICABLE CSR IL, CSR CL AND CSR PL STANDARDS

**TABLE**
CONCENTRATION IN SOIL EXCEEDS APPLICABLE CSR PL STANDARD
10 CONCENTRATION IN SOIL EXCEEDS APPLICABLE CSR CL STANDARD
10 CONCENTRATION IN SOIL EXCEEDS APPLICABLE CSR IL STANDARD

**ABBREVIATIONS**

| | |
|---|---|
| IL | INDUSTRIAL LAND USE |
| CL | COMMERCIAL LAND USE |
| PL | PARK LAND USE |
| FD | FIELD DUPLICATE |
| FDA | FIELD DUPLICATE AVAILABLE |

**NOTES**
1. ALL VALUES ARE IN MICROGRAMS PER LITRE (µg/g), UNLESS OTHERWISE NOTED.
2. SAMPLING LOCATIONS ARE APPROXIMATE.

**REFERENCES**
AERIAL IMAGE © 2019 GOOGLE OBTAINED FROM GOOGLE EARTH PRO, USED UNDER LICENSE. IMAGE DATE: 8/18/2016. GOOGLE EARTH IMAGE IS NOT TO SCALE.
LOT BOUNDARIES OBTAINED FROM BC LAND TITLE AND SURVEY ON 2019-12-18
DATUM: NAD83, PROJECTION: UTM ZONE 10

0 25 50
1:1,000 METRES
0 50 100
1:2,000 METRES





CLIENT
TOWN OF LADYSMITH

CONSULTANT
GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-26 |
| DESIGNED | MN |
| PREPARED | RTJ |
| REVIEWED | GG |
| APPROVED | DF |

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
**SOIL ANALYTICAL RESULTS - HYDROCARBONS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | 0 | 6B |

Path: \\golder.gds\gal\Kelowna\CAD-GIS\Client\TOWN OF LADYSMITH\Ladysmith Harbour\99_PROJECTS\18109842_Enviro1000\02_PRODUCTION\DWG\ | File Name: 18109842_1000 - Results.dwg | Last Edited By: ryjames Date: 2020-02-28 Time:11:00:19 AM | Printed By: RYJames Date: 2020-02-28 Time:11:04:53 AM


| Location | MW00-2 |
|---|---|
| Date Sampled | 18/11/2009 |
| Hardness (mg/L) | 125 |
| pH | 7.55 |
| Metals | < |

| Location | MW00-4 |
|---|---|
| Date Sampled | 11/12/2009 |
| Hardness (mg/L) | 101 |
| pH | 6.66 |
| Zinc | 0.19 |
| Metals | < |

| Location | MW00-09 |
|---|---|
| Date Sampled | 11/12/2009 |
| Hardness (mg/L) | 56 |
| pH | 6.33 |
| Metals | < |

| Location | MW00-11 |
|---|---|
| Date Sampled | 11/12/2009 |
| Hardness (mg/L) | 198 |
| pH | 7.33 |
| Metals | < |

| Location | MW09-1 |
|---|---|
| Date Sampled | 18/11/2009 |
| Hardness (mg/L) | 106 |
| pH | 7.97 |
| Metals | < |

| Location | MW09-2 |
|---|---|
| Date Sampled | 16/11/2009 |
| Hardness (mg/L) | 151 |
| pH | 7.36 |
| Manganese | 2.37 |
| Metals | < |

| Location | MW09-3 |
|---|---|
| Date Sampled | 18/11/2009 |
| Hardness (mg/L) | 144 |
| pH | 7.69 |
| Metals | < |

| Location | MW09-4 |
|---|---|
| Date Sampled | 19/11/2009 |
| Hardness (mg/L) | 206 |
| pH | 7.64 |
| Metals | < |

| Location | MW09-5 |
|---|---|
| Date Sampled | 19/11/2009 |
| Hardness (mg/L) | 175 |
| pH | 7.6 |
| Metals | < |

| Location | MW09-07 | | |
|---|---|---|---|
| Date Sampled | 16/02/2011 | 20/11/2009 | 22/02/2011 |
| Hardness (mg/L) | 185 | 102 | 1010 |
| pH | 6.34 | 7.22 | 6.49 |
| Dissolved Chloride | 384 | - | 2170 |
| Iron | < | < | 7.68 |
| Sodium | 287 | < | 1210 |
| Metals | < | < | < |

| Location | MW09-08 | | | | |
|---|---|---|---|---|---|
| Date Sampled | 16/02/2011 | 16/02/2011 | 22/02/2011 | 20/11/2009 | 20/11/2009 |
| Hardness (mg/L) | 694 | 684 | 3850 | 1480 | 1890 |
| pH | 6.99 | 6.99 | 6.68 | 6.92 | 6.92 |
| Dissolved Chloride | 2340 | 2150 | 10800 | 5410 | 6480 |
| Dissolved Sulfate (SO4 | < | < | 1510 | 686 | 843 |
| Arsenic | < | < | < | 0.011 | 0.014 |
| Lithium | < | < | < | 0.035 | 0.039 |
| Sodium | 1270 | 1250 | 6310 | 2800 | 3450 |
| Strontium | < | < | 4.79 | 2.8 | 3.43 |
| Metals | < | < | < | < | < |

| Location | MW09-9 | |
|---|---|---|
| Date Sampled | 25/11/2009 | |
| Hardness (mg/L) | 149.00 | 149.00 |
| pH | 6.75 | 6.75 |
| Manganese | 2.45 | 2.47 |
| Metals | < | < |

| Location | MW09-10 |
|---|---|
| Date Sampled | 19/11/2009 |
| Hardness (mg/L) | 149 |
| pH | 8.13 |
| Metals | < |

| Location | MW09-11 |
|---|---|
| Date Sampled | 19/11/2009 |
| Hardness (mg/L) | 145 |
| pH | 7.88 |
| Manganese | 3.77 |
| Metals | < |

| Location | MW09-16 |
|---|---|
| Date Sampled | 20/11/2009 |
| Hardness (mg/L) | 32 |
| pH | 7.62 |
| Metals | < |

| Location | MW11-01 | |
|---|---|---|
| Date Sampled | 16/02/2011 | 22/02/2011 |
| Hardness (mg/L) | 425 | 4330 |
| pH | 7.69 | 6.76 |
| Dissolved Chloride | 2000 | 12600 |
| Dissolved Sulfate (SO4 | < | 1790 |
| Sodium | 869 | 7520 |
| Strontium | < | 5.37 |
| Metals | < | < |

| Location | MW11-02 | |
|---|---|---|
| Date Sampled | 16/02/2011 | 22/02/2011 |
| Hardness (mg/L) | 83.50 | 73.20 |
| pH | 8.05 | 7.87 |
| Arsenic | 0.0109 | 0.0304 |
| Metals | < | < |

**LEGEND**

SITE BOUNDARY
LOT BOUNDARY
MONITORING WELL LOCATION
BOREHOLE LOCATION
TEST PIT LOCATION
SURFACE SAMPLE LOCATION
GROUNDWATER PARAMETER CONCENTRATION MEETS APPLICABLE STANDARDS
GROUNDWATER PARAMETER CONCENTRATION IS GREATER THAN APPLICABLE STANDARDS

**TABLE**

100 CONCENTRATION IN GROUNDWATER EXCEEDS APPLICABLE CSR DW STANDARD
100 CONCENTRATION IN GROUNDWATER EXCEEDS APPLICABLE CSR AW-F STANDARD
100 CONCENTRATION IN GROUNDWATER EXCEEDS APPLICABLE CSR DW AND CSR AW-F STANDARDS

**ABBREVIATIONS**

DW DRINKING WATER
AW-F AQUATIC LIFE, MARINE
FD FIELD DUPLICATE
FDA FIELD DUPLICATE AVAILABLE

**NOTES**

1. ALL VALUES ARE IN MICROGRAMS PER LITRE (µg/L), UNLESS OTHERWISE NOTED.
2. SAMPLING LOCATIONS ARE APPROXIMATE.

**REFERENCES**

AERIAL IMAGE © 2019 GOOGLE OBTAINED FROM GOOGLE EARTH PRO, USED UNDER LICENSE. IMAGE DATE: 8/18/2016. GOOGLE EARTH IMAGE IS NOT TO SCALE.

LOT BOUNDARIES OBTAINED FROM BC LAND TITLE AND SURVEY ON 2019-12-18

DATUM: NAD83, PROJECTION: UTM ZONE 10

0 25 50
1:1,000 METRES
0 50 100
1:2,000 METRES





CLIENT
TOWN OF LADYSMITH

CONSULTANT
GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-26 |
| DESIGNED | MN |
| PREPARED | RTJ |
| REVIEWED | GG |
| APPROVED | DF |

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
**GROUNDWATER ANALYTICAL RESULTS - METALS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | 0 | 7A |

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


| Location | MW00-9 |
|---|---|
| Date Sampled | 10/12/2009 |
| Hardness (mg/L) | 56 |
| pH | 6.33 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW00-11 |
|---|---|
| Date Sampled | 10/12/2009 |
| Hardness (mg/L) | 198 |
| pH | 7.33 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW09-1 |
|---|---|
| Date Sampled | 18/11/2009 |
| Hardness (mg/L) | 106 |
| pH | 7.97 |
| Benzene | 56 |
| Toluene | 198 |
| Total Xylene | 1200 |
| VPH | 3800 |

| Location | MW09-2 |
|---|---|
| Date Sampled | 18/11/2009 |
| Hardness (mg/L) | 151 |
| pH | 7.36 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW09-3 |
|---|---|
| Date Sampled | 18/11/2009 |
| Hardness (mg/L) | 144 |
| pH | 7.69 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW09-4 |
|---|---|
| Date Sampled | 19/11/2009 |
| Hardness (mg/L) | 206 |
| pH | 7.64 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW09-5 |
|---|---|
| Date Sampled | 19/11/2009 |
| Hardness (mg/L) | 175 |
| pH | 7.6 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW09-6 |
|---|---|
| Date Sampled | 19/11/2009 |
| Hardness (mg/L) | - |
| pH | 6.76 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW09-7 | | |
|---|---|---|---|
| Date Sampled | 16/02/2011 | 22/02/2011 | 20/11/2009 |
| Hardness (mg/L) | 185 | - | 102 |
| pH | 6.34 | 6.49 | 7.22 |
| Monoaromatic Hydrocarbons | < | < | < |
| PAHs | < | < | < |
| Other Hydrocarbons | < | < | < |

| Location | MW09-8 | | | | |
|---|---|---|---|---|---|
| Date Sampled | 16/02/2011 | 16/02/2011 | 20/11/2009 | 20/11/2009 | 22/02/2011 |
| Hardness (mg/L) | 694 | 684 | 1480 | 1890 | - |
| pH | 6.99 | 6.99 | 6.92 | 6.92 | 6.68 |
| benzo(a)pyrene | < | < | 0.03 | 0.03 | < |
| benzo(b)fluoranthene | < | < | 0.09 | < | < |
| pyrene | < | < | 0.23 | 0.23 | < |

| Location | MW09-9 | |
|---|---|---|
| Date Sampled | 25-Nov-09 | 25-Nov-09 |
| Hardness (mg/L) | 149 | 149 |
| pH | 6.75 | 6.75 |
| Monoaromatic Hydrocarbons | < | < |
| PAHs | < | < |
| Other Hydrocarbons | < | < |

| Location | MW09-10 |
|---|---|
| Date Sampled | 19/11/2009 |
| Hardness (mg/L) | 149 |
| pH | 8.13 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW09-11 |
|---|---|
| Date Sampled | 19/11/2009 |
| Hardness (mg/L) | 145 |
| pH | 7.88 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW09-16 |
|---|---|
| Date Sampled | 20/11/2009 |
| Hardness (mg/L) | 32 |
| pH | 7.62 |
| Monoaromatic Hydrocarbons | < |
| PAHs | < |
| Other Hydrocarbons | < |

| Location | MW11-01 | |
|---|---|---|
| Date Sampled | 16/02/2011 | 22/02/2011 |
| Hardness (mg/L) | 425 | - |
| pH | 7.69 | 6.76 |
| benzo(a)pyrene | 0.399 | < |
| benzo(b)fluoranthene | 0.467 | < |
| pyrene | 0.854 | < |

| Location | MW11-02 | |
|---|---|---|
| Date Sampled | 16/02/2011 | 22/02/2011 |
| Hardness (mg/L) | 83.50 | - |
| pH | 8.05 | 7.87 |
| Monoaromatic Hydrocarbons | < | < |
| PAHs | < | < |
| Other Hydrocarbons | < | < |

| Location | MW00-02 | |
|---|---|---|
| Date Sampled | 25/09/2000 | 18/11/2009 |
| Hardness (mg/L) | - | 125.00 |
| pH | - | 7.55 |
| Monoaromatic Hydrocarbons | - | < |
| PAHs | - | < |
| Other Hydrocarbons | < | < |

| Location | MW00-04 | |
|---|---|---|
| Date Sampled | 25/09/2000 | 10/12/2009 |
| Hardness (mg/L) | - | 101.00 |
| pH | - | 6.66 |
| Monoaromatic Hydrocarbons | - | < |
| PAHs | - | < |
| Other Hydrocarbons | < | < |

| Location | MW00-06 |
|---|---|
| Date Sampled | 25/09/2000 |
| Hardness (mg/L) | - |
| pH | - |
| Monoaromatic Hydrocarbons | - |
| PAHs | - |
| Other Hydrocarbons | < |

| Location | MW00-09 |
|---|---|
| Date Sampled | 25/09/2000 |
| Hardness (mg/L) | - |
| pH | - |
| Monoaromatic Hydrocarbons | - |
| PAHs | - |
| Other Hydrocarbons | < |

**LEGEND**

- SITE BOUNDARY
- LOT BOUNDARY
- MONITORING WELL LOCATION
- BOREHOLE LOCATION
- TEST PIT LOCATION
- SURFACE SAMPLE LOCATION
- GROUNDWATER PARAMETER CONCENTRATION MEETS APPLICABLE STANDARDS
- GROUNDWATER PARAMETER CONCENTRATION IS GREATER THAN APPLICABLE STANDARDS

**TABLE**

- 100 — CONCENTRATION IN GROUNDWATER EXCEEDS APPLICABLE CSR DW STANDARD
- 100 — CONCENTRATION IN GROUNDWATER EXCEEDS APPLICABLE CSR AW-F STANDARD
- 100 — CONCENTRATION IN GROUNDWATER EXCEEDS APPLICABLE CSR DW AND CSR AW-F STANDARDS

**ABBREVIATIONS**

| | |
|---|---|
| DW | DRINKING WATER |
| AW-F | AQUATIC LIFE, MARINE |
| FD | FIELD DUPLICATE |
| FDA | FIELD DUPLICATE AVAILABLE |

**NOTES**

1. ALL VALUES ARE IN MICROGRAMS PER LITRE (µg/L), UNLESS OTHERWISE NOTED.
2. SAMPLING LOCATIONS ARE APPROXIMATE.

**REFERENCES**

AERIAL IMAGE © 2019 GOOGLE OBTAINED FROM GOOGLE EARTH PRO, USED UNDER LICENSE. IMAGE DATE: 8/18/2016. GOOGLE EARTH IMAGE IS NOT TO SCALE.

LOT BOUNDARIES OBTAINED FROM BC LAND TITLE AND SURVEY ON 2019-12-18

DATUM: NAD83, PROJECTION: UTM ZONE 10

0 25 50
1:1,000 METRES

0 50 100
1:2,000 METRES



CLIENT
TOWN OF LADYSMITH

CONSULTANT
GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-26 |
| DESIGNED | MN |
| PREPARED | RTJ |
| REVIEWED | GG |
| APPROVED | DF |

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
**GROUNDWATER ANALYTICAL RESULTS - HYDROCARBONS**

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | 0 | 7B |


**LEGEND**

⊕ HAND AUGER SAMPLE

— LEGAL BOUNDARY

SITE BOUNDARY

**NOT FOR CONSTRUCTION**

0 20 40

1:1,000 METRES

**NOTE(S)**

1. LOCATIONS ARE APPROXIMATE.

**REFERENCE(S)**

1. IMAGERY COPYRIGHT © 20191219 ESRI AND ITS LICENSORS. SOURCE: DIGITALGLOBE. USED UNDER LICENSE, ALL RIGHTS RESERVED.
2. OTHER BASEDATA OBTAINED FROM WMS IN THE PROVINCE OF BRITISH COLUMBIA. COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N

CLIENT

TOWN OF LADYSMITH

PROJECT

LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR

TITLE

**DECEMBER 2019 SOIL SAMPLE LOCATIONS**

CONSULTANT

GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-27 |
| DESIGNED | AU |
| PREPARED | CDAB |
| REVIEWED | AU |
| APPROVED | DF |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | A | 8 |


**LEGEND**

SITE BOUNDARY
LOT BOUNDARY
APPROXIMATE APEC/AEC BOUNDARY

| APEC/AEC | DESCRIPTION |
|---|---|
| AEC 1 | FORMER FUEL PUMP ISLANDS, ASTs AND POSSIBLE PCB STORAGE |
| AEC 2 | FORMER RAILWAY MAINTENANCE AREAS AND CURRENT BOAT REPAIR AND CONSTRUCTION OPERATIONS |
| AEC 3 | FORMER WASTE OIL STORAGE AREA AND COMPRESSOR STORAGE AREA |
| APEC 4 | STOCKPILE OF MATERIAL FROM AROUND SEWAGE TREATMENT PLANT |
| APEC 5 | FILL OF UNKNOWN QUALITY ON LOT 5 |
| APEC 6 | FILL MATERIAL AT BLOCK B AND D OF DL 2016 (FORMER LOCATION OF THE SHINGLE MILL/SAWMILL |
| AEC 7 | FORMER LOG DUMP (LOT 17G) |

**NOTES**

1. SAMPLING LOCATIONS ARE APPROXIMATE.
2. AEC = AREA OF ENVIRONMENTAL CONCERN
   APEC = AREA OF POTENTIAL ENVIRONMENTAL CONCERN

**REFERENCES**

AERIAL IMAGE © 2019 GOOGLE OBTAINED FROM GOOGLE EARTH PRO, USED UNDER LICENSE.
IMAGE DATE: 8/18/2016. GOOGLE EARTH IMAGE IS NOT TO SCALE.

LOT BOUNDARIES OBTAINED FROM BC LAND TITLE AND SURVEY ON 2019-12-18

DATUM: NAD83, PROJECTION: UTM ZONE 10

0 25 50
1:1,000 METRES

0 50 100
1:2,000 METRES



CLIENT
TOWN OF LADYSMITH

PROJECT
LOTS 1, 4 AND 5 ADJACENT TO LADYSMITH HARBOUR
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
**AREAS OF ENVIRONMENTAL CONCERN AND AREAS OF POTENTIAL ENVIRONMENTAL CONCERN**

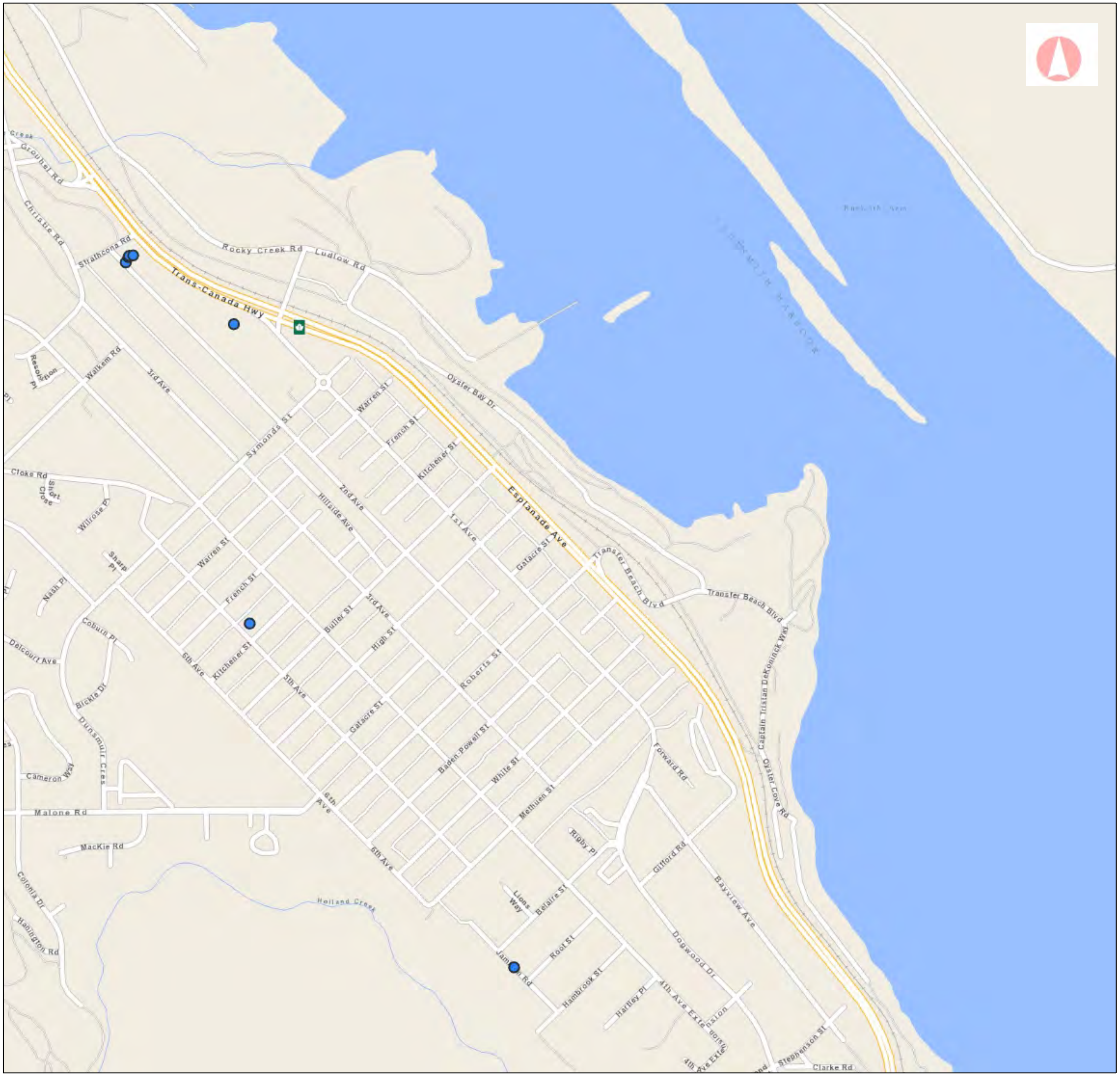
CONSULTANT
GOLDER

| | |
|---|---|
| YYYY-MM-DD | 2020-02-26 |
| DESIGNED | MN |
| PREPARED | RTJ |
| REVIEWED | GG |
| APPROVED | DF |

| PROJECT NO. | PHASE | REV. | FIGURE |
|---|---|---|---|
| 18109842 | 1000 | 0 | 9 |

**APPENDIX A**

# iMapBC




Water Wells near Site

***Legend***

● Water Wells - All

0 | 0.41 | 0.81 km

1: 20,000

Copyright/Disclaimer



CAUTION: Maps obtained using this site are not designed to assist in navigation. These maps may be generalized and may not reflect current conditions. Uncharted hazards may exist. DO NOT USE THESE MAPS FOR NAVIGATIONAL PURPOSES.

Datum: NAD83

Projection: WGS_1984_Web_Mercator_Auxiliary_Sphere

Key Map of British Columbia

**APPENDIX B**

# Land Title Search

**CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN**

| | |
|---|---|
| **Land Title District** | VICTORIA |
| Land Title Office | VICTORIA |
| | |
| **Title Number** | CA7424608 |
| From Title Number | ET76069 |
| | |
| **Application Received** | 2019-04-01 |
| | |
| **Application Entered** | 2019-04-01 |

**Registered Owner in Fee Simple**

| | |
|---|---|
| Registered Owner/Mailing Address: | TOWN OF LADYSMITH<br>410 ESPLANADE, PO BOX 220<br>LADYSMITH, BC<br>V9G 1A2 |

| | |
|---|---|
| **Taxation Authority** | Ladysmith, Town of |

**Description of Land**

Parcel Identifier: 010-208-861

Legal Description:

LOT 5, DISTRICT LOTS 24 AND 56, OYSTER DISTRICT, PLAN 45800

**Legal Notations**

HERETO IS ANNEXED EASEMENT EB15415 OVER DISTRICTS LOTS 138, 142 AND 6G OYSTER DISTRICT AND LOT 4, PLAN 45800
SERVIENT TENEMENT CANCELLED AS TO DISTRICT LOT 6G, OYSTER DISTRICT, BY EP107093, 2000-12-20

**Charges, Liens and Interests**

| | |
|---|---|
| Nature: | UNDERSURFACE RIGHTS |
| Registration Number: | D23415 |
| Registration Date and Time: | 1975-01-27 08:10 |
| Registered Owner: | HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA |
| Remarks: | INTER ALIA<br>ASSIGNMENT OF 84658G AND 195198G (SEE 74848G, 379783G, 325302G, 19225N AND 325301G) |

| | |
|---|---|
| **Duplicate Indefeasible Title** | NONE OUTSTANDING |

| | |
|---|---|
| **Transfers** | NONE |
| **Pending Applications** | NONE |

**CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN**

**Land Title District** VICTORIA
Land Title Office VICTORIA

**Title Number** ET76069
From Title Number EM113875

**Application Received** 2002-07-04

**Application Entered** 2002-07-11

**Title Cancelled** **2019-04-01**

**Registered Owner in Fee Simple**
Registered Owner/Mailing Address: INVET HOLDINGS CORP., INC.NO. 48357-A
801 - 1039 - 17TH AVENUE S.W.
CALGARY, AB
T2T 0B2

**Taxation Authority** Ladysmith, Town of

**Description of Land**
Parcel Identifier: 010-208-861
Legal Description:
LOT 5, DISTRICT LOTS 24 AND 56, OYSTER DISTRICT, PLAN 45800

**Legal Notations**
EXPROPRIATION ACT NOTICE, SEE CA7163118, 2018-10-31
DEALINGS RESTRICTED

HERETO IS ANNEXED EASEMENT EB15415 OVER DISTRICTS LOTS 138, 142 AND 6G
OYSTER DISTRICT AND LOT 4, PLAN 45800
SERVIENT TENEMENT CANCELLED AS TO DISTRICT LOT 6G, OYSTER DISTRICT,
BY EP107093, 2000-12-20

NOTICE OF INTEREST, BUILDERS LIEN ACT (S.3(2)), SEE ET83785
FILED 2002-07-22

**Charges, Liens and Interests**

| | |
|---|---|
| Nature: | UNDERSURFACE RIGHTS |
| Registration Number: | D23415 |
| Registration Date and Time: | 1975-01-27 08:10 |
| Registered Owner: | HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA |
| Remarks: | INTER ALIA<br>ASSIGNMENT OF 84658G AND 195198G (SEE 74848G, 379783G, 325302G, 19225N AND 325301G) |

**Duplicate Indefeasible Title** NONE OUTSTANDING

**Transfers**

| | |
|---|---|
| Registration Date: | 2019-04-01 |
| Description: | ALL EPROPRATION ACT CA7424608 |

**CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN**

**Land Title District** VICTORIA
Land Title Office VICTORIA

**Title Number** EM113875
From Title Number EK27544

**Application Received** 1998-11-27

**Application Entered** 1998-12-02

**Title Cancelled** **2002-07-11**

**Registered Owner in Fee Simple**
Registered Owner/Mailing Address: S.V.R. ACQUISITIONS LTD., INC.NO. 48357-A
801 - 1039 - 17TH AVENUE S.W.
CALGARY, AB
T2T 0B2

**Taxation Authority** Ladysmith, Town of

**Description of Land**
Parcel Identifier: 010-208-861
Legal Description:
LOT 5, DISTRICT LOTS 24 AND 56, OYSTER DISTRICT, PLAN 45800

**Legal Notations**
HERETO IS ANNEXED EASEMENT EB15415 OVER DISTRICTS LOTS 138, 142 AND 6G
OYSTER DISTRICT AND LOT 4, PLAN 45800
SERVIENT TENEMENT CANCELLED AS TO DISTRICT LOT 6G, OYSTER DISTRICT,
BY EP107093, 2000-12-20

**Charges, Liens and Interests**
Nature: UNDERSURFACE RIGHTS
Registration Number: D23415
Registration Date and Time: 1975-01-27 08:10
Registered Owner: HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA
Remarks: ASSIGNMENT OF 84658G AND 195198G (SEE 74848G, 379783G, 325302G, 19225N AND 325301G)

| | |
|---|---|
| Nature: | OPTION TO PURCHASE |
| Registration Number: | EP40977 |
| Registration Date and Time: | 2000-05-26 14:56 |
| Registered Owner: | GRANBY HARBOUR DEVELOPMENT CORPORATON<br>INCORPORATION NO. 593903 |

| | |
|---|---|
| Nature: | MORTGAGE |
| Registration Number: | EP83606 |
| Registration Date and Time: | 2000-10-04 09:40 |
| Registered Owner: | MONTREAL TRUST COMPANY OF CANADA<br>INCORPORATION NO. 34,811A |
| Remarks: | OF EP40977 |

**Duplicate Indefeasible Title** NONE OUTSTANDING

**Transfers**

| | |
|---|---|
| Registration Date: | 2002-07-11 |
| Description: | ALL ET76069 |

Declared Value $ 605000

**CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN**

**Land Title District** VICTORIA
Land Title Office VICTORIA

**Title Number** EK27544
From Title Number EH148391

**Application Received** 1996-03-15

**Application Entered** 1996-03-26

**Title Cancelled** **1998-12-02**

**Registered Owner in Fee Simple**
Registered Owner/Mailing Address: SEA VISION RESORTS DEVELOPMENT LTD., INC.NO. A42285,
19 GATACRE STREET,
P.O. BOX 1589,
LADYSMITH, BC
V0R 2E0.

**Taxation Authority** Ladysmith, Town of

**Description of Land**
Parcel Identifier: 010-208-861
Legal Description:
LOT 5, DISTRICT LOTS 24 AND 56, OYSTER DISTRICT, PLAN 45800

**Legal Notations**
HERETO INTER ALIA IS ANNEXED RESTRICTIVE COVENANT EB15414 OVER
DISTRICT LOT 6G, OYSTER DISTRICT.
DOMINANT TENEMENT CANCELLED AS TO ALL EXCEPT LOT 5, PLAN 45800,
SEE EK27539/41, 15-03-1996, K. JACQUES PER DBC.

HERETO IS ANNEXED EASEMENT EB15415 OVER DISTRICTS LOTS 138, 142 AND 6G
OYSTER DISTRICT AND LOT 4, PLAN 45800

**Charges, Liens and Interests**

| | |
|---|---|
| Nature: | UNDERSURFACE RIGHTS |
| Registration Number: | D23415 |
| Registration Date and Time: | 1975-01-27 08:10 |
| Registered Owner: | HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA |
| Remarks: | ASSIGNMENT OF 84658G AND 195198G (SEE 74848G, 379783G, 325302G, 19225N AND 325301G) |

**Duplicate Indefeasible Title** NONE OUTSTANDING

**Transfers**

| | |
|---|---|
| Registration Date: | 1998-12-02 |
| Description: | ALL EM113875 |

Declared Value $NOMINAL

**CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN**

**Land Title District** VICTORIA
Land Title Office VICTORIA

**Title Number** EH148391
From Title Number EG17932

**Application Received** 1994-11-10

**Application Entered** 1994-11-29

**Title Cancelled** **1996-03-26**

**Registered Owner in Fee Simple**
Registered Owner/Mailing Address: TIMBERWEST FOREST I LIMITED, INC.NO. 440252
P.O. BOX 10058, PACIFIC CENTRE
VANCOUVER, BC
V7V 1J7

**Taxation Authority** Ladysmith, Town of

**Description of Land**
Parcel Identifier: 010-208-861
Legal Description:
LOT 5, DISTRICT LOTS 24 AND 56, OYSTER DISTRICT, PLAN 45800

**Legal Notations**
HERETO INTER ALIA IS ANNEXED RESTRICTIVE COVENANT EB15414 OVER
DISTRICT LOT 6G, OYSTER DISTRICT.
DOMINANT TENEMENT CANCELLED AS TO ALL EXCEPT LOT 5, PLAN 45800,
SEE EK27539/41, 15-03-1996, K. JACQUES PER DBC.

HERETO IS ANNEXED EASEMENT EB15415 OVER DISTRICTS LOTS 138, 142 AND 6G
OYSTER DISTRICT AND LOT 4, PLAN 45800

**Charges, Liens and Interests**

| | |
|---|---|
| Nature: | UNDERSURFACE RIGHTS |
| Registration Number: | D23415 |
| Registration Date and Time: | 1975-01-27 08:10 |
| Registered Owner: | HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA |
| Remarks: | ASSIGNMENT OF 84658G AND 195198G (SEE 74848G, 379783G, 325302G, 19225N AND 325301G) |

**Duplicate Indefeasible Title** NONE OUTSTANDING

**Transfers**

| | |
|---|---|
| Registration Date: | 1996-03-26 |
| Description: | ALL EK27544 |

**CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN**

**Land Title District** VICTORIA
Land Title Office VICTORIA

**Title Number** EG17932
From Title Number EG10509

**Application Received** 1993-02-15

**Application Entered** 1993-04-08

**Title Cancelled** **1994-11-29**

**Registered Owner in Fee Simple**
Registered Owner/Mailing Address: ELK FALLS WOOD PRODUCTS LIMITED, INC.NO. 440252
9TH FLOOR, 700 WEST GEORGIA STREET
VANCOUVER, BC
V7Y 1J7

**Taxation Authority** Ladysmith, Town of

**Description of Land**
Parcel Identifier: 010-208-861
Legal Description:
LOT 5, DISTRICT LOTS 24 AND 56, OYSTER DISTRICT, PLAN 45800

**Legal Notations**
HERETO INTER ALIA IS ANNEXED RESTRICTIVE COVENANT EB15414 OVER DISTRICT LOT 6G, OYSTER DISTRICT

HERETO INTER ALIA IS ANNEXED EASEMENT EB15415 OVER DISTRICTS LOTS 138, 142 AND 6G, OYSTER DISTRICT AND OVER LOT 4, PLAN 45800

**Charges, Liens and Interests**
Nature: UNDERSURFACE RIGHTS
Registration Number: D23415
Registration Date and Time: 1975-01-27 08:10
Registered Owner: HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA
Remarks: ASSIGNMENT OF 84658G AND 195198G (SEE 74848G, 379783G, 325302G, 19225N AND 325301G)

| | |
|---|---|
| Nature: | RIGHT OF FIRST REFUSAL |
| Registration Number: | EB15410 |
| Registration Date and Time: | 1988-02-24 12:19 |
| Registered Owner: | TOWN OF LADYSMITH |

**Duplicate Indefeasible Title** NONE OUTSTANDING

**Transfers**

| | |
|---|---|
| Registration Date: | 1994-11-29 |
| Description: | ALL EH148391 |

PARCEL IDENTIFIER (PID): 010-208-828

SHORT LEGAL DESCRIPTION:S/45800/////4
MARG:* REM.
TAXATION AUTHORITY:
1 Ladysmith, Town of

FULL LEGAL DESCRIPTION: CURRENT
LOT 4, DISTRICT LOTS 8G, 11G, 24 AND 56, OYSTER DISTRICT, PLAN 45800,
EXCEPT PART IN PLANS VIP64405, VIP71943 AND VIP72131

MISCELLANEOUS NOTES:
SRW PLAN 45801

ASSOCIATED PLAN NUMBERS:
PLAN VIP45800
STATUTORY RIGHT OF WAY PLAN VIP45801
SUBDIVISION PLAN VIP64405
PLAN VIP71943
SUBDIVISION PLAN VIP72131

AFB/IFB: MN: Y PE: 3 SL: 1 TI: 1

PARCEL IDENTIFIER (PID): 010-208-861

SHORT LEGAL DESCRIPTION:S/45800/////5
MARG:
TAXATION AUTHORITY:
1 Ladysmith, Town of

FULL LEGAL DESCRIPTION: CURRENT
LOT 5, DISTRICT LOTS 24 AND 56, OYSTER DISTRICT, PLAN 45800

MISCELLANEOUS NOTES:

ASSOCIATED PLAN NUMBERS:
PLAN VIP45800

AFB/IFB: MN: N PE: 0 SL: 1 TI: 1

PARCEL IDENTIFIER (PID): 023-652-926

SHORT LEGAL DESCRIPTION:S/VIP64405/////1
MARG:

TAXATION AUTHORITY:
1 Ladysmith, Town of

FULL LEGAL DESCRIPTION: CURRENT
LOT 1 DISTRICT LOTS 24 AND 56 OYSTER DISTRICT PLAN VIP64405

MISCELLANEOUS NOTES:
SRW PLAN 45801

ASSOCIATED PLAN NUMBERS:
PLAN VIP45800
STATUTORY RIGHT OF WAY PLAN VIP45801
SUBDIVISION PLAN VIP64405

AFB/IFB: MN: Y PE: 0 SL: 1 TI: 1

**CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN**

**Title Issued Under** SECTION 98 LAND TITLE ACT

**Land Title District** VICTORIA
Land Title Office VICTORIA

**Title Number** EB15407
From Title Number S110892
19225N

**Application Received** 1988-02-24

**Application Entered** 1988-03-07

**Title Cancelled** **1988-03-07**

**Registered Owner in Fee Simple**
Registered Owner/Mailing Address: TOWN OF LADYSMITH,
410 ESPLANADE
LADYSMITH, BC
V0R 2E0

**Taxation Authority** Ladysmith, Town of

**Description of Land**
Parcel Identifier: 010-208-861
Legal Description:
LOT 5, DISTRICT LOTS 24 AND 56, OYSTER DISTRICT, PLAN 45800

**Legal Notations** NONE

**Charges, Liens and Interests**
Nature: UNDERSURFACE RIGHTS
Registration Number: D23415
Registration Date and Time: 1975-01-27 08:10
Registered Owner: HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA
Remarks: ASSIGNMENT OF 84658G AND 195198G (SEE 74848G, 379783G, 325302G, 19225N AND 325301G)

**Duplicate Indefeasible Title** NONE OUTSTANDING

Declared Value $NOMINAL

**Transfers**

| | |
|---|---|
| Registration Date: | 1988-03-07 |
| Description: | ALL EB15409 |

**CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN**

**Land Title District** VICTORIA
Land Title Office VICTORIA

**Title Number** EB15409
From Title Number EB15407

**Application Received** 1988-02-24

**Application Entered** 1988-03-07

**Title Cancelled** **1993-02-08**

**Registered Owner in Fee Simple**
Registered Owner/Mailing Address: CROWN FOREST INDUSTRIES LIMITED, INC.NO. 338,579
600 - 815 WEST HASTINGS STREET
VANCOUVER, BC
V6C 2Y4

**Taxation Authority** Ladysmith, Town of

**Description of Land**
Parcel Identifier: 010-208-861
Legal Description:
LOT 5, DISTRICT LOTS 24 AND 56, OYSTER DISTRICT, PLAN 45800

**Legal Notations**
HERETO INTER ALIA IS ANNEXED RESTRICTIVE COVENANT EB15414 OVER DISTRICT LOT 6G, OYSTER DISTRICT

HERETO INTER ALIA IS ANNEXED EASEMENT EB15415 OVER DISTRICTS LOTS 138, 142 AND 6G, OYSTER DISTRICT AND OVER LOT 4, PLAN 45800

**Charges, Liens and Interests**
Nature: UNDERSURFACE RIGHTS
Registration Number: D23415
Registration Date and Time: 1975-01-27 08:10
Registered Owner: HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA
Remarks: ASSIGNMENT OF 84658G AND 195198G (SEE 74848G, 379783G, 325302G, 19225N AND 325301G)

| | |
|---|---|
| Nature: | RIGHT OF FIRST REFUSAL |
| Registration Number: | EB15410 |
| Registration Date and Time: | 1988-02-24 12:19 |
| Registered Owner: | TOWN OF LADYSMITH |

**Duplicate Indefeasible Title** NONE OUTSTANDING

**Transfers**

| | |
|---|---|
| Registration Date: | 1993-02-08 |
| Description: | ALL EG10509 |

**CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN**

| | |
|---|---|
| **Title Issued Under** | SECTION 98 LAND TITLE ACT |
| **Land Title District** | VICTORIA |
| Land Title Office | VICTORIA |
| **Title Number** | EK132565 |
| From Title Number | EB15406 |
| **Application Received** | 1996-11-25 |
| **Application Entered** | 1997-01-21 |

**Registered Owner in Fee Simple**

Registered Owner/Mailing Address: TOWN OF LADYSMITH
P.O. BOX 220
410 ESPLANDE
LADYSMITH, BC
V0R 2E0

**Taxation Authority** Ladysmith, Town of

**Description of Land**

Parcel Identifier: 023-652-926
Legal Description:
LOT 1 DISTRICT LOTS 24 AND 56 OYSTER DISTRICT PLAN VIP64405

**Legal Notations**

HERETO IS ANNEXED EASEMENT EL8116 OVER LOT 4, PLAN 45800 EXCEPT PART IN PLAN VIP64405

**Charges, Liens and Interests**

Nature: EXCEPTIONS AND RESERVATIONS
Registration Number: M76300
Registered Owner: ESQUIMALT AND NANAIMO RAILWAY COMPANY
Remarks: INTER ALIA
A.F.B. 9.693.7434A, SECTION 172(3)
FOR ACTUAL DATE AND TIME OF REGISTRATION SEE
ORIGINAL GRANT FROM E AND N RAILWAY COMPANY
AS TO PART FORMERLY PARCEL B (DD 10119N),
DISTRICT LOT 24, OYSTER DISTRICT
FOR ACTUAL DATE AND TIME OF REGISTRATION SEE
ORIGINAL GRANT FROM E & N RAILWAY COMPANY

| | |
|---|---|
| Nature: | UNDERSURFACE RIGHTS |
| Registration Number: | D23415 |
| Registration Date and Time: | 1975-01-27 08:10 |
| Registered Owner: | HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA |
| Remarks: | INTER ALIA<br>AS TO PART FORMERLY LOT 1, INCLUDING PARCEL "A"<br>OF PLAN 4224 AND TO THAT PART FORMERLY DISTRICT<br>LOT 56, OYSTER DISTRICT AND TO<br>THAT PART IN DISTRICT LOT 24 OYSTER DISTRICT<br>SHOWN COLOURED PINK ON PLAN 2030<br>ASSIGNMENT OF 195198G AND 84658G (SEE 74848G,<br>379783G, 325301G, 325302G, 19225N AND<br>325303G) |

| | |
|---|---|
| Nature: | EASEMENT |
| Registration Number: | EB15415 |
| Registration Date and Time: | 1988-02-24 12:21 |
| Remarks: | INTER ALIA, APPURTENANT TO LOT 5, PLAN 45800<br>AND TO LEASE EB15413 REGISTERED AGAINST DISTRICT<br>LOT 16G, OYSTER DISTRICT AND TO LEASE EB15411<br>REGISTERED AGAINST DISTRICT LOT 17G, OYSTER<br>DISTRICT AND TO LEASE EB15412 REGISTERED AGAINST<br>DISTRICT LOT 651, COWICHAN DISTRICT<br>DOMINANT TENEMENT RE: LEASE EB15413 CANCELLED BY<br>EK27539, 15-03-1996, K. JACQUES PER DBC<br>DOMINANT TENEMENT RE. LEASE EB15411 CANCELLED<br>BY EK27540 - 15.03.1996 - K JACQUES PER DBC.<br>DOMINANT TENEMENT RE. LEASE EB15412 CANCELLED<br>BY EK27541 - 15.03.1996 - K JACQUES PER DBC. |

| | |
|---|---|
| **Duplicate Indefeasible Title** | NONE OUTSTANDING |
| **Transfers** | NONE |
| **Pending Applications** | NONE |

**CURRENT AND CANCELLED INFORMATION SHOWN**

**Land Title District** VICTORIA
Land Title Office VICTORIA

**Title Number** ES24122
From Title Number ES11109

**Application Received** 2001-03-30

**Application Entered** 2001-04-03

**Registered Owner in Fee Simple**
Registered Owner/Mailing Address: TOWN OF LADYSMITH
P.O. BOX 220
410 ESPLANDE
LADYSMITH, BC
V0R 2E0

**Taxation Authority** Ladysmith, Town of

**Description of Land**
Parcel Identifier: 010-208-828
Legal Description:
LOT 4, DISTRICT LOTS 8G, 11G, 24 AND 56, OYSTER DISTRICT, PLAN 45800,
EXCEPT PART IN PLANS VIP64405, VIP71943 AND VIP72131

**Legal Notations**
NOTICE OF INTEREST BUILDERS LIEN ACT, (S.3(2)) SEE ET83784 2002 07 22
REGARDING EB15408

**Charges, Liens and Interests**
Nature: EXCEPTIONS AND RESERVATIONS
Registration Number: M76300
Registered Owner: ESQUIMALT AND NANAIMO RAILWAY COMPANY
Remarks: INTER ALIA
A.F.B. 9.693.7434A, SECTION 172(3)
FOR ACTUAL DATE AND TIME OF REGISTRATION SEE
ORIGINAL GRANT FROM E AND N RAILWAY COMPANY
AS TO PART FORMERLY PARCEL B (DD 10119N),
DISTRICT LOT 24, OYSTER DISTRICT
FOR ACTUAL DATE AND TIME OF REGISTRATION SEE
ORIGINAL GRANT FROM E & N RAILWAY COMPANY

| | |
|---|---|
| Nature: | UNDERSURFACE RIGHTS |
| Registration Number: | D23415 |
| Registration Date and Time: | 1975-01-27 08:10 |
| Registered Owner: | HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA |
| Remarks: | INTER ALIA<br>AS TO PART FORMERLY LOT 1, INCLUDING PARCEL "A" OF PLAN 4224 AND TO THAT PART FORMERLY DISTRICT LOT 56, OYSTER DISTRICT AND TO<br>THAT PART IN DISTRICT LOT 24 OYSTER DISTRICT SHOWN COLOURED PINK ON PLAN 2030<br>ASSIGNMENT OF 195198G AND 84658G (SEE 74848G, 379783G, 325301G, 325302G, 19225N AND 325303G) |

| | |
|---|---|
| Nature: | UNDERSURFACE AND OTHER EXC & RES |
| Registration Number: | S6166 |
| Registration Date and Time: | 1987-01-27 14:18 |
| Registered Owner: | HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA |
| Remarks: | SECTION 47, LAND ACT, DD S6163<br>AS TO PART IN DISTRICT LOT 11G, OYSTER DISTRICT |

| | |
|---|---|
| Nature: | UNDERSURFACE AND OTHER EXC & RES |
| Registration Number: | S6170 |
| Registration Date and Time: | 1987-01-27 14:26 |
| Registered Owner: | HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA |
| Remarks: | SECTION 47, LAND ACT, DD S6167<br>AS TO PART IN DISTRICT LOT 8G, OYSTER DISTRICT |

| | |
|---|---|
| Nature: | STATUTORY RIGHT OF WAY |
| Registration Number: | EB15408 |
| Registration Date and Time: | 1988-02-22 12:18 |
| Registered Owner: | CROWN FOREST INDUSTRIES LIMITED, (INC. NO. 338,579) |
| Transfer Number: | EB15408 TRANSFERRED TO EJ69244 |
| Registered Owner: | CROWN FOREST INDUSTRIES LIMITED<br>INCORPORATION NO. A37357 |
| Transfer Number: | EJ69244 TRANSFERRED TO EK27546 |
| Registered Owner: | SEA VISION RESORTS DEVELOPMENT LTD. |
| Transfer Number: | EK27546 TRANSFERRED TO EM113867 |
| Registered Owner: | S.V.R. ACQUISITIONS LTD.<br>INCORPORATION NO. 48357-A |
| Transfer Number: | EM113867 TRANSFERRED TO ET76070 |
| Registered Owner: | INVET HOLDING CORP.<br>INCORPORATION NO. A48357 |
| Transfer Number: | ET76070 |
| Remarks: | PART IN PLAN 45801 |

| | |
|---|---|
| Nature: | COVENANT |
| Registration Number: | EB15402 |
| Registration Date and Time: | 1988-02-24 12:17 |
| Registered Owner: | HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA |
| Remarks: | PURSUANT TO SECTION 215 LAND TITLE ACT INCLUDES INDEMNITY PURSUANT TO SECTION 215(2)(A) LAND TITLE ACT, AS TO PARTS IN DISTRICT LOT 8G AND 11G, OYSTER DISTRICT |

| | |
|---|---|
| Nature: | EASEMENT |
| Registration Number: | EB15415 |
| Registration Date and Time: | 1988-02-24 12:21 |
| Remarks: | INTER ALIA, APPURTENANT TO LOT 5, PLAN 45800 AND TO LEASE EB15413 REGISTERED AGAINST DISTRICT LOT 16G, OYSTER DISTRICT AND TO LEASE EB15411 REGISTERED AGAINST DISTRICT LOT 17G, OYSTER DISTRICT AND TO LEASE EB15412 REGISTERED AGAINST DISTRICT LOT 651, COWICHAN DISTRICT<br>DOMINANT TENEMENT RE: LEASE EB15413 CANCELLED BY EK27539, 15-03-1996, K. JACQUES PER DBC<br>DOMINANT TENEMENT RE. LEASE EB15411 CANCELLED BY EK27540 - 15.03.1996 - K JACQUES PER DBC.<br>DOMINANT TENEMENT RE. LEASE EB15412 CANCELLED BY EK27541 - 15.03.1996 - K JACQUES PER DBC. |

| | |
|---|---|
| Nature: | EASEMENT |
| Registration Number: | EL8116 |
| Registration Date and Time: | 1997-01-20 11:02 |
| Remarks: | INTER ALIA<br>APPURTENANT TO LOT 1, PLAN VIP64405 |

| | |
|---|---|
| Nature: | OPTION TO PURCHASE |
| Registration Number: | ES2683 |
| Registration Date and Time: | 2001-01-15 09:30 |
| Registered Owner: | GRANBY HARBOUR DEVELOPMENT CORP.<br>INCORPORATION NO. 593903 |
| Remarks: | INTER ALIA |
| **Cancelled By:** | **EV58154** |
| **Cancelled Date:** | **2003-06-04** |

| | |
|---|---|
| Nature: | CAVEAT |
| Registration Number: | EV63640 |
| Registration Date and Time: | 2003-06-17 14:39 |
| Registered Owner: | GRANBY HARBOUR DEVELOPMENT CORP. |
| Remarks: | INTER ALIA |
| **Cancelled By:** | **EV98275** |
| **Cancelled Date:** | **2003-08-27** |

| | |
|---|---|
| **Duplicate Indefeasible Title** | NONE OUTSTANDING |
| **Transfers** | NONE |

**Pending Applications**

| | |
|---|---|
| Parcel Identifier: | 010-208-828 |
| Application Number/Type: | CA7808088 TO CA7808090 CHARGE RELEASE |

**Corrections**

ET62424A CHARGE OWNER NAME CORRECTED M76300 2002-06-05 09:30:00

**APPENDIX C**

# BC ENV Contaminated Site Registry


BC MoE Site Registry

## Legend

Environmental Remediation

0 0.20 0.41 km

1: 10,000

## Copyright/Disclaimer



CAUTION: Maps obtained using this site are not designed to assist in navigation. These maps may be generalized and may not reflect current conditions. Uncharted hazards may exist. DO NOT USE THESE MAPS FOR NAVIGATIONAL PURPOSES.

Datum: NAD83

Projection: WGS_1984_Web_Mercator_Auxiliary_Sphere

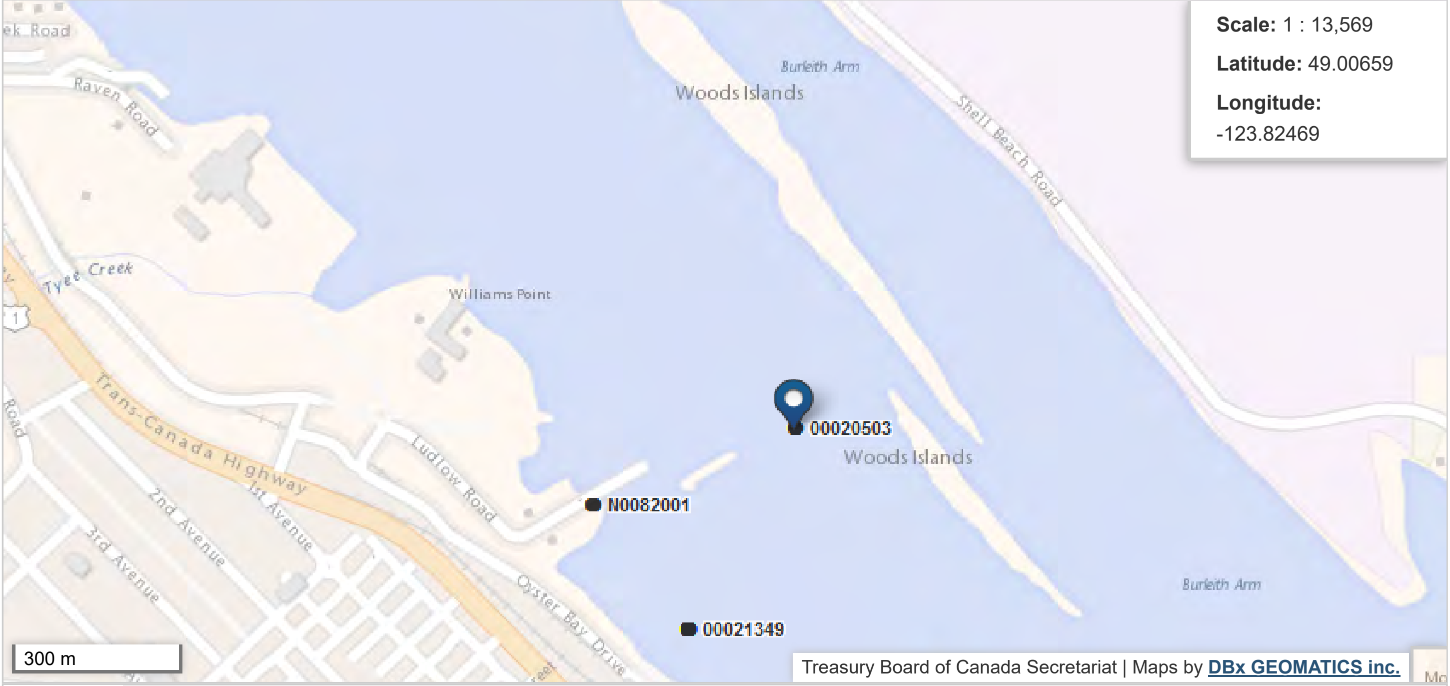
## Key Map of British Columbia

**APPENDIX D**

# Federal Contaminated Site Inventory

## DFRP/FCSI - Map Navigator

**Area:** Ladysmith, Cowichan Valley H **Content:** 0 Federal Property, 0 Federal Building, 7 Federal Contaminated Sites




## Layers

- Federal Properties
- Federal Buildings
- Federal Contaminated Sites
- Economic Region
- Census Divisions
- Census Subdivisions
- Metropolitan Areas
- Federal Electoral Districts
- Treaty Areas

1 This layer is visible only when the map scale is smaller than 1:3,000,000.

2 Suspected Active Closed

3 Google base maps are only available when the map scale is smaller than 1:60,000.

The tables content is currently representating the actual map.

UPDATE TABLES

Federal Properties (0) / Parcels (0) | Federal Buildings (0) | Federal Contaminated Sites (7)

Number of rows per page: 25 Page(s): 1 / 1

| Site Number | Reporting Organization or Branch | Internal Identifier | Site Name |
|---|---|---|---|
| 00020503 | Fisheries and Oceans Canada | P K 01227 | Ladysmith Boat Basin No. 1 - Unassessed |
| 00021349 | Fisheries and Oceans Canada | P S 06086 | Ladysmith (Waste Oil ASTs) |
| 00021350 | Fisheries and Oceans Canada | P S 06086 | Ladysmith (Nearshore Sediment and surface water) |
| 00021352 | Fisheries and Oceans Canada | P S 06086 | Ladysmith (Boat Grid) |
| 00021353 | Fisheries and Oceans Canada | P S 06086 | Ladysmith (Fill Material) |
| 00021354 | Fisheries and Oceans Canada | P S 06086 | Ladysmith (Stormwater Discharge) |
| N0082001 | Transport Canada | N0082001 | Waterlot |

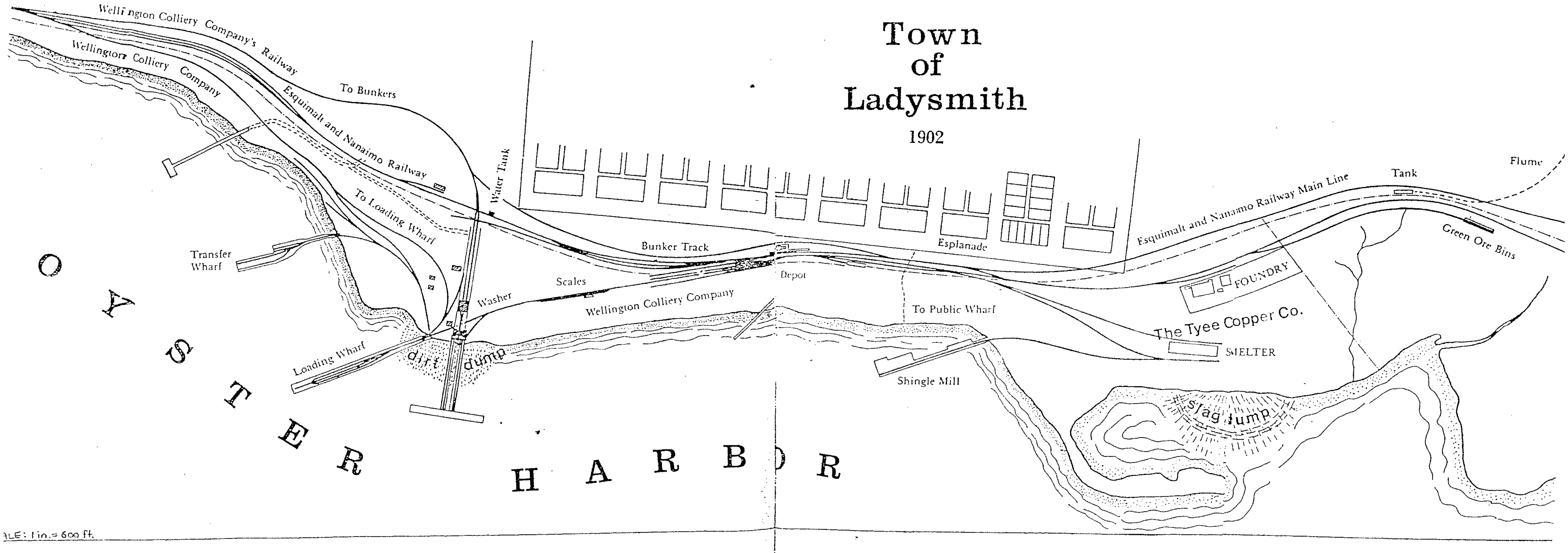
Number of rows per page: 25 Page(s): 1 / 1

**APPENDIX E**

# Local and Regional Government Responses

07/07/01 · 8 :5

The E&N Railway 1884-1905 Donald F. MacLachlan



**From:** User - Infoaction [infoaction@vpl.ca]
**Sent:** September 4, 2009 4:43 PM
**To:** Daniels, Amber
**Subject:** RE: Directory Search

Hi Amber,

I'm terribly sorry but there are no city directories with street indexes for Ladysmith, so we will not be able to carry out this search for you.

Regrets,

Claudia

InfoAction
Vancouver Public Library's Information & Research Centre
Level 5, 350 West Georgia St.
Vancouver, BC V6B 6B1
t. 604-331-3612
f. 604-331-3611
e. infoaction@vpl.ca

http://www.infoaction.ca

---

**From:** Daniels, Amber [Amber_Daniels@golder.com]
**Sent:** Friday, September 04, 2009 4:01 PM
**To:** User - Infoaction
**Subject:** Directory Search

Hello! I was hoping someone could perform an historical directory search for Ladysmith: Please go back as far as possible, if you will go over 100 or so dollars please give me a call. I am specifically looking for these streets:

All of: Oyster Bay Drive
Captain de Konnick Way
Transfer Beach Blvd
Oyster Cove Rd
Ludlow Rd

Blocks 100-600 for First and Second Avenues
Blocks 0-200 for Buller St, High St, Gatacre St, Roberts St. Baden-Powell St, White Street, and Methuen Street

Thanks so much, PO # 09-1436-5008

Amber Daniels

---

**Amber Daniels (B.Sc., GradTech.)** | Environmental Scientist | **Golder Associates Ltd.**
500 - 4260 Still Creek Drive, Burnaby, British Columbia, Canada V5C 6C6
**T:** +1 (604) 296 4200 | **D:** +1 (604) 296-4308 | **F:** +1 (604) 298 5253 | **E:** Amber_Daniels@golder.com |
**www.golder.com**


N:\Bur-Graphics\Projects\2009\1436\09-1436-5008\GIS\projects\3000\figure-02_siteplan.mxd

150 0 150

SCALE 1:6,004 METRES

**LEGEND**

- Site Boundary
- Filled Foreshore
- Uplands
- Water Lot

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

*DRAFT*

**REFERENCE**

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

| | |
|---|---|
| PROJECT | CROWN CONTAMINATED SITES PROGRAM, CROWN LAND OPPORTUNITIES AND RESTORATION BRANCH<br>B.C. MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS<br>LADYSMITH HARBOUR, LADYSMITH, B.C. |
| TITLE | **SITE PLAN<br>SHOWING LEGAL LOTS** |

Golder Associates
Greater Vancouver Office, B.C.

| PROJECT No.09-1436-5008 | | | PHASE No. 3000 | |
|---|---|---|---|---|
| DESIGN | LK | 02SEP10 | SCALE AS SHOWN | REV. 1 |
| GIS | MH | 02SEP10 | **FIGURE 2** | |
| CHECK | | | | |
| REVIEW | | | | |

| | |
|---|---|
| **From:** | Geoff Goodall |
| **To:** | Newman, Mark; Jake Belobaba; Flotten, Dawn |
| **Cc:** | Chatwin-Davies, Robyn |
| **Subject:** | RE: Stage 1: Uplands |
| **Date:** | December 4, 2019 8:37:05 AM |
| **Attachments:** | image006.jpg<br>image008.png<br>image004.png<br>image005.jpg<br>20191204084605826.pdf |

There may be some confusion here, the material that was taken to the site was native material that was removed from the ground at the sewage treatment plant site to facilitate expansion of the plant. To our knowledge there was no contamination in this material. Apparently it was a very sandy material. I have enclosed a map that indicates the approximate area where the material was placed.


Geoff Goodall
Director
Infrastructure Services
250-245-6440
330 6th Avenue MAIL PO Box 220 Ladysmith, BC V9G 1A2

Working together to build our future

**From:** Newman, Mark [mailto:Mark_Newman@golder.com]
**Sent:** December 3, 2019 5:33 PM
**To:** Jake Belobaba; Flotten, Dawn
**Cc:** Geoff Goodall; Chatwin-Davies, Robyn
**Subject:** RE: Stage 1: Uplands

Hi Jake,

Thanks for this. If Geoff is able to provide some more details on where and when the byproducts were deposited, that would be useful (I have attached a figure showing the outlines of the lots for reference).

If you have any information to suggest chemicals (flocculants for example) were disposed of there, that would be useful to know also.

Just to give you a brief update – I have not yet had time to reach out to Kelly or Clayton yet regarding the site visit. I'm hoping to line that up for next week, depending on their schedule.

Thanks,
Mark


**Mark Newman (MSc, PGeo)**
*Environmental Geoscientist*

Golder Associates Ltd.
2nd floor, 3795 Carey Road, Victoria, British Columbia, Canada V8Z 6T8
**D:** +1 250 419 4930 | **T:** +1 250 881 7372 | **C:** +1 604 354 4539 | **golder.com**
LinkedIn | Facebook | Twitter

**Work Safe, Home Safe**



---

**From:** Jake Belobaba <jbelobaba@ladysmith.ca>
**Sent:** December-02-19 3:41 PM
**To:** Flotten, Dawn <Dawn_Flotten@golder.com>; Newman, Mark <Mark_Newman@golder.com>
**Cc:** Geoff Goodall <ggoodall@ladysmith.ca>
**Subject:** RE: Stage 1: Uplands

**EXTERNAL EMAIL**

Hi Dawn and Mark

One more thing I forgot to mention, in the past there had been some disposal of byproducts from the sewage treatment plant on the “jewel” portion of Lot 4. I’ve cc’d Geoff who can provide you with more information about this. We believe this was occurring pre-2012, but will need to do a bit of digging to be sure.

Cheers

---

**From:** Jake Belobaba
**Sent:** November 27, 2019 4:25 PM
**To:** Flotten, Dawn <Dawn_Flotten@golder.com>; 'Newman, Mark' <Mark_Newman@golder.com>
**Cc:** Kelly Giesbrecht (kgiesbrecht@ladysmith.ca) <kgiesbrecht@ladysmith.ca>; Clayton Postings (cpostings@ladysmith.ca) <cpostings@ladysmith.ca>
**Subject:** Stage 1: Uplands

Hi Dawn and Mark

Thanks for the call today. I’ve attached Kelly and Clayton’s contact info. Please contact them to set up site visits and interviews. Clayton should be able to provide you with some contacts of folks from the historical society that worked in the rail facility (if necessary). As I mentioned, there have been some excavations on site that may be useful for the site visit (Kelly can provide more detail). There’s been no industrial use of the site since the original Golder Report in 2012

As always, feel free to contact me if you need any additional info.

Cheers

Jake Belobaba, RPP, MCIP
Director of Development Services
Development Services Department
Phone: 250.245.6405
Cell: 250.616.3755
132C Roberts St MAIL PO Box 220 Ladysmith, BC V9G 1A2

Working together to build our future

**APPENDIX F**

# Site Photos

**Photo 1: Former Railway Repair Building (looking northwest)**

**Photo 2: Bank on the south side of Former Railway Repair Building (looking northwest)**

**Photo 3: Interior of Former Railway Repair Building (looking northwest)**

**Photo 4: Excavation for footing installation inside Former Railway Repair Building (soil sample location HS19-01)**

**Photo 5: Railyard area on Site (looking southeast)**

**Photo 6: Septic access (round metal plate) at the north end of the Washroom Building (looking southwest)**


**Photo 7: Car Shop Building on Site (looking southeast)**

**Photo 8: Stockpiled soil removed from footing installation excavations inside the Former Railway Repair Building located southeast of the Former Railway Repair Building (looking southeast)**

**Photo 9: Historical location of Former Compressor House, oil drum storage area and ASTs (looking southeast)**

**Photo 10: Former Cable Splicing Shed (looking west)**


**Photo 11: Co-Op Cardlock and “Wash me on Ludlow” car wash located adjacent to the north of the Site (looking southeast)**

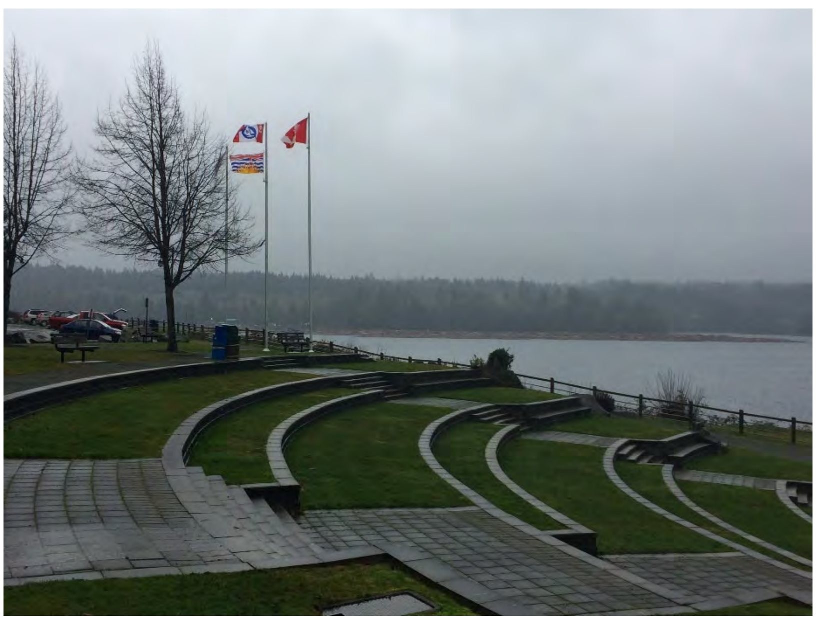


**Photo 12: Slack Point Park located adjacent to the south east of the southeast of the Site (looking north)**

**Photo 13: Shell service station located at 728 Esplanade Avenue located southwest of the Site across the Trans Canada Highway (looking west)**

**APPENDIX G**

# Laboratory Certificate of Analysis

GOLDER ASSOCIATES LTD.
ATTN: Alanna Umphrey
3795 Carey Road, Second Floor
Victoria BC V8Z 6T8

Date Received: 18-DEC-19
Report Date: 27-DEC-19 14:55 (MT)
Version: FINAL

Client Phone: 250-881-7372

# Certificate of Analysis

Lab Work Order #: L2398084

Project P.O. #: NOT SUBMITTED
Job Reference: 18109842
C of C Numbers: 07043
Legal Site Desc:

Amber Springer, B.Sc
Account Manager

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping | Analyte | L2398084-1 | L2398084-2 | L2398084-3 | L2398084-4 | L2398084-5 |
|---|---|---|---|---|---|---|
| | Description | SO | SO | SO | SO | SO |
| | Sampled Date | 16-DEC-19 | 16-DEC-19 | 16-DEC-19 | 16-DEC-19 | 16-DEC-19 |
| | Sampled Time | | | | | |
| | Client ID | 07043-01 | 07043-02 | 07043-03 | 07043-04 | 07043-05 |
| **SOIL** | | | | | | |
| **Physical Tests** | Moisture (%) | 19.0 | 22.8 | 18.3 | 21.4 | 34.0 |
| | pH (1:2 soil:water) (pH) | 6.86 | 8.15 | 8.04 | 7.32 | 5.89 |
| **Metals** | Aluminum (Al) (mg/kg) | 17300 | 20900 | 21000 | 25400 | 21600 |
| | Antimony (Sb) (mg/kg) | 0.12 | 0.14 | 0.15 | 0.20 | 2.78 |
| | Arsenic (As) (mg/kg) | 6.12 | 7.01 | 8.43 | 7.33 | 7.46 |
| | Barium (Ba) (mg/kg) | 67.1 | 73.7 | 83.1 | 81.1 | 325 |
| | Beryllium (Be) (mg/kg) | 0.31 | 0.28 | 0.28 | 0.35 | 0.45 |
| | Bismuth (Bi) (mg/kg) | <0.20 | <0.20 | <0.20 | <0.20 | 0.29 |
| | Boron (B) (mg/kg) | <5.0 | <5.0 | <5.0 | <5.0 | 10.3 |
| | Cadmium (Cd) (mg/kg) | 0.093 | 0.031 | 0.041 | 0.113 | 0.655 |
| | Calcium (Ca) (mg/kg) | 4500 | 9760 | 10200 | 5540 | 7380 |
| | Chromium (Cr) (mg/kg) | 29.3 | 38.6 | 36.5 | 37.0 | 36.0 |
| | Cobalt (Co) (mg/kg) | 8.35 | 12.3 | 12.1 | 12.3 | 11.4 |
| | Copper (Cu) (mg/kg) | 23.4 | 49.4 | 49.6 | 31.4 | 118 |
| | Iron (Fe) (mg/kg) | 22500 | 30600 | 31800 | 35300 | 23200 |
| | Lead (Pb) (mg/kg) | 4.29 | 2.57 | 2.80 | 5.88 | 59.4 |
| | Lithium (Li) (mg/kg) | 17.5 | 13.7 | 13.1 | 13.0 | 17.9 |
| | Magnesium (Mg) (mg/kg) | 4640 | 6660 | 6570 | 5540 | 5560 |
| | Manganese (Mn) (mg/kg) | 205 | 532 | 553 | 918 | 301 |
| | Mercury (Hg) (mg/kg) | 0.055 | 0.063 | 0.051 | 0.051 | 0.175 |
| | Molybdenum (Mo) (mg/kg) | 0.78 | 0.21 | 0.25 | 1.98 | 1.17 |
| | Nickel (Ni) (mg/kg) | 16.1 | 21.9 | 21.1 | 20.8 | 32.4 |
| | Phosphorus (P) (mg/kg) | 194 | 557 | 529 | 253 | 473 |
| | Potassium (K) (mg/kg) | 350 | 590 | 610 | 440 | 590 |
| | Selenium (Se) (mg/kg) | <0.20 | <0.20 | <0.20 | 0.27 | 0.83 |
| | Silver (Ag) (mg/kg) | <0.10 | <0.10 | <0.10 | <0.10 | 0.21 |
| | Sodium (Na) (mg/kg) | 246 | 604 | 668 | 314 | 332 |
| | Strontium (Sr) (mg/kg) | 32.0 | 67.8 | 72.8 | 59.5 | 68.6 |
| | Sulfur (S) (mg/kg) | <1000 | <1000 | <1000 | <1000 | <1000 |
| | Thallium (Tl) (mg/kg) | <0.050 | <0.050 | <0.050 | <0.050 | 0.063 |
| | Tin (Sn) (mg/kg) | <2.0 | <2.0 | <2.0 | <2.0 | 5.6 |
| | Titanium (Ti) (mg/kg) | 1350 | 1520 | 1760 | 1740 | 1280 |
| | Tungsten (W) (mg/kg) | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| | Uranium (U) (mg/kg) | 0.533 | 0.258 | 0.271 | 0.404 | 0.515 |
| | Vanadium (V) (mg/kg) | 78.8 | 82.5 | 91.5 | 116 | 82.6 |
| | Zinc (Zn) (mg/kg) | 30.8 | 34.0 | 33.8 | 33.5 | 132 |
| | Zirconium (Zr) (mg/kg) | 3.9 | 5.5 | 6.1 | 3.2 | 4.4 |



* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping | Analyte | L2398084-1 | L2398084-2 | L2398084-3 | L2398084-4 | L2398084-5 |
|---|---|---|---|---|---|---|
| | Description | SO | SO | SO | SO | SO |
| | Sampled Date | 16-DEC-19 | 16-DEC-19 | 16-DEC-19 | 16-DEC-19 | 16-DEC-19 |
| | Sampled Time | | | | | |
| | Client ID | 07043-01 | 07043-02 | 07043-03 | 07043-04 | 07043-05 |
| **SOIL** | | | | | | |
| **Volatile Organic Compounds** | VOC Sample Container | Field MeOH | Field MeOH | Field MeOH | Field MeOH | Field MeOH |
| | Benzene (mg/kg) | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 |
| | Ethylbenzene (mg/kg) | <0.015 | <0.015 | <0.015 | <0.015 | <0.015 |
| | Methyl t-butyl ether (MTBE) (mg/kg) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| | Styrene (mg/kg) | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| | Toluene (mg/kg) | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| | ortho-Xylene (mg/kg) | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| | meta- & para-Xylene (mg/kg) | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| | Xylenes (mg/kg) | <0.075 | <0.075 | <0.075 | <0.075 | <0.075 |
| | Surrogate: 4-Bromofluorobenzene (SS) (%) | 95.7 | 96.0 | 91.3 | 89.3 | 87.5 |
| | Surrogate: 1,4-Difluorobenzene (SS) (%) | 87.8 | 88.3 | 85.2 | 84.0 | 80.8 |
| **Hydrocarbons** | EPH10-19 (mg/kg) | <200 | <200 | <200 | <200 | <200 |
| | EPH19-32 (mg/kg) | <200 | <200 | <200 | <200 | <200 |
| | LEPH (mg/kg) | <200 | <200 | <200 | <200 | <200 |
| | HEPH (mg/kg) | <200 | <200 | <200 | <200 | <200 |
| | Surrogate: 2-Bromobenzotrifluoride (%) | 99.4 | 103.3 | 94.9 | 98.1 | 103.0 |
| **Polycyclic Aromatic Hydrocarbons** | Acenaphthene (mg/kg) | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.040 DLCI |
| | Acenaphthylene (mg/kg) | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.030 DLCI |
| | Anthracene (mg/kg) | <0.0040 | <0.0040 | <0.0040 | <0.0040 | <0.090 DLCI |
| | Benz(a)anthracene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.113 |
| | Benzo(a)pyrene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.072 |
| | Benzo(b&j)fluoranthene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.135 |
| | Benzo(b+j+k)fluoranthene (mg/kg) | <0.015 | <0.015 | <0.015 | <0.015 | 0.177 |
| | Benzo(g,h,i)perylene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.073 |
| | Benzo(k)fluoranthene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.042 |
| | Chrysene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.125 |
| | Dibenz(a,h)anthracene (mg/kg) | <0.0050 | <0.0050 | <0.0050 | <0.0050 | 0.0137 |
| | Fluoranthene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.196 |
| | Fluorene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.066 |
| | Indeno(1,2,3-c,d)pyrene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.056 |
| | 1-Methylnaphthalene (mg/kg) | <0.050 | <0.050 | <0.050 | <0.050 | 0.499 |
| | 2-Methylnaphthalene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.521 |
| | Naphthalene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.183 |
| | Phenanthrene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.706 |
| | Pyrene (mg/kg) | <0.010 | <0.010 | <0.010 | <0.010 | 0.171 |
| | Quinoline (mg/kg) | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |



* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Sample ID** | L2398084-1 | L2398084-2 | L2398084-3 | L2398084-4 | L2398084-5 |
| | **Description** | SO | SO | SO | SO | SO |
| | **Sampled Date** | 16-DEC-19 | 16-DEC-19 | 16-DEC-19 | 16-DEC-19 | 16-DEC-19 |
| | **Sampled Time** | | | | | |
| | **Client ID** | 07043-01 | 07043-02 | 07043-03 | 07043-04 | 07043-05 |
| **Grouping** | **Analyte** | | | | | |
| **SOIL** | | | | | | |
| **Polycyclic Aromatic Hydrocarbons** | Surrogate: Chrysene d12 (%) | 102.2 | 98.6 | 101.8 | 96.8 | 96.9 |
| | Surrogate: Naphthalene d8 (%) | 97.7 | 95.0 | 98.7 | 95.0 | 97.6 |
| | Surrogate: Phenanthrene d10 (%) | 104.3 | 111.8 | 125.6 | 117.9 | 116.1 |
| | B(a)P Total Potency Equivalent (mg/kg) | <0.020 | <0.020 | <0.020 | <0.020 | 0.122 |
| | IACR (CCME) | <0.15 | <0.15 | <0.15 | <0.15 | 1.79 |



* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# Reference Information

**QC Samples with Qualifiers & Comments:**

| QC Type Description | Parameter | Qualifier | Applies to Sample Number(s) |
|---|---|---|---|
| Duplicate | Cadmium (Cd) | DUP-H | L2398084-1, -2, -3, -4, -5 |
| Duplicate | Manganese (Mn) | DUP-H | L2398084-1, -2, -3, -4, -5 |

**Qualifiers for Individual Parameters Listed:**

| Qualifier | Description |
|---|---|
| DLCI | Detection Limit Raised: Chromatographic Interference due to co-elution. |
| DUP-H | Duplicate results outside ALS DQO, due to sample heterogeneity. |

## Test Method References:

| ALS Test Code | Matrix | Test Description | Method Reference** |
|---|---|---|---|
| **EPH-TUMB-FID-VA** | Soil | EPH in Solids by Tumbler and GCFID | BC MOE EPH GCFID |

Analysis is in accordance with BC MOE Lab Manual method "Extractable Petroleum Hydrocarbons in Solids by GC/FID", v2.1, July 1999. Soil samples are extracted with a 1:1 mixture of hexane and acetone using a rotary extraction technique modified from EPA 3570 prior to gas chromatography with flame ionization detection (GC-FID). EPH results include Polycyclic Aromatic Hydrocarbons (PAH) and are therefore not equivalent to Light and Heavy Extractable Petroleum Hydrocarbons (LEPH/HEPH).

| | | | |
|---|---|---|---|
| **HG-200.2-CVAF-VA** | Soil | Mercury in Soil by CVAAS | EPA 200.2/1631E (mod) |

Soil samples are digested with hot nitric and hydrochloric acids, followed by CVAAS analysis. This method is fully compliant with the BC SALM strong acid leachable metals digestion method.

| | | | |
|---|---|---|---|
| **LEPH/HEPH-CALC-VA** | Soil | LEPHs and HEPHs | BC MOE LEPH/HEPH |

LEPHs and HEPHs are measures of Light and Heavy Extractable Petroleum Hydrocarbons in soil. Results are calculated by subtraction of applicable PAH concentrations from EPH10-19 and EPH19-32, as per the BC Lab Manual LEPH/HEPH calculation procedure.

LEPHs = EPH10-19 minus Naphthalene and Phenanthrene.

HEPHs = EPH19-32 minus Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and Pyrene.

| | | | |
|---|---|---|---|
| **MET-200.2-CCMS-VA** | Soil | Metals in Soil by CRC ICPMS | EPA 200.2/6020A (mod) |

Soil/sediment is dried, disaggregated, and sieved (2 mm). Strong Acid Leachable Metals in the <2mm fraction are solubilized by heated digestion with nitric and hydrochloric acids. Instrumental analysis is by Collision / Reaction Cell ICPMS.

Limitations: This method is intended to liberate environmentally available metals. Silicate minerals are not solubilized. Some metals may be only partially recovered (matrix dependent), including Al, Ba, Be, Cr, S, Sr, Ti, Tl, V, W, and Zr. Elemental Sulfur may be poorly recovered by this method. Volatile forms of sulfur (e.g. sulfide, H2S) may be excluded if lost during sampling, storage, or digestion.

| | | | |
|---|---|---|---|
| **MOISTURE-VA** | Soil | Moisture content | CCME PHC in Soil - Tier 1 (mod) |

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of two hours.

| | | | |
|---|---|---|---|
| **PAH-TMB-H/A-MS-VA** | Soil | PAH - Rotary Extraction (Hexane/Acetone) | EPA 3570/8270 |

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3570 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a mechanical shaking technique to extract a subsample of the sediment/soil with a 1:1 mixture of hexane and acetone. The extract is then solvent exchanged to toluene. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Surrogate recoveries may not be reported in cases where interferences from the sample matrix prevent accurate quantitation. Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.

Benzo(a)pyrene Total Potency Equivalents [B(a)P TPE] represents the sum of estimated cancer potency relative to B(a)P for all potentially carcinogenic unsubstituted PAHs, and is calculated as per the CCME PAH Soil Quality Guidelines reference document (2010).

| | | | |
|---|---|---|---|
| **PH-1:2-VA** | Soil | pH in Soil (1:2 Soil:Water Extraction) | BC WLAP METHOD: PH, ELECTROMETRIC, SOIL |

This analysis is carried out in accordance with procedures described in "pH, Electrometric in Soil and Sediment - Prescriptive Method", Rev. 2005, Section B Physical, Inorganic and Misc. Constituents, BC Environmental Laboratory Manual. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

| | | | |
|---|---|---|---|
| **VOC7-L-HSMS-VA** | Soil | VOCs in soil by Headspace GCMS | EPA 5035A/5021A/8260C |

The soil methanol extract is added to water and reagents, then heated in a sealed vial to equilibrium. The headspace from the vial is transferred into a gas chromatograph. Target compound concentrations are measured using mass spectrometry detection.

| | | | |
|---|---|---|---|
| **VOC7/VOC-SURR-MS-VA** | Soil | VOC7 and/or VOC Surrogates for Soils | EPA 5035A/5021A/8260C |
| **XYLENES-CALC-VA** | Soil | Sum of Xylene Isomer Concentrations | EPA 8260B & 524.2 |

Calculation of Total Xylenes

Total Xylenes is the sum of the concentrations of the ortho, meta, and para Xylene isomers. Results below detection limit (DL) are treated as zero. The DL for Total Xylenes is set to a value no less than the square root of the sum of the squares of the DLs of the individual Xylenes.

# Reference Information

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location |
|---|---|
| VA | ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA |

**Chain of Custody Numbers:**

07043

**GLOSSARY OF REPORT TERMS**

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*
*mg/kg - milligrams per kilogram based on dry weight of sample.*
*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*
*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*
*mg/L - milligrams per litre.*
*< - Less than.*
*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*
*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*
*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*
*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*

# Quality Control Report



Client: GOLDER ASSOCIATES LTD.
3795 Carey Road, Second Floor
Victoria BC V8Z 6T8
Contact: Alanna Umphrey

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **EPH-TUMB-FID-VA** | **Soil** | | | | | | | |
| **Batch R4945676** | | | | | | | | |
| **WG3245924-3 DUP** | | **L2398084-4** | | | | | | |
| EPH10-19 | | <200 | <200 | RPD-NA | mg/kg | N/A | 40 | 20-DEC-19 |
| EPH19-32 | | <200 | <200 | RPD-NA | mg/kg | N/A | 40 | 20-DEC-19 |
| **WG3245924-4 IRM** | | **ALS PHC RM3** | | | | | | |
| EPH10-19 | | | 104.7 | | % | | 70-130 | 20-DEC-19 |
| EPH19-32 | | | 111.1 | | % | | 70-130 | 20-DEC-19 |
| **WG3245924-2 LCS** | | | | | | | | |
| EPH10-19 | | | 107.3 | | % | | 70-130 | 20-DEC-19 |
| EPH19-32 | | | 102.7 | | % | | 70-130 | 20-DEC-19 |
| **WG3245924-1 MB** | | | | | | | | |
| EPH10-19 | | | <200 | | mg/kg | | 200 | 20-DEC-19 |
| EPH19-32 | | | <200 | | mg/kg | | 200 | 20-DEC-19 |
| Surrogate: 2-Bromobenzotrifluoride | | | 101.9 | | % | | 60-140 | 20-DEC-19 |
| **HG-200.2-CVAF-VA** | **Soil** | | | | | | | |
| **Batch R4949181** | | | | | | | | |
| **WG3245929-4 CRM** | | **VA-CANMET-TILL2** | | | | | | |
| Mercury (Hg) | | | 106.4 | | % | | 70-130 | 20-DEC-19 |
| **WG3245929-2 DUP** | | **L2398084-4** | | | | | | |
| Mercury (Hg) | | 0.051 | 0.059 | | mg/kg | 16 | 40 | 20-DEC-19 |
| **WG3245929-3 LCS** | | | | | | | | |
| Mercury (Hg) | | | 105.7 | | % | | 80-120 | 20-DEC-19 |
| **WG3245929-1 MB** | | | | | | | | |
| Mercury (Hg) | | | <0.0050 | | mg/kg | | 0.005 | 20-DEC-19 |
| **MET-200.2-CCMS-VA** | **Soil** | | | | | | | |
| **Batch R4947508** | | | | | | | | |
| **WG3245929-4 CRM** | | **VA-CANMET-TILL2** | | | | | | |
| Aluminum (Al) | | | 98.1 | | % | | 70-130 | 19-DEC-19 |
| Antimony (Sb) | | | 101.6 | | % | | 70-130 | 19-DEC-19 |
| Arsenic (As) | | | 102.1 | | % | | 70-130 | 19-DEC-19 |
| Barium (Ba) | | | 101.4 | | % | | 70-130 | 19-DEC-19 |
| Beryllium (Be) | | | 98.4 | | % | | 70-130 | 19-DEC-19 |
| Bismuth (Bi) | | | 96.9 | | % | | 70-130 | 19-DEC-19 |
| Cadmium (Cd) | | | 102.1 | | % | | 70-130 | 19-DEC-19 |
| Calcium (Ca) | | | 105.5 | | % | | 70-130 | 19-DEC-19 |
| Copper (Cu) | | | 98.1 | | % | | 70-130 | 19-DEC-19 |
| Iron (Fe) | | | 106.8 | | % | | 70-130 | 19-DEC-19 |
| Lead (Pb) | | | 93.9 | | % | | 70-130 | 19-DEC-19 |

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **MET-200.2-CCMS-VA** | **Soil** | | | | | | | |
| **Batch R4947508** | | | | | | | | |
| **WG3245929-4 CRM** | | **VA-CANMET-TILL2** | | | | | | |
| Lithium (Li) | | | 108.7 | | % | | 70-130 | 19-DEC-19 |
| Magnesium (Mg) | | | 101.0 | | % | | 70-130 | 19-DEC-19 |
| Manganese (Mn) | | | 99.1 | | % | | 70-130 | 19-DEC-19 |
| Molybdenum (Mo) | | | 98.9 | | % | | 70-130 | 19-DEC-19 |
| Nickel (Ni) | | | 102.4 | | % | | 70-130 | 19-DEC-19 |
| Phosphorus (P) | | | 94.3 | | % | | 70-130 | 19-DEC-19 |
| Potassium (K) | | | 103.7 | | % | | 70-130 | 19-DEC-19 |
| Selenium (Se) | | | 0.40 | | mg/kg | | 0.15-0.55 | 19-DEC-19 |
| Silver (Ag) | | | 0.26 | | mg/kg | | 0.16-0.36 | 19-DEC-19 |
| Sodium (Na) | | | 103.0 | | % | | 70-130 | 19-DEC-19 |
| Strontium (Sr) | | | 100.3 | | % | | 70-130 | 19-DEC-19 |
| Thallium (Tl) | | | 95.9 | | % | | 70-130 | 19-DEC-19 |
| Tin (Sn) | | | 2.4 | | mg/kg | | 0.2-4.2 | 19-DEC-19 |
| Titanium (Ti) | | | 102.8 | | % | | 70-130 | 19-DEC-19 |
| Tungsten (W) | | | 1.27 | | mg/kg | | 1-2 | 19-DEC-19 |
| Uranium (U) | | | 96.4 | | % | | 70-130 | 19-DEC-19 |
| Vanadium (V) | | | 104.4 | | % | | 70-130 | 19-DEC-19 |
| Zinc (Zn) | | | 96.2 | | % | | 70-130 | 19-DEC-19 |
| **WG3245929-3 LCS** | | | | | | | | |
| Aluminum (Al) | | | 104.0 | | % | | 80-120 | 19-DEC-19 |
| Antimony (Sb) | | | 91.3 | | % | | 80-120 | 19-DEC-19 |
| Arsenic (As) | | | 97.5 | | % | | 80-120 | 19-DEC-19 |
| Barium (Ba) | | | 106.5 | | % | | 80-120 | 19-DEC-19 |
| Beryllium (Be) | | | 93.7 | | % | | 80-120 | 19-DEC-19 |
| Bismuth (Bi) | | | 88.1 | | % | | 80-120 | 19-DEC-19 |
| Boron (B) | | | 94.0 | | % | | 80-120 | 19-DEC-19 |
| Cadmium (Cd) | | | 97.4 | | % | | 80-120 | 19-DEC-19 |
| Calcium (Ca) | | | 99.1 | | % | | 80-120 | 19-DEC-19 |
| Chromium (Cr) | | | 104.3 | | % | | 80-120 | 19-DEC-19 |
| Cobalt (Co) | | | 99.7 | | % | | 80-120 | 19-DEC-19 |
| Copper (Cu) | | | 94.5 | | % | | 80-120 | 19-DEC-19 |
| Iron (Fe) | | | 110.9 | | % | | 80-120 | 19-DEC-19 |
| Lead (Pb) | | | 92.2 | | % | | 80-120 | 19-DEC-19 |
| Lithium (Li) | | | 93.7 | | % | | 80-120 | 19-DEC-19 |

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **MET-200.2-CCMS-VA** | **Soil** | | | | | | | |
| **Batch R4947508** | | | | | | | | |
| **WG3245929-3 LCS** | | | | | | | | |
| Magnesium (Mg) | | | 105.6 | | % | | 80-120 | 19-DEC-19 |
| Manganese (Mn) | | | 104.4 | | % | | 80-120 | 19-DEC-19 |
| Molybdenum (Mo) | | | 95.7 | | % | | 80-120 | 19-DEC-19 |
| Nickel (Ni) | | | 98.5 | | % | | 80-120 | 19-DEC-19 |
| Phosphorus (P) | | | 100.3 | | % | | 80-120 | 19-DEC-19 |
| Potassium (K) | | | 103.8 | | % | | 80-120 | 19-DEC-19 |
| Selenium (Se) | | | 97.9 | | % | | 80-120 | 19-DEC-19 |
| Silver (Ag) | | | 94.5 | | % | | 80-120 | 19-DEC-19 |
| Sodium (Na) | | | 99.9 | | % | | 80-120 | 19-DEC-19 |
| Strontium (Sr) | | | 92.7 | | % | | 80-120 | 19-DEC-19 |
| Sulfur (S) | | | 94.5 | | % | | 80-120 | 19-DEC-19 |
| Thallium (Tl) | | | 87.8 | | % | | 80-120 | 19-DEC-19 |
| Tin (Sn) | | | 92.5 | | % | | 80-120 | 19-DEC-19 |
| Titanium (Ti) | | | 99.5 | | % | | 80-120 | 19-DEC-19 |
| Tungsten (W) | | | 96.3 | | % | | 80-120 | 19-DEC-19 |
| Uranium (U) | | | 97.7 | | % | | 80-120 | 19-DEC-19 |
| Vanadium (V) | | | 103.4 | | % | | 80-120 | 19-DEC-19 |
| Zinc (Zn) | | | 94.9 | | % | | 80-120 | 19-DEC-19 |
| Zirconium (Zr) | | | 99.1 | | % | | 70-130 | 19-DEC-19 |
| **WG3245929-1 MB** | | | | | | | | |
| Aluminum (Al) | | | <50 | | mg/kg | | 50 | 19-DEC-19 |
| Antimony (Sb) | | | <0.10 | | mg/kg | | 0.1 | 19-DEC-19 |
| Arsenic (As) | | | <0.10 | | mg/kg | | 0.1 | 19-DEC-19 |
| Barium (Ba) | | | <0.50 | | mg/kg | | 0.5 | 19-DEC-19 |
| Beryllium (Be) | | | <0.10 | | mg/kg | | 0.1 | 19-DEC-19 |
| Bismuth (Bi) | | | <0.20 | | mg/kg | | 0.2 | 19-DEC-19 |
| Boron (B) | | | <5.0 | | mg/kg | | 5 | 19-DEC-19 |
| Cadmium (Cd) | | | <0.020 | | mg/kg | | 0.02 | 19-DEC-19 |
| Calcium (Ca) | | | <50 | | mg/kg | | 50 | 19-DEC-19 |
| Chromium (Cr) | | | <0.50 | | mg/kg | | 0.5 | 19-DEC-19 |
| Cobalt (Co) | | | <0.10 | | mg/kg | | 0.1 | 19-DEC-19 |
| Copper (Cu) | | | <0.50 | | mg/kg | | 0.5 | 19-DEC-19 |
| Iron (Fe) | | | <50 | | mg/kg | | 50 | 19-DEC-19 |
| Lead (Pb) | | | <0.50 | | mg/kg | | 0.5 | 19-DEC-19 |

ALS Environmental

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **MET-200.2-CCMS-VA** | **Soil** | | | | | | | |
| **Batch R4947508** | | | | | | | | |
| **WG3245929-1 MB** | | | | | | | | |
| Lithium (Li) | | | <2.0 | | mg/kg | | 2 | 19-DEC-19 |
| Magnesium (Mg) | | | <20 | | mg/kg | | 20 | 19-DEC-19 |
| Manganese (Mn) | | | <1.0 | | mg/kg | | 1 | 19-DEC-19 |
| Molybdenum (Mo) | | | <0.10 | | mg/kg | | 0.1 | 19-DEC-19 |
| Nickel (Ni) | | | <0.50 | | mg/kg | | 0.5 | 19-DEC-19 |
| Phosphorus (P) | | | <50 | | mg/kg | | 50 | 19-DEC-19 |
| Potassium (K) | | | <100 | | mg/kg | | 100 | 19-DEC-19 |
| Selenium (Se) | | | <0.20 | | mg/kg | | 0.2 | 19-DEC-19 |
| Silver (Ag) | | | <0.10 | | mg/kg | | 0.1 | 19-DEC-19 |
| Sodium (Na) | | | <50 | | mg/kg | | 50 | 19-DEC-19 |
| Strontium (Sr) | | | <0.50 | | mg/kg | | 0.5 | 19-DEC-19 |
| Sulfur (S) | | | <1000 | | mg/kg | | 1000 | 19-DEC-19 |
| Thallium (Tl) | | | <0.050 | | mg/kg | | 0.05 | 19-DEC-19 |
| Tin (Sn) | | | <2.0 | | mg/kg | | 2 | 19-DEC-19 |
| Titanium (Ti) | | | <1.0 | | mg/kg | | 1 | 19-DEC-19 |
| Tungsten (W) | | | <0.50 | | mg/kg | | 0.5 | 19-DEC-19 |
| Uranium (U) | | | <0.050 | | mg/kg | | 0.05 | 19-DEC-19 |
| Vanadium (V) | | | <0.20 | | mg/kg | | 0.2 | 19-DEC-19 |
| Zinc (Zn) | | | <2.0 | | mg/kg | | 2 | 19-DEC-19 |
| Zirconium (Zr) | | | <1.0 | | mg/kg | | 1 | 19-DEC-19 |
| **Batch R4954687** | | | | | | | | |
| **WG3245929-2 DUP** | | **L2398084-4** | | | | | | |
| Aluminum (Al) | | 25400 | 24700 | | mg/kg | 2.7 | 40 | 23-DEC-19 |
| Antimony (Sb) | | 0.20 | 0.26 | | mg/kg | 25 | 30 | 23-DEC-19 |
| Arsenic (As) | | 7.33 | 8.65 | | mg/kg | 17 | 30 | 23-DEC-19 |
| Barium (Ba) | | 81.1 | 94.6 | | mg/kg | 15 | 40 | 23-DEC-19 |
| Beryllium (Be) | | 0.35 | 0.37 | | mg/kg | 6.2 | 30 | 23-DEC-19 |
| Bismuth (Bi) | | <0.20 | <0.20 | RPD-NA | mg/kg | N/A | 30 | 23-DEC-19 |
| Boron (B) | | <5.0 | <5.0 | RPD-NA | mg/kg | N/A | 30 | 23-DEC-19 |
| Cadmium (Cd) | | 0.113 | 0.179 | DUP-H | mg/kg | 45 | 30 | 23-DEC-19 |
| Calcium (Ca) | | 5540 | 5640 | | mg/kg | 1.9 | 30 | 23-DEC-19 |
| Chromium (Cr) | | 37.0 | 35.8 | | mg/kg | 3.2 | 30 | 23-DEC-19 |
| Cobalt (Co) | | 12.3 | 13.6 | | mg/kg | 10 | 30 | 23-DEC-19 |
| Copper (Cu) | | 31.4 | 33.8 | | mg/kg | 7.6 | 30 | 23-DEC-19 |

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **MET-200.2-CCMS-VA** | **Soil** | | | | | | | |
| **Batch R4954687** | | | | | | | | |
| **WG3245929-2 DUP** | | **L2398084-4** | | | | | | |
| Iron (Fe) | | 35300 | 33500 | | mg/kg | 5.2 | 30 | 23-DEC-19 |
| Lead (Pb) | | 5.88 | 6.21 | | mg/kg | 5.4 | 40 | 23-DEC-19 |
| Lithium (Li) | | 13.0 | 12.0 | | mg/kg | 7.6 | 30 | 23-DEC-19 |
| Magnesium (Mg) | | 5540 | 5200 | | mg/kg | 6.4 | 30 | 23-DEC-19 |
| Manganese (Mn) | | 918 | 2830 | DUP-H | mg/kg | 102 | 30 | 23-DEC-19 |
| Molybdenum (Mo) | | 1.98 | 2.40 | | mg/kg | 19 | 40 | 23-DEC-19 |
| Nickel (Ni) | | 20.8 | 22.6 | | mg/kg | 8.2 | 30 | 23-DEC-19 |
| Phosphorus (P) | | 253 | 261 | | mg/kg | 3.2 | 30 | 23-DEC-19 |
| Potassium (K) | | 440 | 460 | | mg/kg | 5.0 | 40 | 23-DEC-19 |
| Selenium (Se) | | 0.27 | 0.23 | | mg/kg | 17 | 30 | 23-DEC-19 |
| Silver (Ag) | | <0.10 | <0.10 | RPD-NA | mg/kg | N/A | 40 | 23-DEC-19 |
| Sodium (Na) | | 314 | 298 | | mg/kg | 5.1 | 40 | 23-DEC-19 |
| Strontium (Sr) | | 59.5 | 55.9 | | mg/kg | 6.2 | 40 | 23-DEC-19 |
| Sulfur (S) | | <1000 | <1000 | RPD-NA | mg/kg | N/A | 30 | 23-DEC-19 |
| Thallium (Tl) | | <0.050 | 0.061 | RPD-NA | mg/kg | N/A | 30 | 23-DEC-19 |
| Tin (Sn) | | <2.0 | <2.0 | RPD-NA | mg/kg | N/A | 40 | 23-DEC-19 |
| Titanium (Ti) | | 1740 | 1710 | | mg/kg | 2.1 | 40 | 23-DEC-19 |
| Tungsten (W) | | <0.50 | <0.50 | RPD-NA | mg/kg | N/A | 30 | 23-DEC-19 |
| Uranium (U) | | 0.404 | 0.402 | | mg/kg | 0.6 | 30 | 23-DEC-19 |
| Vanadium (V) | | 116 | 117 | | mg/kg | 0.8 | 30 | 23-DEC-19 |
| Zinc (Zn) | | 33.5 | 34.0 | | mg/kg | 1.3 | 30 | 23-DEC-19 |
| Zirconium (Zr) | | 3.2 | 3.0 | | mg/kg | 4.7 | 30 | 23-DEC-19 |
| **MOISTURE-VA** | **Soil** | | | | | | | |
| **Batch R4945927** | | | | | | | | |
| **WG3245930-3 DUP** | | **L2398084-2** | | | | | | |
| Moisture | | 22.8 | 21.1 | | % | 7.4 | 20 | 18-DEC-19 |
| **WG3245930-2 LCS** | | | | | | | | |
| Moisture | | | 100.5 | | % | | 90-110 | 18-DEC-19 |
| **WG3245930-1 MB** | | | | | | | | |
| Moisture | | | <0.25 | | % | | 0.25 | 18-DEC-19 |
| **PAH-TMB-H/A-MS-VA** | **Soil** | | | | | | | |
| **Batch R4946245** | | | | | | | | |
| **WG3245924-3 DUP** | | **L2398084-4** | | | | | | |
| Acenaphthene | | <0.0050 | <0.0050 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Acenaphthylene | | <0.0050 | <0.0050 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **PAH-TMB-H/A-MS-VA** | **Soil** | | | | | | | |
| **Batch R4946245** | | | | | | | | |
| **WG3245924-3 DUP** | | **L2398084-4** | | | | | | |
| Anthracene | | <0.0040 | <0.0040 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Benz(a)anthracene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Benzo(a)pyrene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Benzo(b&j)fluoranthene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Benzo(g,h,i)perylene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Benzo(k)fluoranthene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Chrysene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Dibenz(a,h)anthracene | | <0.0050 | <0.0050 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Fluoranthene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Fluorene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Indeno(1,2,3-c,d)pyrene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| 1-Methylnaphthalene | | <0.050 | <0.050 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| 2-Methylnaphthalene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Naphthalene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Phenanthrene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Pyrene | | <0.010 | <0.010 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| Quinoline | | <0.050 | <0.050 | RPD-NA | mg/kg | N/A | 50 | 22-DEC-19 |
| **WG3245924-5 IRM** | | **ALS PAH RM2** | | | | | | |
| Acenaphthene | | | 98.9 | | % | | 60-130 | 22-DEC-19 |
| Acenaphthylene | | | 111.4 | | % | | 60-130 | 22-DEC-19 |
| Anthracene | | | 116.3 | | % | | 60-130 | 22-DEC-19 |
| Benz(a)anthracene | | | 92.7 | | % | | 60-130 | 22-DEC-19 |
| Benzo(a)pyrene | | | 89.6 | | % | | 60-130 | 22-DEC-19 |
| Benzo(b&j)fluoranthene | | | 98.1 | | % | | 60-130 | 22-DEC-19 |
| Benzo(g,h,i)perylene | | | 94.0 | | % | | 60-130 | 22-DEC-19 |
| Benzo(k)fluoranthene | | | 99.4 | | % | | 60-130 | 22-DEC-19 |
| Chrysene | | | 86.2 | | % | | 60-130 | 22-DEC-19 |
| Dibenz(a,h)anthracene | | | 98.7 | | % | | 60-130 | 22-DEC-19 |
| Fluoranthene | | | 96.0 | | % | | 60-130 | 22-DEC-19 |
| Fluorene | | | 95.5 | | % | | 60-130 | 22-DEC-19 |
| Indeno(1,2,3-c,d)pyrene | | | 93.8 | | % | | 60-130 | 22-DEC-19 |
| 1-Methylnaphthalene | | | 93.3 | | % | | 60-130 | 22-DEC-19 |
| 2-Methylnaphthalene | | | 91.1 | | % | | 60-130 | 22-DEC-19 |
| Naphthalene | | | 92.7 | | % | | 50-130 | 22-DEC-19 |

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **PAH-TMB-H/A-MS-VA** | **Soil** | | | | | | | |
| **Batch R4946245** | | | | | | | | |
| **WG3245924-5 IRM** | | **ALS PAH RM2** | | | | | | |
| Phenanthrene | | | 94.1 | | % | | 60-130 | 22-DEC-19 |
| Pyrene | | | 98.0 | | % | | 60-130 | 22-DEC-19 |
| **WG3245924-2 LCS** | | | | | | | | |
| Acenaphthene | | | 94.5 | | % | | 60-130 | 22-DEC-19 |
| Acenaphthylene | | | 93.1 | | % | | 60-130 | 22-DEC-19 |
| Anthracene | | | 96.4 | | % | | 60-130 | 22-DEC-19 |
| Benz(a)anthracene | | | 92.5 | | % | | 60-130 | 22-DEC-19 |
| Benzo(a)pyrene | | | 92.9 | | % | | 60-130 | 22-DEC-19 |
| Benzo(b&j)fluoranthene | | | 94.1 | | % | | 60-130 | 22-DEC-19 |
| Benzo(g,h,i)perylene | | | 80.8 | | % | | 60-130 | 22-DEC-19 |
| Benzo(k)fluoranthene | | | 92.2 | | % | | 60-130 | 22-DEC-19 |
| Chrysene | | | 85.1 | | % | | 60-130 | 22-DEC-19 |
| Dibenz(a,h)anthracene | | | 85.1 | | % | | 60-130 | 22-DEC-19 |
| Fluoranthene | | | 91.9 | | % | | 60-130 | 22-DEC-19 |
| Fluorene | | | 93.8 | | % | | 60-130 | 22-DEC-19 |
| Indeno(1,2,3-c,d)pyrene | | | 88.3 | | % | | 60-130 | 22-DEC-19 |
| 1-Methylnaphthalene | | | 91.9 | | % | | 60-130 | 22-DEC-19 |
| 2-Methylnaphthalene | | | 94.3 | | % | | 60-130 | 22-DEC-19 |
| Naphthalene | | | 93.0 | | % | | 50-130 | 22-DEC-19 |
| Phenanthrene | | | 92.4 | | % | | 60-130 | 22-DEC-19 |
| Pyrene | | | 92.3 | | % | | 60-130 | 22-DEC-19 |
| Quinoline | | | 94.1 | | % | | 60-130 | 22-DEC-19 |
| **WG3245924-1 MB** | | | | | | | | |
| Acenaphthene | | | <0.0050 | | mg/kg | | 0.005 | 22-DEC-19 |
| Acenaphthylene | | | <0.0050 | | mg/kg | | 0.005 | 22-DEC-19 |
| Anthracene | | | <0.0040 | | mg/kg | | 0.004 | 22-DEC-19 |
| Benz(a)anthracene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Benzo(a)pyrene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Benzo(b&j)fluoranthene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Benzo(g,h,i)perylene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Benzo(k)fluoranthene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Chrysene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Dibenz(a,h)anthracene | | | <0.0050 | | mg/kg | | 0.005 | 22-DEC-19 |
| Fluoranthene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Fluorene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |

# Quality Control Report



| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **PAH-TMB-H/A-MS-VA** | **Soil** | | | | | | | |
| **Batch R4946245** | | | | | | | | |
| **WG3245924-1 MB** | | | | | | | | |
| Indeno(1,2,3-c,d)pyrene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| 1-Methylnaphthalene | | | <0.050 | | mg/kg | | 0.05 | 22-DEC-19 |
| 2-Methylnaphthalene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Naphthalene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Phenanthrene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Pyrene | | | <0.010 | | mg/kg | | 0.01 | 22-DEC-19 |
| Quinoline | | | <0.050 | | mg/kg | | 0.05 | 22-DEC-19 |
| Surrogate: Naphthalene d8 | | | 92.3 | | % | | 50-130 | 22-DEC-19 |
| Surrogate: Phenanthrene d10 | | | 97.3 | | % | | 60-130 | 22-DEC-19 |
| Surrogate: Chrysene d12 | | | 94.6 | | % | | 60-130 | 22-DEC-19 |
| **PH-1:2-VA** | **Soil** | | | | | | | |
| **Batch R4947830** | | | | | | | | |
| **WG3245929-2 DUP** | | **L2398084-4** | | | | | | |
| pH (1:2 soil:water) | | 7.32 | 7.30 | J | pH | 0.02 | 0.2 | 19-DEC-19 |
| **VOC7-L-HSMS-VA** | **Soil** | | | | | | | |
| **Batch R4933986** | | | | | | | | |
| **WG3246251-2 LCS** | | | | | | | | |
| Benzene | | | 103.0 | | % | | 70-130 | 19-DEC-19 |
| Ethylbenzene | | | 123.2 | | % | | 70-130 | 19-DEC-19 |
| Methyl t-butyl ether (MTBE) | | | 105.4 | | % | | 70-130 | 19-DEC-19 |
| Styrene | | | 105.1 | | % | | 70-130 | 19-DEC-19 |
| Toluene | | | 96.6 | | % | | 70-130 | 19-DEC-19 |
| meta- & para-Xylene | | | 104.0 | | % | | 70-130 | 19-DEC-19 |
| ortho-Xylene | | | 99.6 | | % | | 70-130 | 19-DEC-19 |
| **WG3246251-1 MB** | | | | | | | | |
| Benzene | | | <0.0050 | | mg/kg | | 0.005 | 19-DEC-19 |
| Ethylbenzene | | | <0.015 | | mg/kg | | 0.015 | 19-DEC-19 |
| Methyl t-butyl ether (MTBE) | | | <0.20 | | mg/kg | | 0.2 | 19-DEC-19 |
| Styrene | | | <0.050 | | mg/kg | | 0.05 | 19-DEC-19 |
| Toluene | | | <0.050 | | mg/kg | | 0.05 | 19-DEC-19 |
| meta- & para-Xylene | | | <0.050 | | mg/kg | | 0.05 | 19-DEC-19 |
| ortho-Xylene | | | <0.050 | | mg/kg | | 0.05 | 19-DEC-19 |

**Legend:**

| | |
|---|---|
| Limit | ALS Control Limit (Data Quality Objectives) |
| DUP | Duplicate |
| RPD | Relative Percent Difference |
| N/A | Not Available |
| LCS | Laboratory Control Sample |
| SRM | Standard Reference Material |
| MS | Matrix Spike |
| MSD | Matrix Spike Duplicate |
| ADE | Average Desorption Efficiency |
| MB | Method Blank |
| IRM | Internal Reference Material |
| CRM | Certified Reference Material |
| CCV | Continuing Calibration Verification |
| CVS | Calibration Verification Standard |
| LCSD | Laboratory Control Sample Duplicate |

**Sample Parameter Qualifier Definitions:**

| Qualifier | Description |
|---|---|
| DUP-H | Duplicate results outside ALS DQO, due to sample heterogeneity. |
| J | Duplicate results and limits are expressed in terms of absolute difference. |
| RPD-NA | Relative Percent Difference Not Available due to result(s) being less than detection limit. |

**Hold Time Exceedances:**

All test results reported with this submission were conducted within ALS recommended hold times.

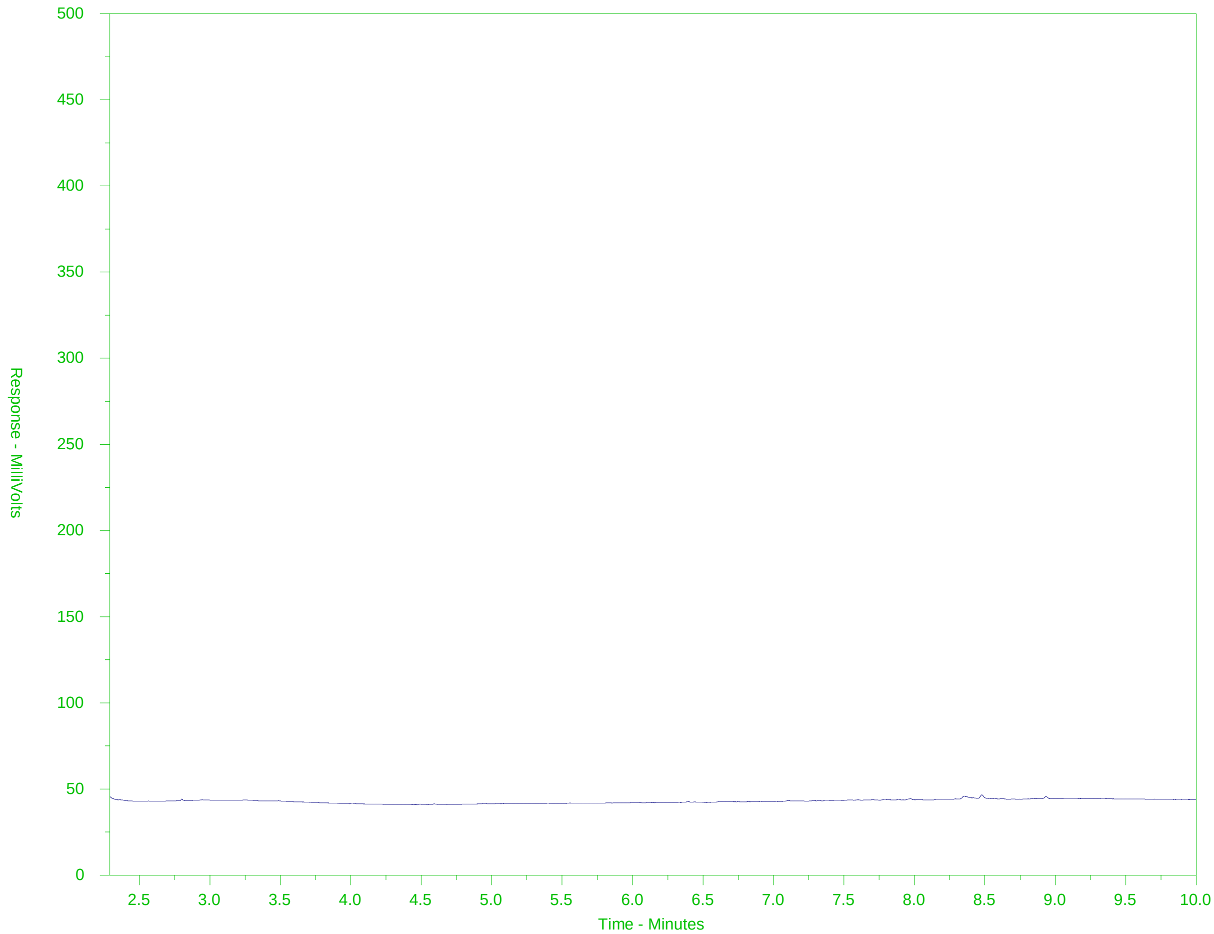
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

# BC EPH HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2398084-1
Client Sample ID: 07043-01




| ← EPH10-19 → | ← EPH19-32 → | |
|---|---|---|
| nC10 | nC19 | nC32 |
| 174°C | 330°C | 467°C |
| 346°F | 626°F | 873°F |
| ← Gasoline → | ← Motor Oils/ Lube Oils/ Grease → | |
| ← Diesel/ Jet Fuels → | | |

The BC EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

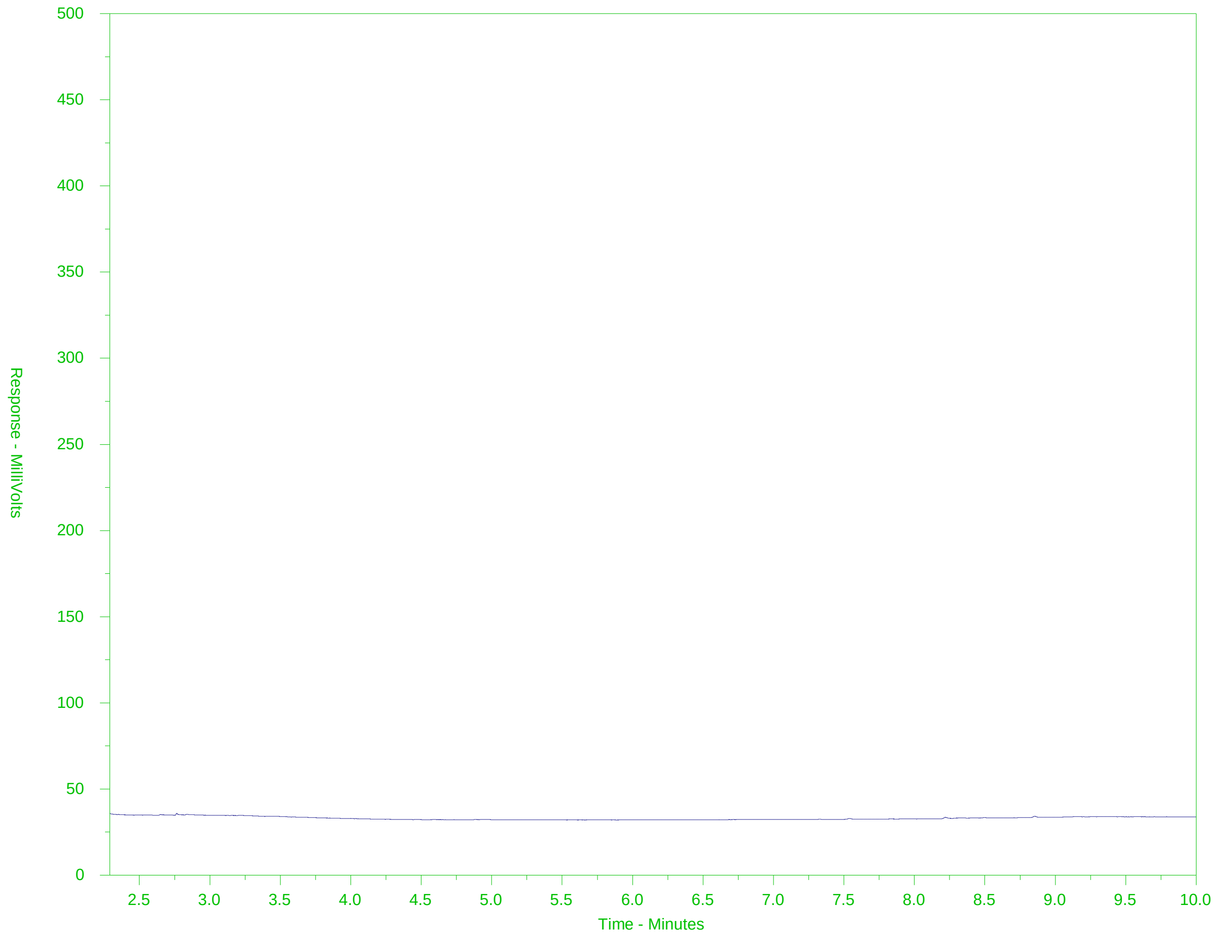
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

Note: This chromatogram was produced using GC conditions that are specific to the ALS Canada EPH method. Refer to the ALS Canada EPH Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

# BC EPH HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2398084-2
Client Sample ID: 07043-02




| EPH10-19 | | EPH19-32 |
|---|---|---|
| nC10 | nC19 | nC32 |
| 174°C | 330°C | 467°C |
| 346°F | 626°F | 873°F |
| Gasoline | Motor Oils/ Lube Oils/ Grease | |
| Diesel/ Jet Fuels | | |

The BC EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

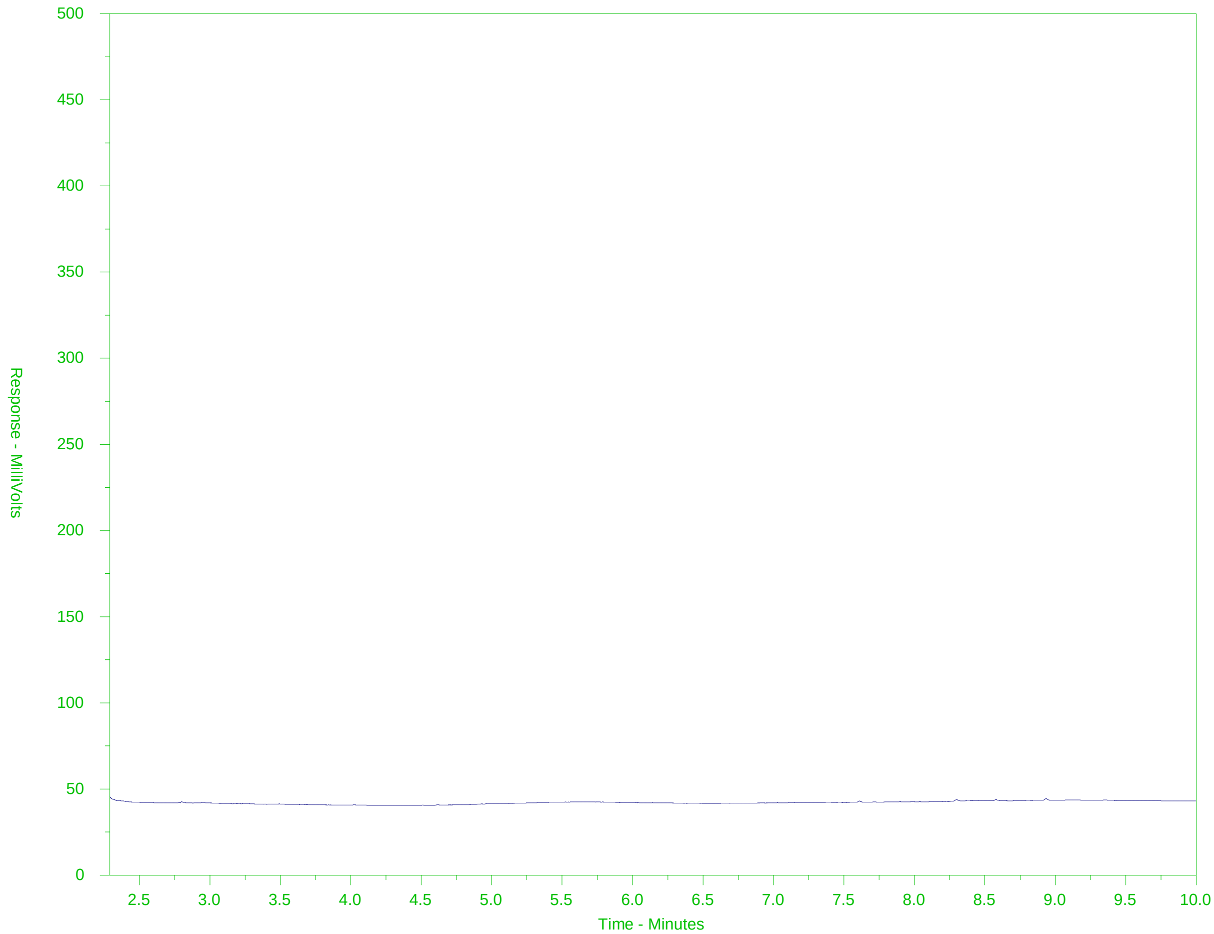
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

Note: This chromatogram was produced using GC conditions that are specific to the ALS Canada EPH method. Refer to the ALS Canada EPH Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

# BC EPH HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2398084-3
Client Sample ID: 07043-03




| | | |
|---|---|---|
| ← EPH10-19 → | ← EPH19-32 → | |
| nC10 | nC19 | nC32 |
| 174°C | 330°C | 467°C |
| 346°F | 626°F | 873°F |
| ← Gasoline → | ← Motor Oils/ Lube Oils/ Grease → | |
| ← Diesel/ Jet Fuels → | | |

The BC EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

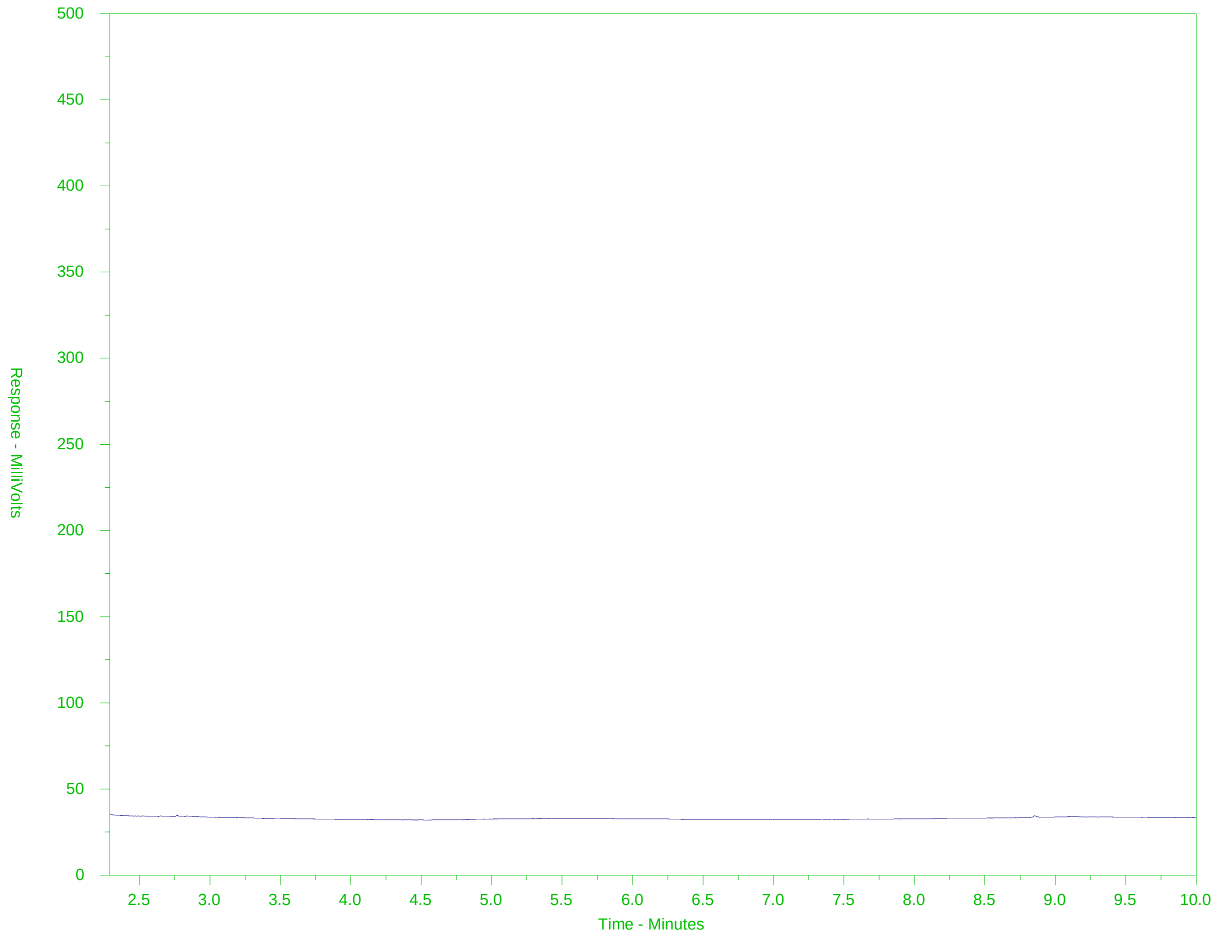
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

Note: This chromatogram was produced using GC conditions that are specific to the ALS Canada EPH method. Refer to the ALS Canada EPH Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

# BC EPH HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2398084-4
Client Sample ID: 07043-04




| ← EPH10-19 → | ← EPH19-32 → | |
|---|---|---|
| nC10 | nC19 | nC32 |
| 174°C | 330°C | 467°C |
| 346°F | 626°F | 873°F |
| ← Gasoline → | ← Motor Oils/ Lube Oils/ Grease → | |
| ← Diesel/ Jet Fuels → | | |

The BC EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

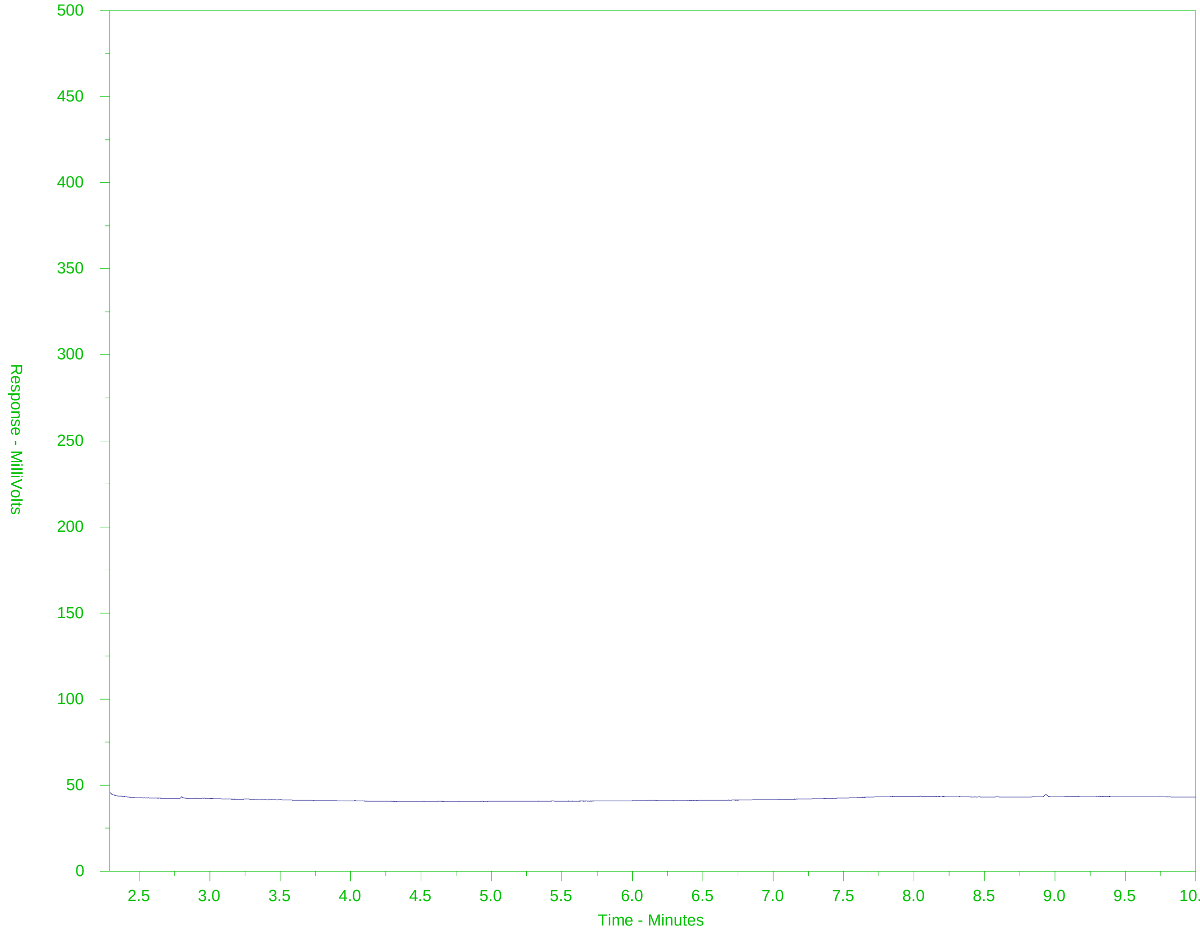
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

Note: This chromatogram was produced using GC conditions that are specific to the ALS Canada EPH method. Refer to the ALS Canada EPH Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

# BC EPH HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: WG3245924-3#L2398084-4
Client Sample ID: 07043-04




| | | |
|---|---|---|
| ← EPH10-19 → | ← EPH19-32 → | |
| nC10 | nC19 | nC32 |
| 174°C | 330°C | 467°C |
| 346°F | 626°F | 873°F |
| ← Gasoline → | ← Motor Oils/ Lube Oils/ Grease → | |
| ← Diesel/ Jet Fuels → | | |

The BC EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

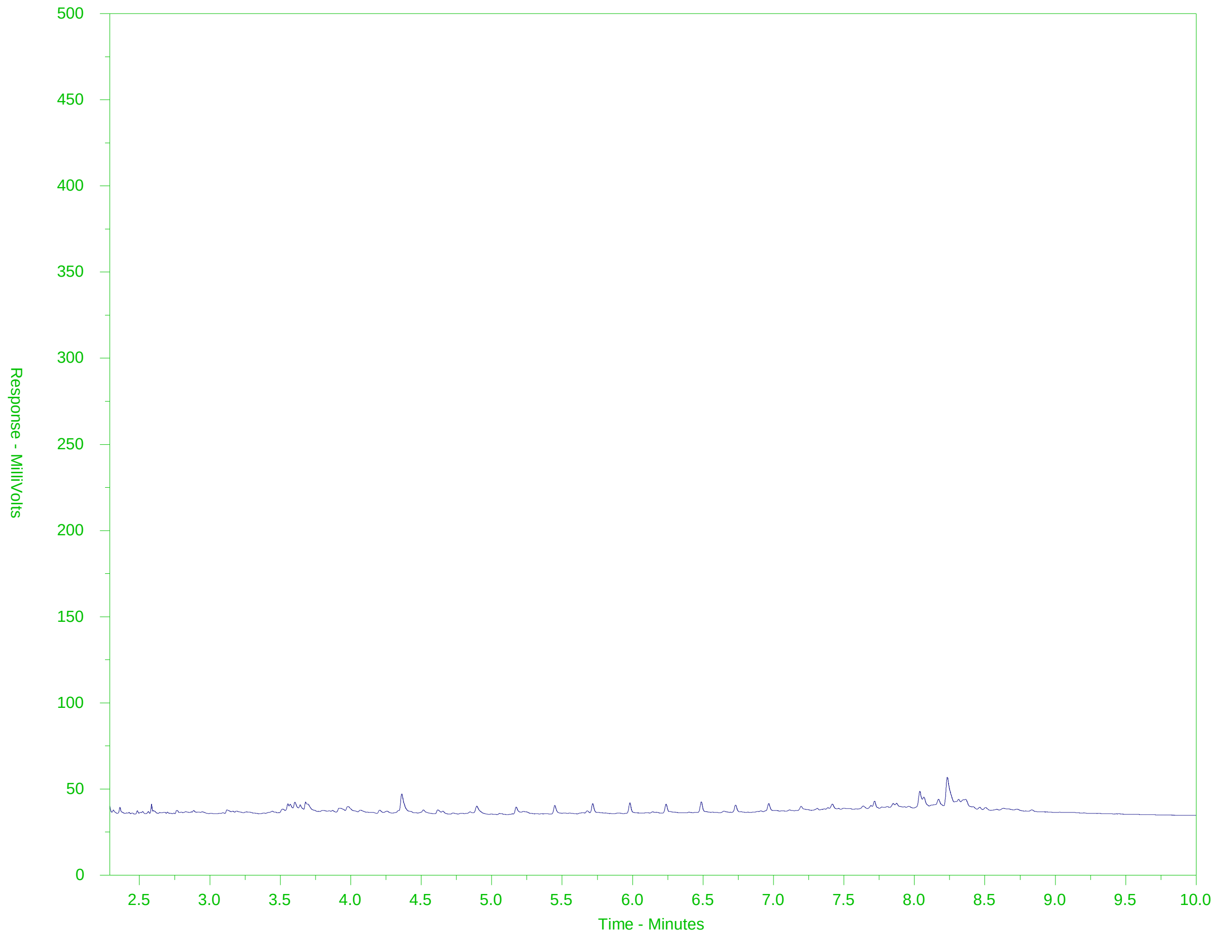
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

Note: This chromatogram was produced using GC conditions that are specific to the ALS Canada EPH method. Refer to the ALS Canada EPH Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

# BC EPH HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2398084-5
Client Sample ID: 07043-05




| | | |
|---|---|---|
| ← EPH10-19 → | ← EPH19-32 → | |
| nC10 | nC19 | nC32 |
| 174°C | 330°C | 467°C |
| 346°F | 626°F | 873°F |
| ← Gasoline → | ← Motor Oils/ Lube Oils/ Grease → | |
| ← Diesel/ Jet Fuels → | | |

The BC EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

Note: This chromatogram was produced using GC conditions that are specific to the ALS Canada EPH method. Refer to the ALS Canada EPH Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.

# CHAIN OF CUSTODY RECORD/ANALYSIS REQUEST

No. 07043 page 1 of 1

Golder Associates
200 – 2920 Virtual Way
Vancouver, British Columbia, Canada V5M 0C4
Telephone (604) 296-4200 Fax (604) 298-5253

| | | | |
|---|---|---|---|
| Project Number: 18109842 | | Laboratory Name: ALS | |
| Short Title: ToL | Golder Contact: Alanna Umphrey | Address: 8081 Lougheed Hwy Burnaby | |
| Golder E-mail Address 1: AUmphrey@golder.com | Golder E-mail Address 2: MNewman @golder.com | Telephone/Fax: 604-253-4188 | Contact: Amber Springer |

Office Name: Victoria

EQuIS Facility Code: ______
EQuIS upload: ☐

Turnaround Time: ☐ 24 hr ☐ 48 hr ☐ 72 hr ☒ Regular (5 Days)

Criteria: ☒ CSR ☐ CCME ☐ BC Water Quality ☐ Other

Note: Final Reports to be issued by e-mail

Quote No.:

Analyses Required

| Sample Control Number (SCN) | Sample Location | Sa. # | Sample Depth (m) | Sample Matrix (over) | Date Sampled (D / M / Y) | Time Sampled (HH:MM) | Sample Type (over) | QAQC Code (over) | Related SCN (over) | Number of Containers | BTEX | LEPH/HEPH/PAH | Metals | | | | | | | RUSH (Select TAT above) | Remarks (over) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07043-01 | HS19-01 | — | 0.3-0.6 | SO | 16/12/19 | — | GRAB | — | — | 4 | X | X | X | | | | | | | | |
| 07043-02 | HS19-02 | — | 0.3-0.6 | SO | 16/12/19 | — | GRAB | FDA | 07043-03 | 4 | X | X | X | | | | | | | | |
| 07043-03 | HS19-02 | — | 0.3-0.6 | SO | 16/12/19 | — | GRAB | FD | 07043-02 | 4 | X | X | X | | | | | | | | |
| 07043-04 | HS19-03 | — | 0.3-0.6 | SO | 16/12/19 | — | GRAB | — | — | 4 | X | X | X | | | | | | | | |
| 07043-05 | HS19-04 | — | 0.3-0.6 | SO | 16/12/19 | — | GRAB | — | — | 4 | X | X | X | | | | | | | | |
| -06 | | | | | | | | | | | | | | | | | | | | | |
| -07 | | | | | | | | | | | | | | | | | | | | | |
| -08 | | | | | | | | | | | | | | | | | | | | | |
| -09 | | | | | | | | | | | | | | | | | | | | | |
| -10 | | | | | | | | | | | | | | | | | | | | | |
| -11 | | | | | | | | | | | | | | | | | | | | | |
| -12 | | | | | | | | | | | | | | | | | | | | | |

L2398084-COFC

| | | | | | | |
|---|---|---|---|---|---|---|
| Sampler's Signature: | Relinquished by: Signature | Company Golder | Date 17 Dec 2019 | Time 14:45 | Received by: Signature | Company |
| Comments: ON ICE | Method of Shipment: Purolator | Waybill No.: | Received for Lab by: | | Date 18 Dec 19 | Time 8:30AM |
| | Shipped by: | Shipment Condition: Seal Intact: | Temp (°C) | Cooler opened by: 5C | Date | Time |

WHITE: Golder Copy YELLOW: Lab Copy



ESED

**APPENDIX H**

# Analytical Tables

**Table H-1**
**Stage 1 Update Surface Soil Samples**
**Results of Soil Analyses - Metals**
**Ladysmith Harbour, Ladysmith, BC**

| Location / SCN / Depth (m bgs) / Date Sampled (mm/dd/yyyy) / QA/QC | CSR standards for PL | MCS | **CSR standards for CL** | MCS | CSR standards for IL | MCS | HS19-01 | HS19-02 | HS19-02 | HS19-03 | HS19-04 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SCN** | | | | | | | 07043-01 | 07043-02 | 07043-03 | 07043-04 | 07043-05 |
| **Depth (m bgs)** | | | | | | | 0.3-0.6 | 0.3-0.6 | 0.3-0.6 | 0.3-0.6 | 0.3-0.6 |
| **Date Sampled (mm/dd/yyyy)** | | | | | | | 2019-12-16 | 2019-12-16 | 2019-12-16 | 2019-12-16 | 2019-12-16 |
| **QA/QC** | | | | | | | | FDA | FD | | |
| ***Field Parameters*** | | | | | | | | | | | |
| Soil Vapours (ppm) | | | | | | | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 |
| ***Physical Parameters*** | | | | | | | | | | | |
| moisture (%) | | | | | | | 19.0 | 22.8 | 18.3 | 21.4 | 34.0 |
| pH (pH units) | | | | | | | 6.86 | 8.15 | 8.04 | 7.32 | 5.89 |
| ***Total Metals*** | | | | | | | | | | | |
| *aluminum | 55000 | HH | 250000 | HH | 250000 | HH | 17300 | 20900 | 21000 | 25400 | 21600 |
| antimony | 20 | EH | 40 | EH | 40 | EH | 0.12 | 0.14 | 0.15 | 0.20 | 2.78 |
| arsenic | 10 | AW-M/DW | **10** | AW-M | 10 | AW-M/DW | 6.12 | 7.01 | 8.43 | 7.33 | 7.46 |
| barium | 350 | DW | 350 | DW | 350 | DW | 67.1 | 73.7 | 83.1 | 81.1 | 325 |
| beryllium pH | 1-150 | AW-M/I/DW | 1-350 | DW/T | 1-350 | DW/T | 0.31 | 0.28 | 0.28 | 0.35 | 0.45 |
| bismuth | | | | | | | <0.20 | <0.20 | <0.20 | <0.20 | 0.29 |
| boron (hot water soluble) | | | | | | | <5.0 | <5.0 | <5.0 | <5.0 | 10.3 |
| cadmium pH | 1-30 | AW-M/T | 1-70 | DW/AW-M | 1-70 | AW-M/DW | 0.093 | 0.031 | 0.041 | 0.113 | 0.655 |
| calcium | | | | | | | 4500 | 9760 | 10200 | 5540 | 7380 |
| *chromium, total | 65 | AW-M/DW | 65 | DW/AW-M | 65 | AW-M/DW | 29.3 | 38.6 | 36.5 | 37.0 | 36.0 |
| *cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 30 | AW-M/DW | 8.35 | 12.3 | 12.1 | 12.3 | 11.4 |
| *copper pH | 100-150 | AW-M/T | **100-300** | AW-M/T | 100-300 | AW-M/T | 23.4 | 49.4 | 49.6 | 31.4 | **118** |
| *iron | 70000 | HH | 150000 | HH | 150000 | HH | 22500 | 30600 | 31800 | 35300 | 23200 |
| lead pH | 120 | I | **120-150** | I/DW | 120-1000 | DW/T | 4.29 | 2.57 | 2.80 | 5.88 | 59.4 |
| lithium | 65 | HH | **450** | HH | 450 | HH | 17.5 | 13.7 | 13.1 | 13.0 | 17.9 |
| magnesium | | | | | | | 4640 | 6660 | 6570 | 5540 | 5560 |
| *manganese | 5000 | DW/T | 5000 | DW/T | 5000 | DW/T | 205 | 532 | 553 | 918 | 301 |
| mercury (inorganic) | 25 | I | 75 | I/T | 75 | T | 0.055 | 0.063 | 0.051 | 0.051 | 0.175 |
| molybdenum | 15 | DW | 15 | DW | 15 | DW | 0.78 | 0.21 | 0.25 | 1.98 | 1.17 |
| nickel pH | 70-150 | AW-M/DW | 70-250 | AW-M/DW | 70-250 | AW-M/DW | 16.1 | 21.9 | 21.1 | 20.8 | 32.4 |
| phosphorus | | | | | | | 194 | 557 | 529 | 253 | 473 |
| potassium | | | | | | | 350 | 590 | 610 | 440 | 590 |
| *selenium | 4 | AW-M/DW | 4 | AW-M/DW | 4 | AW-M/DW | <0.20 | <0.20 | <0.20 | 0.27 | 0.83 |
| silver | 20 | EH | 40 | EH | 40 | EH | <0.10 | <0.10 | <0.10 | <0.10 | 0.21 |
| sodium | 200 | T/ion | **1000** | T/ion | 1000 | T/ion | 246 | 604 | 668 | 314 | 332 |
| strontium (stable) | 20000 | HH | 150000 | HH | 150000 | HH | 32.0 | 67.8 | 72.8 | 59.5 | 68.6 |
| sulphur | | | | | | | <1000 | <1000 | <1000 | <1000 | <1000 |
| thallium | 9 | EH | 25 | EH | 25 | EH | <0.050 | <0.050 | <0.050 | <0.050 | 0.063 |
| tin | 50 | EH | 300 | EH | 300 | EH | <2.0 | <2.0 | <2.0 | <2.0 | 5.6 |
| titanium | | | | | | | 1350 | 1520 | 1760 | 1740 | 1280 |
| tungsten | 25 | HH | 200 | HH | 200 | HH | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| uranium | 30 | DW | 30 | DW | 30 | DW | 0.533 | 0.258 | 0.271 | 0.404 | 0.515 |
| *vanadium | 200 | DW | 200 | DW | 200 | DW | 78.8 | 82.5 | 91.5 | 116 | 82.6 |
| zinc pH | 150-200 | AW-M | **150-200** | AW-M | 150-200 | AW-M | 30.8 | 34.0 | 33.8 | 33.5 | 132 |
| zirconium | | | | | | | 3.9 | 5.5 | 6.1 | 3.2 | 4.4 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 24 January 2019).
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; DW Drinking Water; AW = Groundwater Flow to Surface Water used by Aquatic Life, and M = Marine Aquatic Life.
EH = generic standard for the protection of ecological health
HH = generic standard for the protection of human health
pH = standard is pH dependant
FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzed
QA/QC = quality assurance/quality control
V = Standard is valence dependant: III - trivalent chromium ($Cr^{3+}$); VI - hexa-valent chromium ($Cr^{6+}$)
italics = Laboratory Method Detection Limit above applicable standards
*Background concentrations applied as detailed in Protocol 4 is applied to replace CSR Standards.

**Table H-2**
**Stage 1 Update Surface Soil Samples**
**Results of Soil Analyses - Hydrocarbons and PCBs**
**Ladysmith Harbour, Ladysmith, BC**

| **Location** | CSR Standards for PL | **MCS** | **CSR Standards for CL** | **MCS** | CSR Standards for IL | **MCS** | HS19-01 | HS19-02 | HS19-02 | HS19-03 | HS19-04 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SCN** | | | | | | | 07043-01 | 07043-02 | 07043-03 | 07043-04 | 07043-05 |
| **Depth (m bgs)** | | | | | | | 0.3-0.6 | 0.3-0.6 | 0.3-0.6 | 0.3-0.6 | 0.3-0.6 |
| **Date Sampled (mm/dd/yyyy)** | | | | | | | 2019-12-16 | 2019-12-16 | 2019-12-16 | 2019-12-16 | 2019-12-16 |
| **QA/QC** | | | | | | | | FDA | FD | | |
| **Field Parameters** | | | | | | | | | | | |
| Soil Vapours (ppm unless otherwise indicated) | | | | | | | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 |
| **Physical Parameters** | | | | | | | | | | | |
| moisture (%) | | | | | | | 19.0 | 22.8 | 18.3 | 21.4 | 34.0 |
| pH (pH units) | | | | | | | 6.86 | 8.15 | 8.04 | 7.32 | 5.89 |
| **Extractable Hydrocarbons** | | | | | | | | | | | |
| $EPH_{C10-19}$ [a] | *1000* | | *2,000* | | *2,000* | | <200 | <200 | <200 | <200 | <200 |
| $EPH_{C19-32}$ [a] | *1000* | | *5000* | | *5,000* | | <200 | <200 | <200 | <200 | <200 |
| LEPH | 1000 | EH/HH | 2,000 | EH/HH | 2,000 | EH/HH | <200 | <200 | <200 | <200 | <200 |
| HEPH | 1000 | EH/HH | 5000 | EH/HH | 5,000 | EH/HH | <200 | <200 | <200 | <200 | <200 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | |
| 1-Methylnaphthalene | 500 | HH | 1000 | HH | 1000 | HH | <0.050 | <0.050 | <0.050 | <0.050 | 0.499 |
| 2-methylnaphthalene | 100 | HH | 950 | HH | 950 | HH | <0.010 | <0.010 | <0.010 | <0.010 | 0.521 |
| acenaphthene | 2000 | HH | 15000 | HH | 15000 | HH | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.040 |
| acenaphthylene | | | | | | | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.030 |
| anthracene | 2.5 | T | 30 | T | 30 | T | <0.0040 | <0.0040 | <0.0040 | <0.0040 | <0.090 |
| benzo(a)anthracene | 1 | EH | 10 | EH | 10 | EH | <0.010 | <0.010 | <0.010 | <0.010 | 0.113 |
| benzo(a)pyrene | 10 | I | 30 | I | 50 | I | <0.010 | <0.010 | <0.010 | <0.010 | 0.072 |
| Benzo(b&j)fluoranthene | 1 | EH | 10 | EH | 10 | EH | <0.010 | <0.010 | <0.010 | <0.010 | 0.135 |
| Benzo(b+j+k)fluoranthene | | | | | | | <0.015 | <0.015 | <0.015 | <0.015 | 0.177 |
| benzo(g,h,i)perylene | | | | | | | <0.010 | <0.010 | <0.010 | <0.010 | 0.073 |
| benzo(k)fluoranthene | 1 | EH | 10 | EH | 10 | EH | <0.010 | <0.010 | <0.010 | <0.010 | 0.042 |
| chrysene | 400 | HH | 4500 | HH | 4500 | HH | <0.010 | <0.010 | <0.010 | <0.010 | 0.125 |
| dibenz(a,h)anthracene | 1 | EH | 10 | EH | 10 | EH | <0.0050 | <0.0050 | <0.0050 | <0.0050 | 0.0137 |
| fluoranthene | 50 | T | 200 | T | 200 | T | <0.010 | <0.010 | <0.010 | <0.010 | 0.196 |
| fluorene | 1000 | HH | 9500 | HH | 9500 | HH | <0.010 | <0.010 | <0.010 | <0.010 | 0.066 |
| indeno(1,2,3-c,d)pyrene | 1 | EH | 10 | EH | 10 | EH | <0.010 | <0.010 | <0.010 | <0.010 | 0.056 |
| naphthalene | 0.6 | T | 20 | T | 20 | T | <0.010 | <0.010 | <0.010 | <0.010 | 0.183 |
| phenanthrene | 5 | EH | 50 | EH | 50 | EH | <0.010 | <0.010 | <0.010 | <0.010 | 0.706 |
| pyrene | 10 | EH | 100 | EH | 100 | EH | <0.010 | <0.010 | <0.010 | <0.010 | 0.171 |
| quinoline | 4.5 | HH | 10 | HH | 10 | HH | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| B(a)P Total Potency Equivalent | | | | | | | <0.020 | <0.020 | <0.020 | <0.020 | 0.122 |
| IACR (CCME) | | | | | | | <0.15 | <0.15 | <0.15 | <0.15 | 1.79 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | |
| benzene | 0.035 | DW | 0.035 | DW | 0.035 | DW | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 |
| ethylbenzene | 15 | DW | 15 | DW | 15 | DW | <0.015 | <0.015 | <0.015 | <0.015 | <0.015 |
| styrene | 5 | EH | 50 | EH | 50 | EH | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| toluene | 6 | DW | 6 | DW | 6 | DW | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| ortho-Xylene | | | | | | | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| meta- & para-Xylene | | | | | | | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| Total xylene | 6.5 | DW | 6.5 | DW | 6.5 | DW | <0.075 | <0.075 | <0.075 | <0.075 | <0.075 |
| Methyl t-butyl ether (MTBE) | 8000 | HH | 20000 | HH | 20000 | HH | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial).
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; AW = Groundwater Flow to Surface Water used by Aquatic Life, M = Marine;
DW = Drinking Water; EH = generic standard for the protection of ecological health; HH = generic standard for the protection of human health
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including
amendments up to BC Reg. 13/2019, updated to 24 January 2019)
MCS = most conservative standard based on applicable site-specific standards
QA/QC = quality assurance/quality control
a. LEPH and HEPH criteria used as a conservative screen for EPH10-19 and EPH19-32, respectively
FDA = Field duplicate available; FD = Field duplicate.
*italics* = Laboratory Method Detection Limit above applicable standards
< = less than laboratory reporting limit; - = not analyzed
$EPH_{C10-19}$ = extractable petroleum hydrocarbons, carbon range 10-19
$EPH_{C19-32}$ = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
PAH = polycyclic aromatic hydrocarbon
ppm = parts per milion

Table H-3
Stage 1 Update Surface Soil Samples
Results of Soil Analyses - Quality Assurance/Quality Control
Ladysmith Harbour, Ladysmith, BC

| Location | HS19-02 | HS19-02 | | | | |
|---|---|---|---|---|---|---|
| SCN | 07043-02 | 07043-03 | **Method Reporting Limit** | **Mean** | **Relative Percent Difference** | **Difference Factor (DF)** |
| Laboratory ID | L2398084-2 | L2398084-3 | | | | |
| Depth (m bgs) | 0.3-0.6 | 0.3-0.6 | | | | |
| Date Sampled | 2019-12-16 | 2019-12-16 | | | | |
| QA/QC | FDA | FD | | | | |
| **Total Metals** | | | | | | |
| *aluminum | 20900 | 21000 | 50 | 20950 | 0.48% | NA |
| antimony | 0.14 | 0.15 | 0.10 | 0.145 | NA | 0.10 |
| arsenic | 7.01 | 8.43 | 0.10 | 7.72 | 18% | NA |
| barium | 73.7 | 83.1 | 0.50 | 78.4 | 12% | NA |
| beryllium$^{pH}$ | 0.28 | 0.28 | 0.10 | 0.28 | NA | 0.00 |
| bismuth | <0.20 | <0.20 | 0.20 | NC | NC | NC |
| boron (hot water soluble) | <5.0 | <5.0 | 5.0 | NC | NC | NC |
| cadmium$^{pH}$ | 0.031 | 0.041 | 0.020 | 0.036 | NA | 0.50 |
| calcium | 9760 | 10200 | 50 | 9980 | 4.4% | NA |
| *chromium, total | 38.6 | 36.5 | 0.50 | 37.55 | 5.6% | NA |
| *cobalt | 12.3 | 12.1 | 0.10 | 12.2 | 1.6% | NA |
| *copper$^{pH}$ | 49.4 | 49.6 | 0.50 | 49.5 | 0.40% | NA |
| *iron | 30600 | 31800 | 50 | 31200 | 3.8% | NA |
| lead$^{pH}$ | 2.57 | 2.80 | 0.50 | 2.685 | 8.6% | NA |
| lithium | 13.7 | 13.1 | 2.0 | 13.4 | 4.5% | NA |
| magnesium | 6660 | 6570 | 20 | 6615 | 1.4% | NA |
| *manganese | 532 | 553 | 1.0 | 542.5 | 3.9% | NA |
| mercury (inorganic) | 0.063 | 0.051 | 0.05 | 0.057 | NA | 0.24 |
| molybdenum | 0.21 | 0.25 | 0.10 | 0.23 | NA | 0.40 |
| nickel$^{pH}$ | 21.9 | 21.1 | 0.50 | 21.5 | 3.7% | NA |
| phosphorus | 557 | 529 | 50 | 543 | 5.2% | NA |
| potassium | 590 | 610 | 100 | 600 | 3.33% | NA |
| *selenium | <0.20 | <0.20 | 0.20 | NC | NC | NC |
| silver | <0.10 | <0.10 | 0.10 | NC | NC | NC |
| sodium | 604 | 668 | 50 | 636 | 10% | NA |
| strontium (stable) | 67.8 | 72.8 | 0.50 | 70.3 | 7.1% | NA |
| sulphur | <1000 | <1000 | 1000 | NC | NC | NC |
| thallium | <0.050 | <0.050 | 0.050 | NC | NC | NC |
| tin | <2.0 | <2.0 | 2.0 | NC | NC | NC |
| titanium | 1520 | 1760 | 1.0 | 1640 | 15% | NA |
| tungsten | <0.50 | <0.50 | 0.50 | NC | NC | NC |
| uranium | 0.258 | 0.271 | 0.050 | 0.2645 | 4.9% | NA |
| *vanadium | 82.5 | 91.5 | 0.20 | 87 | 10% | NA |
| zinc$^{pH}$ | 34.0 | 33.8 | 2.0 | 33.9 | 0.59% | NA |
| zirconium | 5.5 | 6.1 | 1.0 | 5.8 | 10% | NA |
| **Extractable Hydrocarbons** | | | | - | - | - |
| $EPH_{C10-19}$ [a] | <200 | <200 | 200 | NC | NC | NC |
| $EPH_{C19-32}$ [a] | <200 | <200 | 200 | NC | NC | NC |
| LEPH | <200 | <200 | 200 | NC | NC | NC |
| HEPH | <200 | <200 | 200 | NC | NC | NC |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | |
| 1-Methylnaphthalene | <0.050 | <0.050 | 0.050 | NC | NC | NC |
| 2-methylnaphthalene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| acenaphthene | <0.0050 | <0.0050 | 0.0050 | NC | NC | NC |
| acenaphthylene | <0.0050 | <0.0050 | 0.0050 | NC | NC | NC |
| anthracene | <0.0040 | <0.0040 | 0.0040 | NC | NC | NC |
| benzo(a)anthracene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| benzo(a)pyrene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| Benzo(b&j)fluoranthene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| Benzo(b+j+k)fluoranthene | <0.015 | <0.015 | 0.015 | NC | NC | NC |
| benzo(g,h,i)perylene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| benzo(k)fluoranthene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| chrysene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| dibenz(a,h)anthracene | <0.0050 | <0.0050 | 0.0050 | NC | NC | NC |
| fluoranthene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| fluorene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| indeno(1,2,3-c,d)pyrene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| naphthalene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| phenanthrene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| pyrene | <0.010 | <0.010 | 0.010 | NC | NC | NC |
| quinoline | <0.050 | <0.050 | 0.050 | NC | NC | NC |
| B(a)P Total Potency Equivalent | <0.020 | <0.020 | 0.020 | NC | NC | NC |
| IACR (CCME) | <0.15 | <0.15 | 0.15 | NC | NC | NC |
| **Non-Halogenated Volatiles** | | | | | | |
| benzene | <0.0050 | <0.0050 | 0.0050 | NC | NC | NC |
| ethylbenzene | <0.015 | <0.015 | 0.015 | NC | NC | NC |
| styrene | <0.050 | <0.050 | 0.050 | NC | NC | NC |
| toluene | <0.050 | <0.050 | 0.050 | NC | NC | NC |
| ortho-Xylene | <0.050 | <0.050 | 0.050 | NC | NC | NC |
| meta- & para-Xylene | <0.050 | <0.050 | 0.050 | NC | NC | NC |
| Total xylene | <0.075 | <0.075 | 0.075 | NC | NC | NC |
| Methyl t-butyl ether (MTBE) | <0.20 | <0.20 | 0.20 | NC | NC | NC |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
SCN = sample control number
FDA = field duplicate available
FD = field duplicate
QA/QC = quality assurance/quality control

Method Reporting Limit indicates the minimum concentration that could be measured by laboratory instrumentation for a specific sample.

Mean indicates the mean or average value calculated of a field duplicate pair (the FDA and the FD).
Relative Percent Difference (RPD) is calculated when the mean value is greater than five times the method reporting limit; Golder's internal QA/QC target is less than 30% for metals and less than 50% for organic compounds.

Difference Factor (DF) is calculated when the mean value is less than five times the method reporting limit; Golder's internal QA/QC target is less than 2.

NA = not applicable; NC = not calculated
**BOLD** font indicates the parameter analyzed

**APPENDIX I**

# Historical Data Rescreening

# Table I-1a
## Results of Soil Analyses - Metals
## Ladysmith Harbour, Ladysmith, BC
*Updated December 2019*

| APEC | | | | | | | AEC 10 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | CSR standards for PL | MCS | **CSR standards for CL** | MCS | CSR standards for IL | MCS | MW09-1 | MW09-3 | MW09-3 | TP09-01 | TP09-02 | TP09-02 | TP09-02 | TP09-03 | TP09-04 |
| SCN | | | | | | | 21360-02 | 21360-07 | 21360-08 | 21381-01 | 21381-04 | 21381-05 | 21381-06 | 21381-09 | 21381-11 |
| Depth (m bgs) | | | | | | | 0.6 - 0.76 | 0.6 - 0.76 | 2.1 - 2.3 | 0.6-0.8 | 1.5-1.7 | 1.5-1.7 | 2.2-2.4 | 1.8-1.9 | 1.0-1.2 |
| Date Sampled (mm/dd/yyyy) | | | | | | | 2009-11-10 | 2009-11-10 | 2009-11-11 | 2009-12-15 | 2009-12-15 | 2009-12-15 | 2009-12-15 | 2009-12-15 | 2009-12-15 |
| QA/QC | | | | | | | | | | | FDA | FD | | | |
| ***Field Parameters*** | | | | | | | | | | | | | | | |
| Soil Vapours (ppm) | | | | | | | 0 | 10 | 23 | 20 | | | | | 22 |
| ***Physical Parameters*** | | | | | | | | | | | | | | | |
| moisture (%) | | | | | | | 18.5 | 10.6 | 8.4 | - | 16.1 | 18.5 | 20.8 | 10.9 | 17 |
| pH (pH units) | | | | | | | 5.7 | 7.3 | - | 5.9 | - | - | - | - | 7.2 |
| ***Total Metals*** | | | | | | | | | | | | | | | |
| *aluminum | 55000 | HH | 250000 | HH | 250000 | HH | 20900 | 11900 | - | 13600 | - | - | - | - | 19100 |
| antimony | 20 | EH | 40 | EH | 40 | EH | < 10 | < 10 | - | < 10 | - | - | - | - | < 10 |
| arsenic | 10 | AW-M/DW | **10** | AW-M | 10 | AW-M/DW | < 10 | < 10 | - | < 10 | - | - | - | - | **11** |
| barium | 350 | DW | 350 | DW | 350 | DW | 135 | 42 | - | 116 | - | - | - | - | 153 |
| beryllium$^{pH}$ | 1-150 | AW-M/I/DW | 1-350 | DW/T | 1-350 | DW/T | < 1 | < 1 | - | < 1 | - | - | - | - | < 1 |
| boron (hot water soluble) | | | | | | | 17 | 13 | - | < 1 | - | - | - | - | 3 |
| cadmium$^{pH}$ | 1-30 | AW-M/T | 1-70 | DW/AW-M | 1-70 | AW-M/DW | 0.8 | < 0.5 | - | < 0.5 | - | - | - | - | 1.8 |
| calcium | | | | | | | 4860 | 4470 | - | 3650 | - | - | - | - | 7800 |
| *chromium, total | 65 | AW-M/DW | 65 | DW/AW-M | 65 | AW-M/DW | 40 | 30 | - | 27 | - | - | - | - | 35 |
| *cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 30 | AW-M/DW | 11 | 8 | - | 12 | - | - | - | - | 16 |
| *copper$^{pH}$ | 100-150 | AW-M/T | 100-300 | AW-M/T | 100-300 | AW-M/T | 89 | 49 | - | 82 | - | - | - | - | 119 |
| *iron | 70000 | HH | 150000 | HH | 150000 | HH | 24900 | 18800 | - | 20500 | - | - | - | - | 28100 |
| lead$^{pH}$ | 120 | I | **120-150** | I/DW | 120-1000 | DW/T | 89 | 23 | - | 75 | - | - | - | - | 52 |
| magnesium | | | | | | | 4220 | 5430 | - | 5190 | - | - | - | - | 3890 |
| *manganese | 5000 | DW/T | 5000 | DW/T | 5000 | DW/T | 558 | 274 | - | 493 | - | - | - | - | 1070 |
| mercury (inorganic) | 25 | I | 75 | I/T | 75 | T | 0.06 | 0.02 | - | 0.07 | - | - | - | - | 0.06 |
| molybdenum | 15 | DW | 15 | DW | 15 | DW | < 4 | < 4 | - | < 4 | - | - | - | - | < 4 |
| nickel$^{pH}$ | 70-150 | AW-M/DW | 70-250 | AW-M/DW | 70-250 | AW-M/DW | 21 | 17 | - | 24 | - | - | - | - | 25 |
| phosphorus | | | | | | | 447 | 440 | - | 582 | - | - | - | - | 915 |
| potassium | | | | | | | 348 | 741 | - | 450 | - | - | - | - | 411 |
| *selenium | 4 | AW-M/DW | 4 | AW-M/DW | 4 | AW-M/DW | *< 2* | *< 2* | - | *< 2* | - | - | - | - | *< 2* |
| silver | 20 | EH | 40 | EH | 40 | EH | < 2 | < 2 | - | < 2 | - | - | - | - | < 2 |
| sodium | | | | | | | 246 | 408 | - | 172 | - | - | - | - | 168 |
| strontium (stable) | 20000 | HH | 150000 | HH | 150000 | HH | 38 | 19 | - | 25 | - | - | - | - | 106 |
| tin | 50 | EH | 300 | EH | 300 | EH | < 5 | < 5 | - | < 5 | - | - | - | - | < 5 |
| titanium | | | | | | | 953 | 939 | - | 964 | - | - | - | - | 1280 |
| *vanadium | 200 | DW | 200 | DW | 200 | DW | 102 | 42 | - | 67 | - | - | - | - | 92 |
| zinc$^{pH}$ | 150-200 | AW-M | **150-200** | AW-M | 150-200 | AW-M | 71 | 49 | - | 81 | - | - | - | - | 143 |
| zirconium | | | | | | | 4 | 3 | - | 3 | - | - | - | - | 5 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019).
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; DW Drinking Water; AW = Groundwater Flow to Surface Water used by Aquatic Life, and M = Marine Aquatic Life.
EH = generic standard for the protection of ecological health
HH = generic standard for the protection of human health
pH = standard is pH dependant
FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzed
QA/QC = quality assurance/quality control
V = Standard is valence dependant: III - trivalent chromium ($Cr^{3+}$); VI - hexa-valent chromium ($Cr^{6+}$)
italics = Laboratory Method Detection Limit above applicable standards
*Background concentrations applied as detailed in Protocol 4 is applied to replace CSR Standards.

**Table I-1a**
**Results of Soil Analyses - Metals**
**Ladysmith Harbour, Ladysmith, BC**
***Updated December 2019***

| **APEC** | | | | | APEC 15 | | | | APEC 17 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | | | | | MW09-5 | MW09-5 | BH09-15 | BH09-15 | MW09-16 | MW09-16 | MW09-16 |
| **SCN** | CSR standards for PL | **MCS** | **CSR standards for CL** | **MCS** | 21361-08 | 21361-09 | 21366-03 | 21366-04 | 21366-07 | 21366-09 | 21366-10 |
| **Depth (m bgs)** | | | | | 0.6 - 0.8 | 1.4 - 1.6 | 3.65 - 3.8 | 3.65 - 3.8 | 1.2 - 1.37 | 3.35 - 3.50 | 3.35 - 3.50 |
| **Date Sampled (mm/dd/yyyy)** | | | | | 2009-11-11 | 2009-11-11 | 11/14/2009 | 11/14/2009 | 11/14/2009 | 11/14/2009 | 11/14/2009 |
| **QA/QC** | | | | | | | FDA | FD | | FDA | FD |
| ***Field Parameters*** | | | | | | | | | | | |
| Soil Vapours (ppm) | | | | | 30 | 15 | 340 | 340 | 16 | 26 | 26 |
| ***Physical Parameters*** | | | | | | | | | | | |
| moisture (%) | | | | | 16.8 | - | 14.5 | 11.7 | 10.3 | 18.7 | 18.1 |
| pH (pH units) | | | | | 5.9 | 6.2 | - | - | 6.3 | 7.3 | 7.5 |
| ***Total Metals*** | | | | | | | | | | | |
| *aluminum | 55000 | HH | 250000 | HH | 23800 | 19800 | - | - | 20500 | 11400 | 10900 |
| antimony | 20 | EH | 40 | EH | < 10 | < 10 | - | - | < 10 | < 10 | < 10 |
| arsenic | 10 | AW-M/DW | **10** | AW-M | < 10 | < 10 | - | - | < 10 | < 10 | < 10 |
| barium | 350 | DW | 350 | DW | 122 | 71 | - | - | 91 | 117 | 109 |
| beryllium$^{pH}$ | 1-150 | AW-M/I/DW | 1-350 | DW/T | < 1 | < 1 | - | - | < 1 | < 1 | < 1 |
| boron (hot water soluble) | | | | | 18 | 21 | - | - | 18 | 14 | 14 |
| cadmium$^{pH}$ | 1-30 | AW-M/T | 1-70 | DW/AW-M | < 0.5 | < 0.5 | - | - | < 0.5 | < 0.5 | < 0.5 |
| calcium | | | | | 3170 | 4420 | - | - | 3970 | 4940 | 4860 |
| *chromium, total | 65 | AW-M/DW | 65 | DW/AW-M | 33 | 25 | - | - | 29 | 15 | 15 |
| *cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 12 | 12 | - | - | 10 | 7 | 7 |
| *copper$^{pH}$ | 100-150 | AW-M/T | 100-300 | AW-M/T | 44 | 52 | - | - | 39 | 29 | 29 |
| *iron | 70000 | HH | 150000 | HH | 24900 | 22000 | - | - | 22200 | 16600 | 16600 |
| lead$^{pH}$ | 120 | I | **120-150** | I/DW | 10 | < 5 | - | - | 13 | < 5 | < 5 |
| magnesium | | | | | 6680 | 6580 | - | - | 5110 | 5140 | 5030 |
| *manganese | 5000 | DW/T | 5000 | DW/T | 337 | 323 | - | - | 418 | 242 | 235 |
| mercury (inorganic) | 25 | I | 75 | I/T | 0.05 | 0.04 | - | - | 0.04 | 0.02 | 0.03 |
| molybdenum | 15 | DW | 15 | DW | < 4 | < 4 | - | - | < 4 | < 4 | < 4 |
| nickel$^{pH}$ | 70-150 | AW-M/DW | 70-250 | AW-M/DW | 21 | 17 | - | - | 23 | 16 | 15 |
| phosphorus | | | | | 493 | 470 | - | - | 538 | 440 | 432 |
| potassium | | | | | 401 | 607 | - | - | 552 | 630 | 593 |
| *selenium | 4 | AW-M/DW | 4 | AW-M/DW | *< 2* | *< 2* | - | - | *< 2* | *< 2* | *< 2* |
| silver | 20 | EH | 40 | EH | < 2 | < 2 | - | - | < 2 | < 2 | < 2 |
| sodium | | | | | 162 | 364 | - | - | 176 | 557 | 525 |
| strontium (stable) | 20000 | HH | 150000 | HH | 25 | 28 | - | - | 21 | 29 | 26 |
| tin | 50 | EH | 300 | EH | < 5 | < 5 | - | - | < 5 | < 5 | < 5 |
| titanium | | | | | 1300 | 1270 | - | - | 1230 | 913 | 902 |
| *vanadium | 200 | DW | 200 | DW | 82 | 67 | - | - | 65 | 45 | 46 |
| zinc$^{pH}$ | 150-200 | AW-M | **150-200** | AW-M | 51 | 33 | - | - | 47 | 29 | 28 |
| zirconium | | | | | 6 | 6 | - | - | 8 | 4 | 5 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amenc
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; DW Drinking Wat
EH = generic standard for the protection of ecological health
HH = generic standard for the protection of human health
pH = standard is pH dependant
FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzed
QA/QC = quality assurance/quality control
V = Standard is valence dependant: III - trivalent chromium ($Cr^{3+}$); VI - hexa-valent chromium ($Cr^{6+}$)
italics = Laboratory Method Detection Limit above applicable standards
*Background concentrations applied as detailed in Protocol 4 is applied to replace CSR Standards.

**Table I-1a**
**Results of Soil Analyses - Metals**
**Ladysmith Harbour, Ladysmith, BC**
***Updated December 2019***

| APEC | | | | | AEC 12 | | | | | | | | APEC 9 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | CSR standards for PL | **MCS** | **CSR standards for CL** | **MCS** | MW09-9 | MW09-10 | MW09-10 | MW09-11 | KE SA1 | KE SA2 | KE SA4 | TP09-05 | MW09-6 | TP09-09 | TP09-09 |
| **SCN** | | | | | 21364-02 | 21364-05 | 21364-07 | 21364-09 | 21370-01 | 21370-02 | 21370-04 | 21383-01 | 21362-06 | 21383-12 | 21581-01 |
| **Depth (m bgs)** | | | | | 1.5 - 1.7 | 0.6 - 0.76 | 1.5 - 1.7 | 0.3 - 0.4 | 0.2 - 0.3 | 0.2 - 0.3 | 0.2 - 0.3 | 0.3-0.5 | 2.0 - 2.2 | 0.4-0.6 | 1.0-1.2 |
| **Date Sampled (mm/dd/yyyy)** | | | | | 11/13/2009 | 11/13/2009 | 11/13/2009 | 11/13/2009 | 11/25/2009 | 11/25/2009 | 11/25/2009 | 2009-12-15 | 2009-12-11 | 2009-12-15 | 2009-12-15 |
| **QA/QC** | | | | | | | | | | | | | | | |
| ***Field Parameters*** | | | | | | | | | | | | | | | |
| Soil Vapours (ppm) | | | | | 16 | 10 | 22 | 5 | - | - | - | 20 | 10 | 10 | 15 |
| ***Physical Parameters*** | | | | | | | | | | | | | | | |
| moisture (%) | | | | | 12.6 | 8.5 | 15.4 | 21.2 | 9 | 10.8 | 6.9 | - | - | 15.9 | 16.3 |
| pH (pH units) | | | | | 8.1 | 7.6 | 7.7 | 6.6 | 6.2 | 6 | 6.1 | 7.9 | 6.8 | 7.2 | 7.4 |
| ***Total Metals*** | | | | | | | | | | | | | | | |
| *aluminum | 55000 | HH | 250000 | HH | 10400 | 16000 | 11700 | 21800 | 10800 | 11100 | 11300 | 12600 | 10100 | 11300 | 8200 |
| antimony | 20 | EH | 40 | EH | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| arsenic | 10 | AW-M/DW | **10** | AW-M | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| barium | 350 | DW | 350 | DW | 40 | 189 | 46 | 103 | 43 | 61 | 65 | 273 | 46 | 181 | 68 |
| beryllium$^{pH}$ | 1-150 | AW-M/I/DW | 1-350 | DW/T | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| boron (hot water soluble) | | | | | 16 | 24 | 15 | 22 | 8 | 37 | 10 | 21 | 7 | 8 | < 1 |
| cadmium$^{pH}$ | 1-30 | AW-M/T | 1-70 | DW/AW-M | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | 1.1 | < 0.5 | < 0.5 | < 0.5 |
| calcium | | | | | 7070 | 7730 | 7290 | 4820 | 2920 | 3380 | 3000 | 11200 | 4430 | 6310 | 4030 |
| *chromium, total | 65 | AW-M/DW | 65 | DW/AW-M | 16 | 25 | 20 | 39 | 13 | 17 | 13 | 27 | 25 | 23 | 18 |
| *cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 7 | 10 | 9 | 13 | 7 | 10 | 9 | 11 | 8 | 11 | 6 |
| *copper$^{pH}$ | 100-150 | AW-M/T | 100-300 | AW-M/T | 31 | 62 | 39 | 42 | 52 | 138 | 47 | 140 | 29 | 61 | 20 |
| *iron | 70000 | HH | 150000 | HH | 20100 | 20700 | 19200 | 26900 | 13800 | 16800 | 14900 | 20500 | 18600 | 18400 | 12400 |
| lead$^{pH}$ | 120 | I | **120-150** | I/DW | < 5 | 45 | < 5 | 19 | 15 | 80 | 12 | **175** | < 5 | 20 | < 5 |
| magnesium | | | | | 4500 | 5700 | 5510 | 5150 | 4460 | 5060 | 4680 | 5260 | 3880 | 5410 | 3340 |
| *manganese | 5000 | DW/T | 5000 | DW/T | 482 | 335 | 220 | 747 | 190 | 265 | 237 | 335 | 207 | 280 | 133 |
| mercury (inorganic) | 25 | I | 75 | I/T | 0.04 | 0.08 | 0.04 | 0.06 | 0.05 | 0.05 | 0.02 | 0.16 | 0.03 | 0.08 | 0.02 |
| molybdenum | 15 | DW | 15 | DW | < 4 | < 4 | < 4 | < 4 | < 4 | < 4 | < 4 | < 4 | < 4 | < 4 | < 4 |
| nickel$^{pH}$ | 70-150 | AW-M/DW | 70-250 | AW-M/DW | 13 | 25 | 16 | 21 | 12 | 14 | 11 | 32 | 14 | 31 | 12 |
| phosphorus | | | | | 461 | 683 | 478 | 263 | 546 | 605 | 509 | 750 | 428 | 670 | 376 |
| potassium | | | | | 413 | 630 | 504 | 380 | 330 | 509 | 376 | 541 | 244 | 595 | 151 |
| *selenium | 4 | AW-M/DW | 4 | AW-M/DW | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* |
| silver | 20 | EH | 40 | EH | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| sodium | | | | | 504 | 402 | 524 | 208 | 201 | 205 | 204 | 289 | 210 | 237 | 144 |
| strontium (stable) | 20000 | HH | 150000 | HH | 41 | 111 | 35 | 47 | 16 | 18 | 20 | 166 | 45 | 91 | 32 |
| tin | 50 | EH | 300 | EH | < 5 | < 5 | < 5 | < 5 | < 5 | 9 | < 5 | 8 | < 5 | < 5 | < 5 |
| titanium | | | | | 828 | 773 | 969 | 1160 | 396 | 478 | 478 | 786 | 952 | 458 | 1080 |
| *vanadium | 200 | DW | 200 | DW | 59 | 60 | 63 | 96 | 33 | 40 | 35 | 57 | 65 | 49 | 56 |
| zinc$^{pH}$ | 150-200 | AW-M | **150-200** | AW-M | 25 | 61 | 30 | **210** | 34 | 77 | 66 | 133 | 23 | 85 | 20 |
| zirconium | | | | | 4 | 6 | 5 | 8 | 3 | 2 | 3 | 4 | 4 | 3 | 1 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amenc
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; DW Drinking Wat
EH = generic standard for the protection of ecological health
HH = generic standard for the protection of human health
pH = standard is pH dependant
FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzed
QA/QC = quality assurance/quality control
V = Standard is valence dependant: III - trivalent chromium ($Cr^{3+}$); VI - hexa-valent chromium ($Cr^{6+}$)
italics = Laboratory Method Detection Limit above applicable standards
*Background concentrations applied as detailed in Protocol 4 is applied to replace CSR Standards.

**Table I-1a**
**Results of Soil Analyses - Metals**
**Ladysmith Harbour, Ladysmith, BC**
***Updated December 2019***

| **APEC** | | | | | APEC 20 | | | | | APEC 8 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | CSR standards for PL | **MCS** | **CSR standards for CL** | **MCS** | BH09-13 | BH09-14 | MW09-7 | MW09-8 | MW09-8 | TP09-10 | TP09-10 | TP09-11 | TP09-12 | TP09-12 | TP09-12 |
| **SCN** | | | | | 21365-05 | 21365-11 | 21362-11 | 21363-07 | 21363-08 | 21581-03 | 21581-04 | 21581-06 | 21581-08 | 21581-09 | 21581-10 |
| **Depth (m bgs)** | | | | | 3.8 - 4.0 | 4.1 - 4.3 | 0.5 - 0.7 | 2.9 - 3.0 | 2.9 - 3.0 | 0.3-0.6 | 1.6-1.8 | 0.2-0.4 | 0.1-0.3 | 0.1-0.3 | 1.3-1.5 |
| **Date Sampled (mm/dd/yyyy)** | | | | | 11/14/2009 | 11/14/2009 | 2009-12-11 | 11/13/2009 | 11/13/2009 | 2009-12-15 | 2009-12-15 | 2009-12-15 | 2009-12-15 | 2009-12-15 | 2009-12-15 |
| **QA/QC** | | | | | | | | FDA | FD | | | | FDA | FD | |
| ***Field Parameters*** | | | | | | | | | | | | | | | |
| Soil Vapours (ppm) | | | | | 460 | 210 | 5 | 440 | 440 | 15 | 20 | 30 | 30 | 30 | 25 |
| ***Physical Parameters*** | | | | | | | | | | | | | | | |
| moisture (%) | | | | | 19.3 | 9.5 | - | 20 | 24.3 | 9 | 7.2 | 13.2 | 15 | 18.4 | 12.4 |
| pH (pH units) | | | | | 7.4 | 8.1 | 6.3 | 8 | 7.9 | 7.5 | 6.9 | 6.7 | 6.8 | 6.8 | 7.3 |
| ***Total Metals*** | | | | | | | | | | | | | | | |
| *aluminum | 55000 | HH | 250000 | HH | 23200 | 11600 | 14500 | 12100 | 11000 | 13200 | 12500 | 14300 | 14000 | 15400 | 19000 |
| antimony | 20 | EH | 40 | EH | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| arsenic | 10 | AW-M/DW | **10** | AW-M | **16** | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| barium | 350 | DW | 350 | DW | 95 | 55 | 45 | 55 | 52 | 94 | 108 | 91 | 130 | 131 | 87 |
| beryllium$^{pH}$ | 1-150 | AW-M/I/DW | 1-350 | DW/T | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| boron (hot water soluble) | | | | | 38 | 19 | 8 | 19 | 18 | < 1 | < 1 | < 1 | 1 | < 1 | < 1 |
| cadmium$^{pH}$ | 1-30 | AW-M/T | 1-70 | DW/AW-M | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| calcium | | | | | 1920 | 9380 | 3810 | 14800 | 33000 | 5690 | 3940 | 5020 | 6280 | 5820 | 4840 |
| *chromium, total | 65 | AW-M/DW | 65 | DW/AW-M | 39 | 20 | 17 | 20 | 19 | 26 | 24 | 25 | 27 | 29 | 21 |
| *cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 28 | 7 | 8 | 9 | 8 | 11 | 12 | 13 | 11 | 12 | 11 |
| *copper$^{pH}$ | 100-150 | AW-M/T | 100-300 | AW-M/T | 50 | 21 | 40 | 64 | 56 | 46 | 26 | 57 | 63 | 64 | 25 |
| *iron | 70000 | HH | 150000 | HH | 36300 | 18700 | 19500 | 18400 | 18200 | 22100 | 23800 | 21700 | 20800 | 22900 | 21800 |
| lead$^{pH}$ | 120 | I | **120-150** | I/DW | 30 | 19 | 5 | 36 | 54 | 16 | 5 | 23 | 58 | 60 | 6 |
| magnesium | | | | | 11500 | 6530 | 4900 | 6000 | 5890 | 5870 | 5560 | 5660 | 5390 | 5610 | 4270 |
| *manganese | 5000 | DW/T | 5000 | DW/T | 1190 | 329 | 236 | 425 | 427 | 510 | 734 | 694 | 464 | 608 | 505 |
| mercury (inorganic) | 25 | I | 75 | I/T | 0.11 | 0.07 | 0.05 | 0.2 | 0.26 | 0.04 | 0.02 | 0.05 | 0.09 | 0.09 | 0.05 |
| molybdenum | 15 | DW | 15 | DW | 7 | < 4 | < 4 | 5 | < 4 | < 4 | < 4 | < 4 | < 4 | < 4 | < 4 |
| nickel$^{pH}$ | 70-150 | AW-M/DW | 70-250 | AW-M/DW | 54 | 17 | 13 | 22 | 18 | 22 | 19 | 22 | 21 | 22 | 18 |
| phosphorus | | | | | 441 | 373 | 570 | 492 | 469 | 635 | 1240 | 700 | 766 | 801 | 3010 |
| potassium | | | | | 3790 | 1420 | 412 | 815 | 796 | 647 | 347 | 384 | 422 | 442 | 318 |
| *selenium | 4 | AW-M/DW | 4 | AW-M/DW | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* | *< 2* |
| silver | 20 | EH | 40 | EH | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| sodium | | | | | 3560 | 1760 | 293 | 1470 | 1720 | 298 | 149 | 197 | 366 | 406 | 249 |
| strontium (stable) | 20000 | HH | 150000 | HH | 34 | 70 | 20 | 117 | 266 | 45 | 19 | 36 | 65 | 56 | 49 |
| tin | 50 | EH | 300 | EH | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| titanium | | | | | 186 | 809 | 868 | 597 | 677 | 1010 | 617 | 1240 | 1060 | 1140 | 944 |
| *vanadium | 200 | DW | 200 | DW | 58 | 34 | 61 | 46 | 41 | 63 | 60 | 64 | 67 | 71 | 51 |
| zinc$^{pH}$ | 150-200 | AW-M | **150-200** | AW-M | 131 | 61 | 30 | 68 | 75 | 53 | 57 | 69 | 108 | 123 | 51 |
| zirconium | | | | | 5 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 4 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amenc
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; DW Drinking Wat
EH = generic standard for the protection of ecological health
HH = generic standard for the protection of human health
pH = standard is pH dependant
FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzed
QA/QC = quality assurance/quality control
V = Standard is valence dependant: III - trivalent chromium ($Cr^{3+}$); VI - hexa-valent chromium ($Cr^{6+}$)
italics = Laboratory Method Detection Limit above applicable standards
*Background concentrations applied as detailed in Protocol 4 is applied to replace CSR Standards.

**Table I-1b**
**Results of Soil Analyses - Hydrocarbons and PCBs**
**Ladysmith Harbour, Ladysmith, BC**

| APEC | | | | | | | APEC 9 | | | APEC 10 | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fill Samples** | | | | | | | | | APEC 8 | | | | APEC 8 | | | | | APEC 8 | | | | | APEC 8 | | | | | APEC 8 | APEC 8 | | APEC 8 | APEC 8 | APEC 8 | APEC 8 | APEC 8 |
| **Location** | CSR Standards for PL | MCS | **CSR Standards for CL** | MCS | CSR Standards for IL | MCS | MW09-6 | TP09-09 | TP09-09 | TP09-10 | TP09-10 | TP09-11 | TP09-12 | TP09-12 | TP09-12 | MW09-1 | TP09-01 | TP09-02 | TP09-02 | TP09-02 | TP09-03 | TP09-04 | TP11-02 | TP11-02 | TP11-03 | TP11-04 | TP11-04 | TP11-04 | TP09-07 | TP09-08 | ear TP-8) SA | ear TP-8) SA | ear TP-8) SA |
| **SCN** | | | | | | | 21362-06 | 21383-12 | 21581-01 | 21581-03 | 21581-04 | 21581-06 | 21581-08 | 21581-09 | 21581-10 | 21360-02 | 21381-01 | 21381-04 | 21381-05 | 21381-06 | 21381-09 | 21381-11 | 0527-04 | 0527-05 | 0527-09 | 0528-02 | 0528-03 | 0528-04 | 21383-08 | 21383-11 | 21370-05 | 21370-06 | 21370-07 |
| **Depth (m bgs)** | | | | | | | 2.0 - 2.2 | 0.4-0.6 | 1.0-1.2 | 0.3-0.6 | 1.6-1.8 | 0.2-0.4 | 0.1-0.3 | 0.1-0.3 | 1.3-1.5 | 0.6 - 0.76 | 0.6-0.8 | 1.5-1.7 | 1.5-1.7 | 2.2-2.4 | 1.8-1.9 | 1.0-1.2 | 2-2.25 | 1.8-1.9 | 2.0-2.1 | 0.5-0.6 | 0.5-0.6 | 1.7-1.8 | 0.3-0.5 | 0.4-0.6 | 0.2 - 0.3 | 0.2 - 0.3 | 0.2 - 0.3 |
| **Date Sampled (mm/dd/yyyy)** | | | | | | | 11-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 11-10-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 09-02-11 | 09-02-11 | 09-02-11 | 09-02-11 | 09-02-11 | 09-02-11 | 15-12-09 | 15-12-09 | 11/25/2009 | 11/25/2009 | 11/25/2009 |
| **QA/QC** | | | | | | | | | | | | | FDA | FD | | | | FDA | FD | | | | | | | FDA | FD | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Soil Vapours (ppm unless otherwise indicated) | | | | | | | 10 | 10 | 15 | 15 | 20 | 30 | 30 | 30 | 25 | 0 | 20 | 580 | 580 | 810 | 5% LEL | 22 | 0 | 0 | 0 | 0.6 | 0.6 | 0 | 20 | 10 | - | - | - |
| **Physical Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| moisture (%) | | | | | | | - | 15.9 | 16.3 | 9 | 7.2 | 13.2 | 15 | 18.4 | 12.4 | 18.5 | - | 16.1 | 18.5 | 20.8 | 10.9 | 17 | 18.9 | 11.1 | 21.4 | 33.6 | 52.0 | 20.8 | 6.1 | 11.9 | 20.2 | 7.4 | 19 |
| pH (pH units) | | | | | | | 6.8 | 7.2 | 7.4 | 7.5 | 6.9 | 6.7 | 6.8 | 6.8 | 7.3 | 5.7 | 5.9 | - | - | - | - | 7.2 | - | - | - | - | - | - | - | - | - | - | - |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $EPH_{C10-19}$ [a] | *1000* | | ***2,000*** | | *2,000* | | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | - | 270 | 300 | 430 | < 250 | < 250 | <200 | <200 | <200 | <200 | <200 | <200 | < 250 | < 250 | < 250 | < 250 | 1,000 |
| $EPH_{C10-19}$ (sg) | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| $EPH_{C19-32}$ [a] | *1000* | | ***5000*** | | *5,000* | | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | - | 830 | 980 | 400 | < 250 | < 250 | <200 | <200 | <200 | <200 | <200 | <200 | < 250 | 830 | < 250 | 1,600 | **14,000** |
| $EPH_{C19-32}$ (sg) | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LEPH | 1000 | EH/HH | **2,000** | EH/HH | 2,000 | EH/HH | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | - | 270 | 300 | 430 | < 250 | < 250 | <200 | <200 | <200 | <200 | <200 | <200 | < 250 | < 250 | < 250 | < 250 | 1,000 |
| HEPH | 1000 | EH/HH | **5000** | EH/HH | 5,000 | EH/HH | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | - | 830 | 980 | 400 | < 250 | < 250 | <200 | <200 | <200 | <200 | <200 | <200 | < 250 | 830 | < 250 | 1,600 | **14,000** |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2-methylnaphthalene | 100 | HH | 950 | HH | 950 | HH | < 0.05 | 0.98 | < 0.05 | 0.21 | < 0.05 | 0.17 | 0.16 | 0.13 | < 0.05 | 0.08 | - | < 0.05 | < 0.05 | 0.16 | 3.2 | < 0.05 | <0.050 | 0.250 | <0.050 | 0.060 | 0.106 | <0.050 | < 0.05 | 0.06 | < 0.05 | 0.08 | 0.29 |
| acenaphthene | 2000 | HH | 15000 | HH | 15000 | HH | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.11 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| acenaphthylene | | | | | | | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| anthracene | 2.5 | T | 30 | T | 30 | T | < 0.05 | 0.06 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.12 | 0.07 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzo(a)anthracene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | 0.13 | < 0.05 | < 0.05 | < 0.05 | 0.11 | 0.26 | 0.34 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | 0.068 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzo(a)pyrene | 10 | I | 30 | I | 50 | I | < 0.05 | 0.09 | < 0.05 | 0.05 | < 0.05 | 0.13 | 0.33 | 0.39 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | <0.071 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.1 |
| benzo(b)fluoranthene | | | | | | | < 0.05 | 0.1 | < 0.05 | 0.06 | < 0.05 | 0.14 | 0.38 | 0.46 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | 0.095 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzo(g,h,i)perylene | | | | | | | < 0.05 | 0.07 | < 0.05 | < 0.05 | < 0.05 | 0.07 | 0.22 | 0.26 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | 0.12 | 0.47 |
| benzo(k)fluoranthene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.08 | 0.19 | 0.16 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.08 |
| chrysene | 400 | HH | 4500 | HH | 4500 | HH | < 0.05 | 0.15 | < 0.05 | 0.05 | < 0.05 | 0.12 | 0.32 | 0.45 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | 0.087 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.11 |
| dibenz(a,h)anthracene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.08 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| fluoranthene | 50 | T | 200 | T | 200 | T | < 0.05 | 0.09 | < 0.05 | 0.05 | < 0.05 | 0.16 | 0.52 | 0.44 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | 0.103 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| fluorene | 1000 | HH | 9500 | HH | 9500 | HH | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.11 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| indeno(1,2,3-c,d)pyrene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.06 | 0.18 | 0.21 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | 0.1 | 0.31 |
| naphthalene | 0.6 | T | 20 | T | 20 | T | < 0.05 | 0.45 | < 0.05 | 0.12 | < 0.05 | 0.09 | 0.11 | 0.1 | < 0.05 | 0.07 | - | < 0.05 | < 0.05 | < 0.05 | 2.20 | < 0.05 | <0.050 | 0.136 | <0.050 | <0.050 | 0.060 | <0.050 | < 0.05 | < 0.05 | < 0.05 | 0.07 | 0.27 |
| phenanthrene | 5 | EH | 50 | EH | 50 | EH | < 0.05 | 0.98 | < 0.05 | 0.19 | < 0.05 | 0.22 | 0.62 | 0.41 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | 0.09 | < 0.05 | < 0.05 | <0.050 | 0.144 | <0.050 | 0.069 | 0.127 | <0.050 | < 0.05 | 0.06 | < 0.05 | 0.13 | 0.32 |
| pyrene | 10 | EH | 100 | EH | 100 | EH | < 0.05 | 0.15 | < 0.05 | 0.07 | < 0.05 | 0.18 | 0.56 | 0.58 | < 0.05 | < 0.05 | - | < 0.05 | 0.08 | < 0.05 | < 0.05 | < 0.05 | <0.050 | 0.106 | <0.050 | <0.050 | <0.050 | <0.050 | < 0.05 | < 0.05 | < 0.05 | 0.07 | 0.23 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| benzene | 0.035 | DW | **0.035** | DW | 6.5 | DW | - | - | - | - | - | - | - | - | - | *< 0.04* | - | *< 0.04* | - | *< 0.04* | *< 0.04* | *< 0.04* | *<0.040* | *<0.040* | *<0.040* | *<0.040* | *<0.040* | *<0.040* | - | - | - | - | - |
| ethylbenzene | 15 | DW | **15** | DW | 15 | DW | - | - | - | - | - | - | - | - | - | < 0.5 | - | < 0.5 | - | < 0.5 | < 0.5 | < 0.5 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | - | - | - | - | - |
| styrene | 5 | EH | 50 | EH | 50 | EH | - | - | - | - | - | - | - | - | - | < 0.1 | - | < 0.5 | - | < 0.1 | < 0.1 | < 0.1 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | - | - | - | - | - |
| toluene | 6 | DW | 6 | DW | 6 | DW | - | - | - | - | - | - | - | - | - | < 0.5 | - | < 0.1 | - | < 0.5 | < 0.5 | < 0.5 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | - | - | - | - | - |
| ortho-Xylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | - | - | - | - | - |
| meta- & para-Xylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.050 | 0.060 | <0.050 | <0.050 | <0.050 | <0.050 | - | - | - | - | - |
| Total xylene | 6.5 | DW | **6.5** | DW | 6.5 | DW | - | - | - | - | - | - | - | - | - | < 0.1 | - | < 0.1 | - | < 0.1 | < 0.1 | 0.2 | <0.071 | <0.071 | <0.071 | <0.071 | <0.071 | <0.071 | - | - | - | - | - |
| Methyl t-butyl ether (MTBE) | 8000 | HH | 20000 | HH | 20000 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | - | - | - | - | - |
| VPH | 200 | HH/EH | **200** | EH/HH | 200 | EH/HH | - | - | - | - | - | - | - | - | - | < 100 | - | 118 | < 100 | **546** | **956** | < 100 | <100 | <100 | <100 | <100 | <100 | <100 | - | - | - | - | - |
| VH6-10 | | | | | | | - | - | - | - | - | - | - | - | - | < 100 | - | 118 | < 100 | 546 | 843 | < 100 | <100 | <100 | <100 | <100 | <100 | <100 | - | - | - | - | - |
| **Polychlorinated Biphenyls** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arochlor 1242 | | | | | | | - | < 0.03 | < 0.03 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | < 0.03 | < 0.03 | < 0.03 |
| Arochlor 1248 | | | | | | | - | < 0.03 | < 0.03 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | < 0.03 | < 0.03 | < 0.03 |
| Arochlor 1254 | | | | | | | - | < 0.03 | < 0.03 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | < 0.03 | < 0.03 | < 0.03 |
| Arochlor 1260 | | | | | | | - | < 0.03 | < 0.03 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | < 0.03 | < 0.03 | 0.45 |
| polychlorinated biphenyls (PCB-total) | 1.5 | T | 35 | I/T | 35 | I/T | - | < 0.03 | < 0.03 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | < 0.03 | < 0.03 | 0.45 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial).
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; AW = Groundwater Flow to Surface Water used by Aquatic Life, M = Marine; DW = Drinking Water
EH = generic standard for the protection of ecological health; HH = generic standard for the protection of human health
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019)
MCS = most conservative standard based on applicable site-specific standards
QA/QC = quality assurance/quality control
a. LEPH and HEPH criteria used as a conservative screen for EPH10-19 and EPH19-32, respectively
FDA = Field duplicate available; FD = Field duplicate.
*italics* = Laboratory Method Detection Limit above applicable standards
< = less than laboratory reporting limit; - = not analyzed
$EPH_{C10-19}$ = extractable petroleum hydrocarbons, carbon range 10-19
$EPH_{C19-32}$ = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons
VH (C6-C10) = volatile hydrocarbons, carbon range 6-10
PAH = polycyclic aromatic hydrocarbon
ppm = parts per milion

**Table I-1b**
**Results of Soil Analyses - Hydrocarbons and PCBs**
**Ladysmith Harbour, Ladysmith, BC**

| **APEC** | | | | | | | AEC 13 | | | APEC 17 | | | APEC 15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fill Samples** | | | | | | | | | | | | | | |
| **Location** | CSR Standards for PL | **MCS** | **CSR Standards for CL** | **MCS** | CSR Standards for IL | **MCS** | MW09-3 | MW09-3 | MW11-01 | MW09-16 | MW09-16 | MW09-16 | MW09-5 | MW09-5 |
| **SCN** | | | | | | | 21360-07 | 21360-08 | 0526-03 | 21366-07 | 21366-09 | 21366-10 | 21361-09 | 21362-02 |
| **Depth (m bgs)** | | | | | | | 0.6 - 0.76 | 2.1 - 2.3 | 4 - 4.1 | 1.2 - 1.37 | 3.35 - 3.50 | 3.35 - 3.50 | 1.4 - 1.6 | 7.1-7.3 |
| **Date Sampled (mm/dd/yyyy)** | | | | | | | 11-10-09 | 11-10-09 | 08-02-11 | 11/14/2009 | 11/14/2009 | 11/14/2009 | 11-11-09 | 11-11-09 |
| **QA/QC** | | | | | | | | | | | FDA | FD | | |
| **Field Parameters** | | | | | | | | | | | | | | |
| Soil Vapours (ppm unless otherwise indicated) | | | | | | | 10 | 23 | 0.4 | 16 | 26 | 26 | 15 | 23 |
| **Physical Parameters** | | | | | | | | | | | | | | |
| moisture (%) | | | | | | | 10.6 | 8.4 | 7.88 | 10.3 | 18.7 | 18.1 | | 12.9 |
| pH (pH units) | | | | | | | 7.3 | - | - | 6.3 | 7.3 | 7.5 | 6.2 | - |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | |
| EPH$_{C10-19}$ [a] | *1000* | | ***2,000*** | | *2,000* | | < 250 | < 250 | <200 | < 250 | < 250 | < 250 | - | < 250 |
| EPH$_{C10-19}$ (sg) | | | | | | | - | - | <200 | - | - | - | - | - |
| EPH$_{C19-32}$ [a] | *1000* | | ***5000*** | | *5,000* | | < 250 | < 250 | <200 | < 250 | < 250 | < 250 | - | < 250 |
| EPH$_{C19-32}$ (sg) | | | | | | | - | - | <200 | - | - | - | - | - |
| LEPH | 1000 | EH/HH | **2,000** | EH/HH | 2,000 | EH/HH | < 250 | < 250 | <200 | < 250 | < 250 | < 250 | - | < 250 |
| HEPH | 1000 | EH/HH | **5000** | EH/HH | 5,000 | EH/HH | < 250 | < 250 | <200 | < 250 | < 250 | < 250 | - | < 250 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | | | |
| 2-methylnaphthalene | 100 | HH | 950 | HH | 950 | HH | < 0.05 | < 0.05 | 0.093 | < 0.05 | < 0.05 | < 0.05 | - | 0.2 |
| acenaphthene | 2000 | HH | 15000 | HH | 15000 | HH | < 0.05 | < 0.05 | <0.050 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| acenaphthylene | | | | | | | < 0.05 | < 0.05 | <0.050 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| anthracene | 2.5 | T | 30 | T | 30 | T | < 0.05 | < 0.05 | <0.050 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| benzo(a)anthracene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | < 0.05 | 0.107 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| benzo(a)pyrene | 10 | I | 30 | I | 50 | I | < 0.05 | < 0.05 | 0.107 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| benzo(b)fluoranthene | | | | | | | < 0.05 | < 0.05 | 0.122 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| benzo(g,h,i)perylene | | | | | | | < 0.05 | < 0.05 | 0.072 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| benzo(k)fluoranthene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | < 0.05 | <0.050 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| chrysene | 400 | HH | 4500 | HH | 4500 | HH | < 0.05 | < 0.05 | 0.116 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| dibenz(a,h)anthracene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | < 0.05 | <0.050 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| fluoranthene | 50 | T | 200 | T | 200 | T | < 0.05 | < 0.05 | 0.283 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| fluorene | 1000 | HH | 9500 | HH | 9500 | HH | < 0.05 | < 0.05 | <0.050 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| indeno(1,2,3-c,d)pyrene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | < 0.05 | 0.074 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| naphthalene | 0.6 | T | 20 | T | 20 | T | < 0.05 | < 0.05 | 0.051 | < 0.05 | < 0.05 | < 0.05 | - | 0.1 |
| phenanthrene | 5 | EH | 50 | EH | 50 | EH | < 0.05 | 0.05 | 0.156 | < 0.05 | < 0.05 | < 0.05 | - | 0.11 |
| pyrene | 10 | EH | 100 | EH | 100 | EH | < 0.05 | < 0.05 | 0.263 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | |
| benzene | 0.035 | DW | **0.035** | DW | 6.5 | DW | *< 0.04* | *< 0.04* | *<0.040* | - | - | - | - | **0.12** |
| ethylbenzene | 15 | DW | **15** | DW | 15 | DW | < 0.5 | < 0.5 | <0.050 | - | - | - | - | 0.07 |
| styrene | 5 | EH | 50 | EH | 50 | EH | < 0.1 | < 0.1 | <0.050 | - | - | - | - | < 0.03 |
| toluene | 6 | DW | 6 | DW | 6 | DW | < 0.5 | < 0.5 | <0.050 | - | - | - | - | 0.24 |
| ortho-Xylene | | | | | | | - | - | <0.050 | - | - | - | - | - |
| meta- & para-Xylene | | | | | | | - | - | <0.050 | - | - | - | - | - |
| Total xylene | 6.5 | DW | **6.5** | DW | 6.5 | DW | < 0.1 | < 0.1 | <0.071 | - | - | - | - | 0.3 |
| Methyl t-butyl ether (MTBE) | 8000 | HH | 20000 | HH | 20000 | HH | - | - | <0.20 | - | - | - | - | - |
| VPH | 200 | HH/EH | **200** | EH/HH | 200 | EH/HH | < 100 | < 100 | <100 | - | - | - | - | < 100 |
| VH6-10 | | | | | | | < 100 | < 100 | <100 | - | - | - | - | < 100 |
| **Polychlorinated Biphenyls** | | | | | | | | | | | | | | |
| Arochlor 1242 | | | | | | | - | - | - | - | - | - | - | - |
| Arochlor 1248 | | | | | | | - | - | - | - | - | - | - | - |
| Arochlor 1254 | | | | | | | - | - | - | - | - | - | - | - |
| Arochlor 1260 | | | | | | | - | - | - | - | - | - | - | - |
| polychlorinated biphenyls (PCB-total) | 1.5 | T | 35 | I/T | 35 | I/T | - | - | - | - | - | - | - | - |

| **APEC** | AEC 12 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fill Samples** | | APEC 8 | | APEC 8 | APEC 8 | APEC 8 | APEC 8 | APEC 8 | | | | | | APEC 8 | | | | |
| **Location** | MW09-9 | MW09-10 | MW09-10 | MW09-11 | KE SA1 | KE SA2 | KE SA4 | TP09-05 | TP09-05 | TP09-05 | TP09-06 | TP09-06 | TP09-06 | TP11-05 | TP11-07 | TP11-07 | TP11-07 | TP11-08 |
| **SCN** | 21364-02 | 21364-05 | 21364-07 | 21364-09 | 21370-01 | 21370-02 | 21370-04 | 21383-01 | 21383-02 | 21383-03 | 21383-05 | 21383-06 | 21383-07 | 0528-10 | 0529-03 | 0529-07 | 0529-10 | 0529-12 |
| **Depth (m bgs)** | 1.5 - 1.7 | 0.6 - 0.76 | 1.5 - 1.7 | 0.3 - 0.4 | 0.2 - 0.3 | 0.2 - 0.3 | 0.2 - 0.3 | 0.3-0.5 | 0.7-0.9 | 1.6-1.8 | 0.9-1.1 | 0.9-1.1 | 1.7-1.9 | 0.3-0.4 | 1.5-1.6 | 2.8-3.0 | 2.8-3.0 | 1.4-1.5 |
| **Date Sampled (mm/dd/yyyy)** | 11/13/2009 | 11/13/2009 | 11/13/2009 | 11/13/2009 | 11/25/2009 | 11/25/2009 | 11/25/2009 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 15-12-09 | 09-02-11 | 09-02-11 | 09-02-11 | 09-02-11 | 09-02-11 |
| **QA/QC** | | | | | | | | | | | FDA | FD | | | | FDA | FD | |
| **Field Parameters** | | | | | | | | | | | | | | | | | | |
| Soil Vapours (ppm unless otherwise indicated) | 16 | 10 | 22 | 5 | - | - | - | 20 | 260 | 35 | 410 | 410 | - | 0 | 165.2 | 35 | 0.1 | 0 |
| **Physical Parameters** | | | | | | | | | | | | | | | | | | |
| moisture (%) | 12.6 | 8.5 | 15.4 | 21.2 | 9 | 10.8 | 6.9 | - | 22.4 | 17.9 | 19.5 | 19.8 | 19.2 | 15.5 | 22.8 | 8.71 | 10.5 | 16.3 |
| pH (pH units) | 8.1 | 7.6 | 7.7 | 6.6 | 6.2 | 6 | 6.1 | 7.9 | - | - | - | - | - | - | - | - | - | - |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | | | | | |
| EPH$_{C10-19}$ [a] | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | - | < 250 | < 250 | ***5,100*** | ***6,600*** | 1,000 | <200 | ***4370*** | <200 | <200 | <200 |
| EPH$_{C10-19}$ (sg) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| EPH$_{C19-32}$ [a] | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | - | < 250 | < 250 | *1500* | *2000* | 370 | <200 | *1650* | <200 | <200 | 650 |
| EPH$_{C19-32}$ (sg) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LEPH | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | - | < 250 | < 250 | **5,100** | **6,600** | 1000 | <200 | **4,370** | <200 | <200 | <200 |
| HEPH | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | - | < 250 | < 250 | 1,500 | 2,000 | 370 | <200 | 1,650 | <200 | <200 | 650 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | | | | | | | |
| 2-methylnaphthalene | < 0.05 | 0.28 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | 0.154 | <0.050 | <0.050 | <0.050 | <0.50 |
| acenaphthene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | 0.57 | < 0.05 | <0.050 | <0.46 | <0.050 | <0.050 | <0.50 |
| acenaphthylene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.16 | <0.050 | <0.050 | <0.50 |
| anthracene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.13 | <0.050 | <0.050 | <0.50 |
| benzo(a)anthracene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.50 |
| benzo(a)pyrene | < 0.05 | 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.50 |
| benzo(b)fluoranthene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.50 |
| benzo(g,h,i)perylene | < 0.05 | 0.06 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.50 |
| benzo(k)fluoranthene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.50 |
| chrysene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.056 | <0.050 | <0.050 | <0.50 |
| dibenz(a,h)anthracene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.50 |
| fluoranthene | < 0.05 | 0.06 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | 0.19 | <0.050 | <0.073 | <0.050 | <0.050 | <0.50 |
| fluorene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | 0.6 | 1.1 | < 0.05 | <0.050 | 0.898 | <0.050 | <0.050 | <0.50 |
| indeno(1,2,3-c,d)pyrene | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | < 0.05 | <0.050 | <0.050 | <0.050 | <0.050 | <0.50 |
| naphthalene | < 0.05 | 0.14 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | 0.08 | 0.084 | <0.54 | <0.050 | <0.050 | <0.50 |
| phenanthrene | < 0.05 | 0.3 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | 0.15 | 0.090 | <0.16 | <0.050 | <0.050 | <0.50 |
| pyrene | < 0.05 | 0.07 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.5 | < 0.5 | 0.15 | <0.050 | 0.118 | <0.050 | <0.050 | <0.50 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | | | | | |
| benzene | < 0.03 | - | < 0.03 | - | < 0.03 | **0.06** | < 0.03 | *< 0.04* | *< 0.04* | - | *< 0.04* | - | - | *<0.040* | *<0.040* | *<0.040* | *<0.040* | *<0.040* |
| ethylbenzene | < 0.03 | - | < 0.03 | - | < 0.03 | 0.45 | < 0.03 | **17** | < 0.5 | - | < 0.5 | - | - | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| styrene | < 0.03 | - | < 0.03 | - | 0.07 | 29 | 0.24 | < 0.1 | < 0.1 | - | < 0.1 | - | - | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| toluene | < 0.03 | - | < 0.03 | - | < 0.03 | 0.17 | < 0.03 | < 0.5 | < 0.5 | - | < 0.5 | - | - | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| ortho-Xylene | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| meta- & para-Xylene | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.050 | <0.050 | <0.050 | <0.050 | 0.052 |
| Total xylene | < 0.03 | - | < 0.03 | - | < 0.03 | 2.9 | 0.05 | **96** | 0.3 | - | < 0.1 | - | - | <0.071 | <0.071 | <0.071 | <0.071 | <0.071 |
| Methyl t-butyl ether (MTBE) | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| VPH | < 100 | - | < 100 | - | < 100 | 100 | < 100 | - | < 100 | - | - | - | - | <100 | <100 | <100 | <100 | <100 |
| VH6-10 | < 100 | - | < 100 | - | < 100 | < 100 | < 100 | - | < 100 | - | - | - | - | <100 | <100 | <100 | <100 | <100 |
| **Polychlorinated Biphenyls** | | | | | | | | | | | | | | | | | | |
| Arochlor 1242 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Arochlor 1248 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Arochlor 1254 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Arochlor 1260 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| polychlorinated biphenyls (PCB-total) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial).
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; AW = Groundw
EH = generic standard for the protection of ecological health; HH = generic standard for the protection of human health
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019)
MCS = most conservative standard based on applicable site-specific standards
QA/QC = quality assurance/quality control
a. LEPH and HEPH criteria used as a conservative screen for EPH10-19 and EPH19-32, respectively
FDA = Field duplicate available; FD = Field duplicate.
*italics* = Laboratory Method Detection Limit above applicable standards
< = less than laboratory reporting limit; - = not analyzed
EPH$_{C10-19}$ = extractable petroleum hydrocarbons, carbon range 10-19
EPH$_{C19-32}$ = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons
VH (C6-C10) = volatile hydrocarbons, carbon range 6-10
PAH = polycyclic aromatic hydrocarbon
ppm = parts per milion

**Table I-1b**
**Results of Soil Analyses - Hydrocarbons and PCBs**
**Ladysmith Harbour, Ladysmith, BC**

| **APEC** | | | | | | | APEC 15 | APEC 19 and 20 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fill Samples** | | | | | | | | | | | | | | | | | |
| **Location** | CSR Standards for PL | **MCS** | **CSR Standards for CL** | **MCS** | CSR Standards for IL | **MCS** | MW09-5 | MW09-7 | MW09-7 | MW09-7 | MW09-8 | MW09-8 | MW09-8 | BH09-13 | BH09-14 | BH09-15 | BH09-15 |
| **SCN** | | | | | | | 21361-08 | 21362-11 | 21363-02 | 21363-04 | 21363-07 | 21363-08 | 21363-10 | 21365-05 | 21365-11 | 21366-03 | 21366-04 |
| **Depth (m bgs)** | | | | | | | 0.6 - 0.8 | 0.5 - 0.7 | 2.1 - 2.3 | 3.9 - 4.1 | 2.9 - 3.0 | 2.9 - 3.0 | 3.9 - 5.0 | 3.8 - 4.0 | 4.1 - 4.3 | 3.65 - 3.8 | 3.65 - 3.8 |
| **Date Sampled (mm/dd/yyyy)** | | | | | | | 11-11-09 | 11-12-09 | 11-12-09 | 11-12-09 | 11/13/2009 | 11/13/2009 | 11/13/2009 | 11/14/2009 | 11/14/2009 | 11/14/2009 | 11/14/2009 |
| **QA/QC** | | | | | | | | | | | FDA | FD | | | | FDA | FD |
| **Field Parameters** | | | | | | | | | | | | | | | | | |
| Soil Vapours (ppm unless otherwise indicated) | | | | | | | 30 | 5 | 10 | 5 | 440 | 440 | 60 | 460 | 210 | 340 | 340 |
| **Physical Parameters** | | | | | | | | | | | | | | | | | |
| moisture (%) | | | | | | | 16.8 | - | 16.3 | 15.7 | 20 | 24.3 | 11.4 | 19.3 | 9.5 | 14.5 | 11.7 |
| pH (pH units) | | | | | | | 5.9 | 6.3 | - | - | 8 | 7.9 | - | 7.4 | 8.1 | - | - |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | | | | |
| $EPH_{C10-19}$ [a] | *1000* | | ***2,000*** | | *2,000* | | < 250 | - | < 250 | < 250 | *1,900* | ***7,500*** | < 250 | ***5,200*** | ***3,500*** | ***2,100*** | ***2,500*** |
| $EPH_{C10-19}$ (sg) | | | | | | | - | - | - | - | - | - | - | - | - | - | - |
| $EPH_{C19-32}$ [a] | *1000* | | ***5000*** | | *5,000* | | < 250 | - | 330 | < 250 | *2,000* | ***7,700*** | < 250 | ***9,800*** | *1,800* | *3,100* | *3,300* |
| $EPH_{C19-32}$ (sg) | | | | | | | - | - | - | - | - | - | - | - | - | - | - |
| LEPH | 1000 | EH/HH | **2,000** | EH/HH | 2,000 | EH/HH | < 250 | - | < 250 | < 250 | 1,900 | **7,500** | < 250 | **5,200** | **3,500** | **2,100** | **2,500** |
| HEPH | 1000 | EH/HH | **5000** | EH/HH | 5,000 | EH/HH | < 250 | - | 330 | < 250 | 2,000 | **7,700** | < 250 | **9,800** | 1,800 | 3,100 | 3,300 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | | | | | | |
| 2-methylnaphthalene | 100 | HH | 950 | HH | 950 | HH | 0.2 | - | 0.22 | 0.09 | 0.74 | 0.66 | < 0.05 | 1.5 | < 0.05 | < 0.05 | < 0.05 |
| acenaphthene | 2000 | HH | 15000 | HH | 15000 | HH | 0.82 | - | < 0.05 | < 0.05 | 3 | 1.7 | < 0.05 | 1.7 | < 0.05 | < 0.05 | < 0.05 |
| acenaphthylene | | | | | | | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| anthracene | 2.5 | T | 30 | T | 30 | T | 1.5 | - | 0.06 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzo(a)anthracene | 1 | EH | 10 | EH | 10 | EH | 0.4 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzo(a)pyrene | 10 | I | 30 | I | 50 | I | 0.13 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzo(b)fluoranthene | | | | | | | 0.19 | - | 0.1 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzo(g,h,i)perylene | | | | | | | < 0.05 | - | 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzo(k)fluoranthene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| chrysene | 400 | HH | 4500 | HH | 4500 | HH | 0.3 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| dibenz(a,h)anthracene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| fluoranthene | 50 | T | 200 | T | 200 | T | 1.9 | - | 0.07 | < 0.05 | < 0.05 | 0.84 | < 0.05 | 0.71 | < 0.05 | < 0.05 | < 0.05 |
| fluorene | 1000 | HH | 9500 | HH | 9500 | HH | 0.87 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 1.3 | < 0.05 | < 0.05 | < 0.05 |
| indeno(1,2,3-c,d)pyrene | 1 | EH | 10 | EH | 10 | EH | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| naphthalene | 0.6 | T | 20 | T | 20 | T | 0.42 | - | 0.15 | 0.09 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| phenanthrene | 5 | EH | 50 | EH | 50 | EH | 4 | - | 0.27 | < 0.05 | < 0.05 | < 0.05 | 0.05 | 4.2 | < 0.05 | < 0.05 | < 0.05 |
| pyrene | 10 | EH | 100 | EH | 100 | EH | 1.2 | - | 0.07 | < 0.05 | 5.2 | 3 | 0.09 | 3 | 0.05 | 0.77 | 0.66 |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | | | | |
| benzene | 0.035 | DW | **0.035** | DW | 6.5 | DW | < 0.03 | - | *< 0.04* | *< 0.04* | *< 0.04* | *< 0.04* | *< 0.04* | **0.13** | *< 0.04* | *< 0.04* | *< 0.04* |
| ethylbenzene | 15 | DW | **15** | DW | 15 | DW | < 0.03 | - | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| styrene | 5 | EH | 50 | EH | 50 | EH | < 0.03 | - | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| toluene | 6 | DW | 6 | DW | 6 | DW | < 0.03 | - | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| ortho-Xylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - |
| meta- & para-Xylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - |
| Total xylene | 6.5 | DW | **6.5** | DW | 6.5 | DW | < 0.03 | - | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | 0.3 | < 0.1 | < 0.1 | < 0.1 |
| Methyl t-butyl ether (MTBE) | 8000 | HH | 20000 | HH | 20000 | HH | - | - | - | - | - | - | - | - | - | - | - |
| VPH | 200 | HH/EH | **200** | EH/HH | 200 | EH/HH | < 100 | - | < 100 | < 100 | **250** | 140 | < 100 | < 100 | < 100 | < 100 | < 100 |
| VH6-10 | | | | | | | < 100 | - | < 100 | < 100 | 250 | 140 | < 100 | < 100 | < 100 | < 100 | < 100 |
| **Polychlorinated Biphenyls** | | | | | | | | | | | | | | | | | |
| Arochlor 1242 | | | | | | | - | - | - | - | - | - | - | - | - | - | - |
| Arochlor 1248 | | | | | | | - | - | - | - | - | - | - | - | - | - | - |
| Arochlor 1254 | | | | | | | - | - | - | - | - | - | - | - | - | - | - |
| Arochlor 1260 | | | | | | | - | - | - | - | - | - | - | - | - | - | - |
| polychlorinated biphenyls (PCB-total) | 1.5 | T | 35 | I/T | 35 | I/T | - | - | - | - | - | - | - | - | - | - | - |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial).
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; AW = Groundw
EH = generic standard for the protection of ecological health; HH = generic standard for the protection of human health
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019)
MCS = most conservative standard based on applicable site-specific standards
QA/QC = quality assurance/quality control
a. LEPH and HEPH criteria used as a conservative screen for EPH10-19 and EPH19-32, respectively
FDA = Field duplicate available; FD = Field duplicate.
*italics* = Laboratory Method Detection Limit above applicable standards
< = less than laboratory reporting limit; - = not analyzed
$EPH_{C10-19}$ = extractable petroleum hydrocarbons, carbon range 10-19
$EPH_{C19-32}$ = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
VPH = volatile petroleum hydrocarbons
VH (C6-C10) = volatile hydrocarbons, carbon range 6-10
PAH = polycyclic aromatic hydrocarbon
ppm = parts per milion

**Table I-1c**
**Results of Soil Analyses - Volatile Organic Compounds**
**Ladysmith Harbour, Ladysmith, BC**

| Location | CSR Standards for PL | MCS | CSR Standards for CL | MCS | CSR Standards for IL | MCS | MW09-5 | MW09-5 | MW09-9 | MW09-10 | KE SA1 | KE SA2 | KE SA4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCN | | | | | | | 21361-08 | 21362-02 | 21364-02 | 21364-07 | 21370-01 | 21370-02 | 21370-04 |
| Depth (m bgs) | | | | | | | 0.6 - 0.8 | 7.1-7.3 | 1.5 - 1.7 | 1.5 - 1.7 | 0.2 - 0.3 | 0.2 - 0.3 | 0.2 - 0.3 |
| Date Sampled (mm/dd/yyyy) | | | | | | | 2009-11-11 | 2009-11-11 | 11/13/2009 | 11/13/2009 | 11/25/2009 | 11/25/2009 | 11/25/2009 |
| QA/QC | | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | |
| Soil Vapours (ppm) | | | | | | | 30 | 23 | 16 | 22 | - | - | - |
| **Physical Parameters** | | | | | | | | | | | | | |
| moisture (%) | | | | | | | 16.8 | 12.9 | 12.6 | 15.4 | 9 | 10.8 | 6.9 |
| pH (pH units) | | | | | | | 5.9 | - | 8.1 | 7.7 | 6.2 | 6 | 6.1 |
| **Halogenated Hydrocarbons** | | | | | | | | | | | | | |
| bromodichloromethane (BDCM) | 200 | HH | 550 | HH | 550 | HH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| bromoform (tribromomethane) | 650 | HH | 4,000 | HH | 4,000 | HH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| bromomethane (methyl bromide) | 45 | HH | 300 | HH | 300 | HH | < 0.12 | < 0.12 | < 0.12 | < 0.12 | < 0.12 | < 0.12 | < 0.12 |
| methyl ethyl ketone (2-Butanone) | 20000 | HH | 150000 | HH | 150000 | HH | <1.5 | < 1.5 | < 1.5 | < 1.5 | < 1.5 | < 1.5 | < 1.5 |
| carbon tetrachloride | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| chlorobenzene | 1 | EH | 10 | EH | 10 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| chloroethane | | | | | | | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 |
| chloroform | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| chloromethane (methyl chloride) | | | | | | | < 0.12 | < 0.12 | < 0.12 | < 0.12 | < 0.12 | < 0.12 | < 0.12 |
| dibromochloromethane (DBCM) | 150 | HH | 400 | HH | 400 | HH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,2-dibromoethane (ethylene dibromide) (EDB) | 7 | HH | 15 | HH | 15 | HH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| dibromomethane (methylene bromide) | | | | | | | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,2-dichlorobenzene | 1 | EH | 10 | EH | 10 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,3-dichlorobenzene | 1 | EH | 10 | EH | 10 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,4-dichlorobenzene | 1 | EH | 10 | EH | 10 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| dichlorodifluoromethane (freon 12) | 6500 | HH | 45000 | HH | 45000 | HH | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 |
| 1,1-dichloroethane | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,2-dichloroethane | 5 | EH | 50 | EH | 50 | EH | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 |
| 1,1-dichloroethene | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,2-dichloroethylene (cis) (1,2-dichloroethene) (cis) | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,2-dichloroethylene (trans) (1,2-dichloroethene) (trans) | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,2-dichloropropane (propylene dichloride) | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,3-dichloropropene (cis) | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,3-dichloropropene (trans) | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 2-Hexanone | 150 | HH | 1000 | HH | 1000 | HH | <1.5 | < 1.5 | <1.5 | <1.5 | < 1.5 | < 1.5 | < 1.5 |
| methyl isobutyl ketone (4-Methyl-2-pentanone) | | | | | | | <0.6 | < 0.6 | <0.6 | <0.6 | < 0.6 | < 0.6 | < 0.6 |
| dichloromethane (methylene chloride) | 5 | EH | 50 | EH | 50 | EH | < 0.1 | < 0.1 | <0.1 | <0.1 | < 0.1 | < 0.1 | < 0.1 |
| 1,1,2,2-tetrachloroethane | 70 | HH | 150 | HH | 150 | HH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| tetrachloroethylene (PERC) | 2.5 | AW | 2.5 | AW | 2.5 | AW | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,1,1-trichloroethane | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| 1,1,2-trichloroethane | 5 | EH | 50 | EH | 50 | EH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| trichloroethylene (TCE) | 0.3 | AW | 0.3 | AW | 0.3 | AW | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| trichlorofluoromethane (freon 11) | 9000 | HH | 70000 | HH | 70,000 | HH | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 | < 0.03 |
| vinyl chloride (chloroethene) | 2 | HH | 45 | HH | 45 | HH | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 | < 0.06 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation (“CSR”; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019)
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants;
AW = Groundwater Flow to Surface Water used by Aquatic Life, F = Fresh Water Aquatic Life and M = Marine Aquatic Life;
FDA = field duplicate available
FD = field duplicate
QA/QC = quality assurance/quality control
NS = No Standard
< = less than laboratory reporting limit; - = not analyzed

**TABLE 2a**
**Historic Soil Sampling Results - Total Metals**
**Ladysmith Harbour, Ladysmith, BC**

| Location / SCN / Depth (m) / Date Sampled / Source / QA/QC | CSR Standards for PL | MCS | **CSR Standards for CL** | MCS | CSR Standards for IL | MCS |
|---|---|---|---|---|---|---|
| ***Physical*** | | | | | | |
| pH | | | | | | |
| ***Total Metals*** | | | | | | |
| *Aluminum | 55000 | HH | 250000 | HH | 250000 | HH |
| Antimony | 20 | EH | **40** | EH | 40 | EH |
| Arsenic | 10 | AW-M/DW | **10** | AW-M | 10 | AW-M/DW |
| Barium | 350 | DW | **350** | DW | 350 | DW |
| Beryllium$^{pH}$ | 1-150 | AW-M | 1-350 | DW/T | 1-350 | DW |
| Bismuth | | | | | | |
| Cadmium$^{pH}$ | 1-30 | AW-M | **1-70** | DW/AW-M | 1-70 | AW-M/DW |
| Calcium | | | | | | |
| *Chromium (total) | 65 | AW-M/DW | **65** | DW/AW-M | 65 | AW-M/DW |
| *Cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 30 | AW-M/DW |
| *Copper$^{pH}$ | 100-150 | AW-M/DW | **100-300** | AW-M/T | 100-300 | AW-M |
| *Iron | 70000 | HH | 150000 | HH | 150000 | HH |
| Lead$^{pH}$ | 120 | I | **120-150** | AW-M/DW | 120-1000 | DW |
| Magnesium | | | | | | |
| *Manganese | 5000 | DW/T | 5000 | DW/T | 5000 | DW/T |
| Mercury | 25 | I | 75 | I/T | 75 | T |
| Molybdenum | 15 | DW | **15** | DW | 15 | DW |
| Nickel$^{pH}$ | 70-150 | AW-M/DW | **70-250** | AW-M/DW | 70-250 | AW-M/DW |
| Phosphorus | | | | | | |
| Potassium | | | | | | |
| *Selenium | 4 | AW-M/DW | 4 | AW-M/DW | 4 | AW-M/DW |
| Silver | 20 | EH | 40 | EH | 40 | EH |
| Sodium$^{i}$ | 200 | T | **1000** | T | 1000 | T |
| Strontium | 20000 | HH | 150000 | HH | 150000 | HH |
| Tellurium | | | | | | |
| Thallium | | | | | | |
| Tin | 50 | EH | 300 | EH | 300 | EH |
| Titanium | | | | | | |
| *Vanadium | 200 | DW | 200 | DW | 200 | DW |
| Zinc$^{pH}$ | 150-200 | AW-M | **150-200** | AW-M | 150-200 | AW-M |
| Zirconium | | | | | | |
| ***Inorganic Parameters*** | | | | | | |
| Elemental Sulphur (%) | | | | | | |

| Location | BH05-1 | BH05-1 | MW05-2 | MW05-2 | MW05-3 | MW05-3 | MW05-4 | MW05-4 | MW05-5 | MW05-5 | MW05-6 | MW05-6 | MW5-6 | MW05-7 | MW05-7 | MW05-7 | MW05-7 | MW05-7 | MW05-8 | MW05-9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCN | 0019-08 | 0020-03 | 0020-05 | 0020-08 | 0021-01 | 0021-03 | 0022-01 | 0022-02 | 0022-10 | 0023-06 | 0023-08 | 0023-10 | 0023-12 | 0024-04 | 0024-06 | 0024-09 | 0025-04 | 0025-09 | 0026-01 | 0026-07 |
| Depth (m) | 6.9 | 13.7 | 0.15 | 1.8 | 0.15 | 0.9 | 1.7 | 2.7 | 2.7 | 9.4 | 0.15 | 0.9 | 1.8 | 0.15 | 0.9 | 2.7 | 9.4 | 14.6 | 1 | 0.47 |
| Date Sampled | 28-Mar-05 | 28-Mar-05 | 28-Mar-05 | 28-Mar-05 | 28-Mar-05 | 28-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 29-Mar-05 | 30-Mar-05 | 30-Mar-05 |
| Source | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder |
| QA/QC | | | | | | | | | FDA | | | FDA | | | | | | | | |
| ***Physical*** | | | | | | | | | | | | | | | | | | | | |
| pH | 8.65 | 8.98 | 7.76 | 8.13 | 8.01 | 8.47 | 9.07 | 8.64 | 8.40 | 9.11 | 7.96 | 7.50 | 8.75 | 6.56 | 6.70 | 8.37 | 8.93 | 8.72 | 8.74 | 6.72 |
| ***Total Metals*** | | | | | | | | | | | | | | | | | | | | |
| *Aluminum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Antimony | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Arsenic | <5.0 | <5.0 | 5.1 | 9.3 | 5.4 | 5.8 | <5.0 | <5.0 | <5.0 | <5.0 | 7.6 | <5.0 | <5.0 | **16.3** | <5.0 | <5.0 | <5.0 | **24.5** | <5.0 | **14.2** |
| Barium | 213 | 175 | 177 | 226 | 144 | 198 | 124 | 192 | 191 | 190 | **713** | 52.2 | 162 | 79.7 | 52.7 | 131 | 147 | 213 | 205 | 61.2 |
| Beryllium$^{pH}$ | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Bismuth | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cadmium$^{pH}$ | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | 1.30 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Calcium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Chromium (total) | 9.1 | 5.4 | 37.6 | 39.9 | 31.5 | 35.9 | 19.1 | 11.1 | 16.5 | 7.0 | 40.7 | 14.2 | 27.1 | 16.0 | 11.1 | 21.8 | 24.4 | 14.2 | 26.1 | 13.0 |
| *Cobalt | 4.7 | 3.4 | 9.0 | 10.1 | 8.4 | 9.8 | 6.1 | 4.4 | 5.6 | 4.5 | 10.5 | 3.8 | 6.1 | 7.3 | 3.5 | 6.2 | 6.0 | 4.6 | 7.7 | 4.2 |
| *Copper$^{pH}$ | 56.4 | 33.4 | 115 | 79.2 | 84.0 | 80.0 | 76.9 | 53.4 | 74.4 | 45.2 | 226 | 31.9 | 71.3 | 78.4 | 32.6 | 68.8 | 63.1 | 52.6 | 68.8 | 62.7 |
| *Iron | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lead$^{pH}$ | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | **677** | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |
| Magnesium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Manganese | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mercury | 0.153 | 0.169 | 0.288 | 0.291 | 0.338 | 0.394 | 0.229 | 0.210 | 0.220 | 0.170 | 0.107 | 0.081 | 0.188 | 0.328 | 0.062 | 0.623 | 0.576 | 0.852 | 0.294 | 0.169 |
| Molybdenum | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | 4.3 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Nickel$^{pH}$ | 17.2 | 10.3 | 56.5 | 63.0 | 45.4 | 57.5 | 26.9 | 18.0 | 25.5 | 14.0 | 33.5 | 16.1 | 38.6 | 14.1 | 11.0 | 31.5 | 38.4 | 24.0 | 38.5 | 12.4 |
| Phosphorus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potassium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Selenium | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| Silver | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| Sodium$^{i}$ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Strontium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tellurium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Thallium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tin | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | 23.6 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| Titanium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Vanadium | 33.5 | 25.1 | 45.0 | 50.9 | 40.9 | 41.1 | 30.6 | 26.7 | 28.3 | 28.0 | 63.6 | 24.1 | 41.5 | 36.5 | 22.4 | 40.7 | 37.8 | 35.0 | 34.2 | 25.9 |
| Zinc$^{pH}$ | 34.2 | 27.5 | 156 | 68.6 | 81.6 | 81.7 | 58.4 | 41.6 | 51.6 | 32.5 | **1240** | 79.8 | 77.9 | 94.5 | 94.4 | 51.1 | 47.4 | 34.2 | 66.2 | 102 |
| Zirconium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ***Inorganic Parameters*** | | | | | | | | | | | | | | | | | | | | |
| Elemental Sulphur (%) | 2.32 | 3.54 | - | - | - | - | - | - | 0.520 | 2.31 | - | - | - | - | - | 0.630 | 0.800 | 2.08 | - | - |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019).
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; DW Drinking Water; AW = Groundwater Flow to Surface Water used by Aquatic Life, and M = Marine Aquatic Life.
EH = generic standard for the protection of ecological health
HH = generic standard for the protection of human health
pH = standard is pH dependant
FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzeditalics = Laboratory Method Detection Limit above applicable standards
QA/QC = quality assurance/quality control
italics = Laboratory Method Detection Limit above applicable standards
*Background concentrations applied as detailed in Protocol 4 is applied to replace CSR Standards.
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site
Hardy = Hardy BBT Limited. 1990. Environmental Review for Town of Ladysmith Waterfront Development Slag Point Area,
EBA = EBA Environmental Ltd. 1994. Elk Falles Forest Industries Limited Phase II Environmental Assessment Ladysmith
Levelton[a] = Levelton Engineering Ltd. 2000a. Preliminary Site Investigation Stage 1 and Stage II Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, B.C. Dated August 25, 2000.
Levelton[b] = Levelton Engineering Ltd. 2000b. Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, B.C. Dated October 25, 2000.

**TABLE 2a**
**Historic Soil Sampling Results - Total Metals**
**Ladysmith Harbour, Ladysmith, BC**

| Location / SCN / Depth (m) / Date Sampled / Source / QA/QC | CSR Standards for PL | MCS | **CSR Standards for CL** | MCS | CSR Standards for IL | MCS |
|---|---|---|---|---|---|---|
| ***Physical*** | | | | | | |
| pH | | | | | | |
| ***Total Metals*** | | | | | | |
| *Aluminum | 55000 | HH | 250000 | HH | 250000 | HH |
| Antimony | 20 | EH | **40** | EH | 40 | EH |
| Arsenic | 10 | AW-M/DW | **10** | AW-M | 10 | AW-M/DW |
| Barium | 350 | DW | **350** | DW | 350 | DW |
| Beryllium$^{pH}$ | 1-150 | AW-M | 1-350 | DW/T | 1-350 | DW |
| Bismuth | | | | | | |
| Cadmium$^{pH}$ | 1-30 | AW-M | **1-70** | DW/AW-M | 1-70 | AW-M/DW |
| Calcium | | | | | | |
| *Chromium (total) | 65 | AW-M/DW | **65** | DW/AW-M | 65 | AW-M/DW |
| *Cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 30 | AW-M/DW |
| *Copper$^{pH}$ | 100-150 | AW-M/DW | **100-300** | AW-M/T | 100-300 | AW-M |
| *Iron | 70000 | HH | 150000 | HH | 150000 | HH |
| Lead$^{pH}$ | 120 | I | **120-150** | AW-M/DW | 120-1000 | DW |
| Magnesium | | | | | | |
| *Manganese | 5000 | DW/T | 5000 | DW/T | 5000 | DW/T |
| Mercury | 25 | I | 75 | I/T | 75 | T |
| Molybdenum | 15 | DW | **15** | DW | 15 | DW |
| Nickel$^{pH}$ | 70-150 | AW-M/DW | **70-250** | AW-M/DW | 70-250 | AW-M/DW |
| Phosphorus | | | | | | |
| Potassium | | | | | | |
| *Selenium | 4 | AW-M/DW | 4 | AW-M/DW | 4 | AW-M/DW |
| Silver | 20 | EH | 40 | EH | 40 | EH |
| Sodium$^{i}$ | 200 | T | **1000** | T | 1000 | T |
| Strontium | 20000 | HH | 150000 | HH | 150000 | HH |
| Tellurium | | | | | | |
| Thallium | | | | | | |
| Tin | 50 | EH | 300 | EH | 300 | EH |
| Titanium | | | | | | |
| *Vanadium | 200 | DW | 200 | DW | 200 | DW |
| Zinc$^{pH}$ | 150-200 | AW-M | **150-200** | AW-M | 150-200 | AW-M |
| Zirconium | | | | | | |
| ***Inorganic Parameters*** | | | | | | |
| Elemental Sulphur (%) | | | | | | |

| Location | BH05-10 | BH05-10 | BH05-10 | BH05-10 | BH05-13 | BH05-13 | BH05-13 | BH05-15 | BH05-15 | MW05-17 |
|---|---|---|---|---|---|---|---|---|---|---|
| SCN | 0027-04 | 0027-07 | 0028-02 | 0028-06 | 8721-06 | 8721-11 | 8715-06 | 33753-07 | 33754-08 | 0029-01 |
| Depth (m) | 0.9 | 3.7 | 9.6 | 14 | 2.8 | 7.1 | 15.5 | 2 | 13.1 | 1.7 |
| Date Sampled | 30-Mar-05 | 30-Mar-05 | 30-Mar-05 | 30-Mar-05 | 31-Mar-05 | 31-Mar-05 | 31-Mar-05 | 31-Mar-05 | 31-Mar-05 | 01-Apr-05 |
| Source | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder |
| QA/QC | | | | | FDA | | | | | |
| ***Physical*** | | | | | | | | | | |
| pH | 6.91 | 8.25 | 8.59 | 8.72 | 8.10 | 8.68 | 8.82 | 8.04 | 8.67 | 8.05 |
| ***Total Metals*** | | | | | | | | | | |
| *Aluminum | - | - | - | - | - | - | - | - | - | - |
| Antimony | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Arsenic | <5.0 | <5.0 | **21.8** | <5.0 | <5.0 | <5.0 | <5.0 | 5.5 | <5.0 | <5.0 |
| Barium | 35.4 | 148 | 225 | 185 | 139 | 150 | 222 | 177 | 216 | 201 |
| Beryllium$^{pH}$ | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Bismuth | - | - | - | - | - | - | - | - | - | - |
| Cadmium$^{pH}$ | **1.21** | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Calcium | - | - | - | - | - | - | - | - | - | - |
| *Chromium (total) | 16.1 | 29.0 | 12.9 | 7.2 | 30.8 | 11.3 | 6.1 | 30.9 | 7.4 | 33.7 |
| *Cobalt | 4.4 | 6.3 | 4.4 | 3.9 | 7.3 | 4.7 | 3.8 | 9.4 | 5.0 | 9.6 |
| *Copper$^{pH}$ | 55.4 | 79.5 | 51.3 | 36.0 | 69.5 | 53.6 | 41.9 | 72.9 | 34.5 | 111 |
| *Iron | - | - | - | - | - | - | - | - | - | - |
| Lead$^{pH}$ | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |
| Magnesium | - | - | - | - | - | - | - | - | - | - |
| *Manganese | - | - | - | - | - | - | - | - | - | - |
| Mercury | 0.397 | 0.400 | 0.761 | 0.939 | 0.427 | 0.366 | 0.252 | 0.625 | 0.372 | 0.489 |
| Molybdenum | 8.5 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Nickel$^{pH}$ | 14.5 | 41.6 | 21.2 | 11.9 | 48.9 | 18.5 | 11.7 | 54.2 | 14.4 | 55.2 |
| Phosphorus | - | - | - | - | - | - | - | - | - | - |
| Potassium | - | - | - | - | - | - | - | - | - | - |
| *Selenium | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| Silver | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| Sodium$^{i}$ | - | - | - | - | - | - | - | - | - | - |
| Strontium | - | - | - | - | - | - | - | - | - | - |
| Tellurium | - | - | - | - | - | - | - | - | - | - |
| Thallium | - | - | - | - | - | - | - | - | - | - |
| Tin | 6.7 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| Titanium | - | - | - | - | - | - | - | - | - | - |
| *Vanadium | 37.9 | 40.2 | 35.3 | 35.5 | 38.3 | 40.7 | 30.7 | 40.0 | 35.2 | 39.1 |
| Zinc$^{pH}$ | 147 | 69.3 | 33.6 | 42.3 | 61.1 | 80.5 | 24.9 | 73.0 | 35.1 | 78.8 |
| Zirconium | - | - | - | - | - | - | - | - | - | - |
| ***Inorganic Parameters*** | | | | | | | | | | |
| Elemental Sulphur (%) | - | 0.340 | 1.77 | 2.12 | 0.370 | 2.32 | 2.06 | 0.280 | 2.39 | 0.280 |

| Location | MW05-17 | MW05-18 | MW05-18 | MW05-18 | MW05-18 | MW05-19 | MW05-19 | MW05-19 | BH05-21 | MW05-22 |
|---|---|---|---|---|---|---|---|---|---|---|
| SCN | 0029-12 | 0030-05 | 0030-07 | 0031-07 | 0031-10 | 0131-02 | 0131-09 | 0131-10 | 0130-10 | 0132-05 |
| Depth (m) | 12.7 | 0.47 | 1.7 | 8.4 | 12.1 | 0.47 | 6 | 7.5 | 3.1 | 0.15 |
| Date Sampled | 01-Apr-05 | 01-Apr-05 | 01-Apr-05 | 04-Apr-05 | 04-Apr-05 | 11-Apr-05 | 11-Apr-05 | 11-Apr-05 | 11-Apr-05 | 11-Apr-05 |
| Source | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder |
| QA/QC | | | | | | | | | | |
| ***Physical*** | | | | | | | | | | |
| pH | 8.78 | 7.38 | 6.31 | 7.79 | 7.88 | 7.86 | 7.17 | 8.66 | 8.20 | 8.10 |
| ***Total Metals*** | | | | | | | | | | |
| *Aluminum | - | - | - | - | - | - | - | - | - | - |
| Antimony | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Arsenic | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | 6.5 | <5.0 | <5.0 | <5.0 | 6.6 |
| Barium | 235 | 98.1 | 123 | 213 | 235 | 193 | 29.0 | 280 | 192 | 199 |
| Beryllium$^{pH}$ | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | 0.51 | <0.50 | <0.50 |
| Bismuth | - | - | - | - | - | - | - | - | - | - |
| Cadmium$^{pH}$ | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Calcium | - | - | - | - | - | - | - | - | - | - |
| *Chromium (total) | 7.5 | 29.7 | 22.6 | 8.0 | 11.1 | 33.6 | 2.6 | 27.0 | 18.7 | 21.3 |
| *Cobalt | 4.1 | 10.7 | 6.5 | 3.7 | 4.2 | 9.0 | <2.0 | 7.9 | 7.3 | 7.8 |
| *Copper$^{pH}$ | 38.5 | 74.6 | 60.3 | 40.8 | 56.8 | 86.5 | 9.7 | 57.3 | 67.8 | 69.5 |
| *Iron | - | - | - | - | - | - | - | - | - | - |
| Lead$^{pH}$ | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |
| Magnesium | - | - | - | - | - | - | - | - | - | - |
| *Manganese | - | - | - | - | - | - | - | - | - | - |
| Mercury | 0.194 | 0.061 | 0.131 | 0.256 | 0.183 | 0.406 | 0.091 | 0.354 | 0.216 | 0.413 |
| Molybdenum | <4.0 | <4.0 | 5.1 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Nickel$^{pH}$ | 14.8 | 19.9 | 26.4 | 13.6 | 18.4 | 49.7 | <5.0 | 27.0 | 28.6 | 31.0 |
| Phosphorus | - | - | - | - | - | - | - | - | - | - |
| Potassium | - | - | - | - | - | - | - | - | - | - |
| *Selenium | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| Silver | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| Sodium$^{i}$ | - | - | - | - | - | - | - | - | - | - |
| Strontium | - | - | - | - | - | - | - | - | - | - |
| Tellurium | - | - | - | - | - | - | - | - | - | - |
| Thallium | - | - | - | - | - | - | - | - | - | - |
| Tin | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| Titanium | - | - | - | - | - | - | - | - | - | - |
| *Vanadium | 30.4 | 65.5 | 33.9 | 28.6 | 29.1 | 44.9 | 5.3 | 43.2 | 31.0 | 43.0 |
| Zinc$^{pH}$ | 26.4 | 68.1 | **516** | 29.8 | 37.4 | 78.3 | 10.3 | 46.7 | 59.7 | 65.6 |
| Zirconium | - | - | - | - | - | - | - | - | - | - |
| ***Inorganic Parameters*** | | | | | | | | | | |
| Elemental Sulphur (%) | 1.26 | - | - | 1.51 | 1.07 | - | - | - | 0.250 | - |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amer
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; DW Drinking Wa
EH = generic standard for the protection of ecological health
HH = generic standard for the protection of human health
pH = standard is pH dependant
FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzeditalics = Laboratory Method Detection Limit above applicable standards
QA/QC = quality assurance/quality control
italics = Laboratory Method Detection Limit above applicable standards
*Background concentrations applied as detailed in Protocol 4 is applied to replace CSR Standards.
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site
Hardy = Hardy BBT Limited. 1990. Environmental Review for Town of Ladysmith Waterfront Development Slag Point Area,
EBA = EBA Environmental Ltd. 1994. Elk Falles Forest Industries Limited Phase II Environmental Assessment Ladysmith
Levelton[a] = Levelton Engineering Ltd. 2000a. Preliminary Site Investigation Stage 1 and Stage II Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, B.C. Dated August 25, 2000.
Levelton[b] = Levelton Engineering Ltd. 2000b. Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, B.C. Dated October 25, 2000.

**TABLE 2a**
**Historic Soil Sampling Results - Total Metals**
**Ladysmith Harbour, Ladysmith, BC**

| Location | CSR Standards for PL | MCS | CSR Standards for CL | MCS | CSR Standards for IL | MCS | BH05-23 | BH05-23 | MW05-24 | TP05-1 | TP05-2 | TP05-4 | TP05-8 | TP05-9 | TP05-10 | TP05-11 | TP05-11 | TP05-12 | TP05-13 | TP05-14 | TP05-15 | Stockpile A | Stockpile A | Stockpile A | Stockpile B | Stockpile B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCN | | | | | | | 0133-03 | 0134-06 | 0047-01 | 0032-06 | 0032-07 | 0033-04 | 0034-03 | 0034-05 | 0034-07 | 0034-09 | 0034-11 | 0035-02 | 0035-04 | 0035-06 | 0035-08 | 0094-01 | 0094-05 | COMP 1-6 | 0094-09 | 0094-12 |
| Depth (m) | | | | | | | 0.47 | 14.9 | 0.15 | 0.67 | 0.9 | 1 | 0.4 | 0.6 | 0.6 | 0.3 | 1.6 | 2.5 | 0.4 | 0.5 | 1.2 | n/a | n/a | n/a | n/a | n/a |
| Date Sampled | | | | | | | 11-Apr-05 | 11-Apr-05 | 21-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 06-Apr-05 | 2005-05-18 | 2005-05-18 | 2005-05-18 | 2005-05-18 | 2005-05-18 |
| Source | | | | | | | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder | Golder |
| QA/QC | | | | | | | | | | | | | | | | | | | | | | FDA | | | | |
| ***Physical*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| pH | | | | | | | 7.44 | 9.10 | 7.81 | 5.66 | 5.99 | 5.77 | 7.97 | 7.01 | 6.81 | 5.89 | 6.59 | 7.81 | 6.55 | 8.04 | 7.10 | 6.67 | 6.86 | 6.52 | 6.52 | 6.44 |
| ***Total Metals*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Aluminum | 55000 | HH | 250000 | HH | 250000 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Antimony | 20 | EH | **40** | EH | 40 | EH | <10 | <10 | <10 | <10 | <10 | <10 | <10 | **46** | 34 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Arsenic | 10 | AW-M/DW | **10** | AW-M | 10 | AW-M/DW | <5.0 | <5.0 | <5.0 | <5.0 | **10.8** | <5.0 | **14.2** | **15.8** | **13.5** | <5.0 | <5.0 | 5.2 | <5.0 | <5.0 | <5.0 | 6.3 | 5.8 | 5.5 | 6 | 5.9 |
| Barium | 350 | DW | **350** | DW | 350 | DW | 110 | 230 | 183 | 68.8 | 76.2 | 104 | **2890** | **370** | **750** | 61.1 | 32.6 | 156 | 42.6 | 184 | 296 | 143 | 89 | 89.4 | 90 | 86 |
| Beryllium$^{pH}$ | 1-150 | AW-M | 1-350 | DW/T | 1-350 | DW | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | 0.90 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Bismuth | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cadmium$^{pH}$ | 1-30 | AW-M | **1-70** | DW/AW-M | 1-70 | AW-M/DW | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | 1.48 | 2.92 | **4.72** | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Calcium | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Chromium (total) | 65 | AW-M/DW | **65** | DW/AW-M | 65 | AW-M/DW | 29.4 | 8.4 | 34.6 | 16.5 | 26.3 | 21.4 | 38.6 | **100** | **101** | 14.2 | 11.9 | 29.2 | 15.0 | 25.3 | 29.4 | 22.7 | 21.5 | 22.1 | 28.6 | 29.9 |
| *Cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 30 | AW-M/DW | 9.9 | 4.3 | 8.7 | 6.5 | 7.5 | 6.8 | 13.8 | 19.0 | 25.4 | 3.7 | 3.0 | 7.3 | 2.6 | 6.1 | 10.8 | 9 | 9.1 | 9 | 10.6 | 12.4 |
| *Copper$^{pH}$ | 100-150 | AW-M/DW | **100-300** | AW-M/T | 100-300 | AW-M | 59.5 | 43.0 | 75.8 | 57.1 | 64.2 | 75.8 | **1000** | **4780** | **3540** | 69.9 | 47.8 | 76.4 | 31.5 | 107 | 73.1 | 60.1 | 57.7 | 58.9 | 66.8 | 47.7 |
| *Iron | 70000 | HH | 150000 | HH | 150000 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lead$^{pH}$ | 120 | I | **120-150** | AW-M/DW | 120-1000 | DW | <50 | <50 | <50 | <50 | 54 | <50 | **590** | **2130** | **2230** | <50 | <50 | <50 | <50 | <50 | 88 | <50 | <50 | <50 | <50 | <50 |
| Magnesium | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Manganese | 5000 | DW/T | 5000 | DW/T | 5000 | DW/T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mercury | 25 | I | 75 | I/T | 75 | T | 0.065 | 0.283 | 0.301 | 0.144 | 0.123 | 0.147 | <0.050 | 0.254 | 0.236 | 0.076 | 0.066 | 0.213 | 0.083 | 0.391 | 0.284 | 0.065 | 0.065 | 0.065 | 0.056 | 0.062 |
| Molybdenum | 15 | DW | **15** | DW | 15 | DW | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | 4.4 | **26.0** | **26.4** | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 | <4.0 |
| Nickel$^{pH}$ | 70-150 | AW-M/DW | **70-250** | AW-M/DW | 70-250 | AW-M/DW | 21.8 | 14.7 | 51.8 | 16.7 | 22.4 | 19.5 | 59.8 | **270** | **217** | 14.1 | 10.5 | 45.5 | 8.6 | 36.6 | 25.7 | 17.8 | 17.6 | 18.1 | 21.8 | 20.6 |
| Phosphorus | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potassium | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Selenium | 4 | AW-M/DW | 4 | AW-M/DW | 4 | AW-M/DW | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| Silver | 20 | EH | 40 | EH | 40 | EH | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | 2.9 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| Sodium[i] | 200 | T | **1000** | T | 1000 | T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Strontium | 20000 | HH | 150000 | HH | 150000 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tellurium | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Thallium | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tin | 50 | EH | 300 | EH | 300 | EH | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | 44.6 | 172 | 223 | 5.5 | <5.0 | <5.0 | <5.0 | <5.0 | 13.1 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| Titanium | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Vanadium | 200 | DW | 200 | DW | 200 | DW | 77.5 | 27.3 | 45.2 | 33.9 | 45.4 | 44.9 | 48.4 | 42.8 | 47.8 | 28.0 | 21.3 | 38.1 | 22.0 | 35.2 | 73.8 | 67 | 67.4 | 63.5 | 75.2 | 73.9 |
| Zinc$^{pH}$ | 150-200 | AW-M | **150-200** | AW-M | 150-200 | AW-M | 68.9 | 34.4 | 73.8 | 119 | **551** | 140 | **5300** | **1820** | **2260** | 143 | **538** | 148 | 81.9 | 62.6 | 131 | 59.3 | 60.2 | 57.5 | 45.1 | 53.8 |
| Zirconium | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ***Inorganic Parameters*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Elemental Sulphur (%) | | | | | | | - | 1.91 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amer
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; DW Drinking Wa
EH = generic standard for the protection of ecological health
HH = generic standard for the protection of human health
pH = standard is pH dependant
FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzeditalics = Laboratory Method Detection Limit above applicable standards
QA/QC = quality assurance/quality control
italics = Laboratory Method Detection Limit above applicable standards
*Background concentrations applied as detailed in Protocol 4 is applied to replace CSR Standards.
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site
Hardy = Hardy BBT Limited. 1990. Environmental Review for Town of Ladysmith Waterfront Development Slag Point Area,
EBA = EBA Environmental Ltd. 1994. Elk Falles Forest Industries Limited Phase II Environmental Assessment Ladysmith
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Levelton[b] = Levelton Engineering Ltd. 2000b. Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, B.C. Dated October 25, 2000.

**TABLE 2a**
**Historic Soil Sampling Results - Total Metals**
**Ladysmith Harbour, Ladysmith, BC**

| Parameter | CSR Standards for PL | MCS | CSR Standards for CL | MCS | CSR Standards for IL | MCS |
|---|---|---|---|---|---|---|
| ***Physical*** | | | | | | |
| pH | | | | | | |
| ***Total Metals*** | | | | | | |
| *Aluminum | 55000 | HH | 250000 | HH | 250000 | HH |
| Antimony | 20 | EH | **40** | EH | 40 | EH |
| Arsenic | 10 | AW-M/DW | **10** | AW-M | 10 | AW-M/DW |
| Barium | 350 | DW | **350** | DW | 350 | DW |
| Beryllium[pH] | 1-150 | AW-M | 1-350 | DW/T | 1-350 | DW |
| Bismuth | | | | | | |
| Cadmium[pH] | 1-30 | AW-M | **1-70** | DW/AW-M | 1-70 | AW-M/DW |
| Calcium | | | | | | |
| *Chromium (total) | 65 | AW-M/DW | **65** | DW/AW-M | 65 | AW-M/DW |
| *Cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 30 | AW-M/DW |
| *Copper[pH] | 100-150 | AW-M/DW | **100-300** | AW-M/T | 100-300 | AW-M |
| *Iron | 70000 | HH | 150000 | HH | 150000 | HH |
| Lead[pH] | 120 | I | **120-150** | AW-M/DW | 120-1000 | DW |
| Magnesium | | | | | | |
| *Manganese | 5000 | DW/T | 5000 | DW/T | 5000 | DW/T |
| Mercury | 25 | I | 75 | I/T | 75 | T |
| Molybdenum | 15 | DW | **15** | DW | 15 | DW |
| Nickel[pH] | 70-150 | AW-M/DW | **70-250** | AW-M/DW | 70-250 | AW-M/DW |
| Phosphorus | | | | | | |
| Potassium | | | | | | |
| *Selenium | 4 | AW-M/DW | 4 | AW-M/DW | 4 | AW-M/DW |
| Silver | 20 | EH | 40 | EH | 40 | EH |
| Sodium[i] | 200 | T | **1000** | T | 1000 | T |
| Strontium | 20000 | HH | 150000 | HH | 150000 | HH |
| Tellurium | | | | | | |
| Thallium | | | | | | |
| Tin | 50 | EH | 300 | EH | 300 | EH |
| Titanium | | | | | | |
| *Vanadium | 200 | DW | 200 | DW | 200 | DW |
| Zinc[pH] | 150-200 | AW-M | **150-200** | AW-M | 150-200 | AW-M |
| Zirconium | | | | | | |
| ***Inorganic Parameters*** | | | | | | |
| Elemental Sulphur (%) | | | | | | |

| **Location** | Stockpile B | CPT 1 | CPT 4 | CPT 5 | CPT 9 | CPT 10 | CPT 10 | TP1 | TP2 | TP3 | TP4 | TP4 | TP6 | TP12 | LOT 11G | 1 | 2 | 3 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SCN** | COMP 7-12 | - | - | - | - | - | - | | | | | | | | 009071-32 | | | | | |
| **Depth (m)** | n/a | 1.55 | 2.5 | 0.7 | 2.1 | 2 | 2 | 1 | 1 | 3 | 2 | 4 | 3 | 3 | 0.5 | 3 | 1.3 | 3 | 3 | 4.5 |
| **Date Sampled** | 2005-05-18 | 1990-09-18 | 1990-09-18 | 1990-09-18 | 1990-09-18 | 1990-09-18 | 1990-09-18 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 21-Sep-00 | 07-May-93 | 07-May-93 | 07-May-93 | 07-May-93 | 07-May-93 |
| **Source** | Golder | Hardy | Hardy | Hardy | Hardy | Hardy | Hardy | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[b] | EBA | EBA | EBA | EBA | EBA |
| **QA/QC** | | | | | | FDA | FD | | | | | | | | | | | | | |
| ***Physical*** | | | | | | | | | | | | | | | | | | | | |
| pH | 6.53 | 4.87 | 7.2 | 6.52 | 8.37 | 7.77 | - | 6.2 | 6.5 | - | 6.8 | 6.3 | 8.0 | - | 6.4 | - | - | - | - | - |
| ***Total Metals*** | | | | | | | | | | | | | | | | | | | | |
| *Aluminum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 74700 | 65800 | - | - | - |
| Antimony | <10 | - | - | - | - | - | - | <2 | <2 | - | 3 | <2 | <2 | - | <2 | <1.5 | <1.5 | - | - | - |
| Arsenic | 5.5 | - | *<25* | *<25* | **52** | **26** | **34.2** | 2.4 | 2.9 | - | 7.4 | 2.8 | 4.1 | - | 5.4 | 6.5 | **11** | - | - | - |
| Barium | 99.1 | - | 65.6 | 59.2 | 6.80 | 171 | 123 | 94 | 78 | - | 72 | 79 | **508** | - | 67.6 | **367** | 319 | - | - | - |
| Beryllium[pH] | <0.50 | - | - | - | - | - | - | 0.3 | 0.2 | - | 0.3 | 0.3 | 0.4 | - | 0.2 | 0.7 | 0.6 | - | - | - |
| Bismuth | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <2 | <2 | - | - | - |
| Cadmium[pH] | <0.50 | - | <0.10 | <0.10 | 0.17 | 1.06 | 0.6 | <0.2 | <0.2 | - | <0.2 | <0.2 | 0.4 | - | <0.2 | 0.7 | 0.6 | - | - | - |
| Calcium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 19400 | 10100 | - | - | - |
| *Chromium (total) | 28.7 | - | 26.8 | 28.1 | 49.1 | **77.1** | 59.8 | 20 | 16 | - | 34 | 40 | 24 | - | **72** | 31.9 | 25.1 | - | - | - |
| *Cobalt | 11.8 | - | 14.6 | 15.6 | 9.5 | 12.6 | 15.7 | 8.9 | 7.5 | - | 17 | 11 | 10 | - | 9.0 | 9.7 | 9.6 | - | - | - |
| *Copper[pH] | 84.4 | - | 58.9 | 55.9 | 86.4 | 147 | **252** | 51 | 63 | - | 45 | 40 | 90 | - | 58.4 | 73.9 | 77.9 | - | - | - |
| *Iron | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 16200 | 17700 | - | - | - |
| Lead[pH] | <50 | 28.0 | 2.8 | 2.7 | <2.0 | 83.4 | 55.8 | 14 | 28 | 45 | 6 | 6 | 41 | 7 | 72 | 16 | 29 | - | - | - |
| Magnesium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6130 | 5900 | - | - | - |
| *Manganese | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 253 | 255 | - | - | - |
| Mercury | 0.054 | - | 0.058 | 0.08 | 0.239 | 0.334 | 0.341 | <0.05 | <0.05 | - | 0.06 | 0.05 | 0.07 | - | 0.08 | 0.44 | 0.7 | - | - | - |
| Molybdenum | <4.0 | - | <5.0 | <5.0 | <5.0 | <5.0 | <4.0 | <0.4 | 0.6 | - | <0.4 | 0.8 | 1 | - | 3.4 | <0.4 | 0.5 | - | - | - |
| Nickel[pH] | 22.6 | - | 20.1 | 25.5 | 44.4 | 113 | 108 | 19 | 16 | - | <0.5 | 18 | 2.1 | - | 25.9 | 41.6 | 50.4 | - | - | - |
| Phosphorus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 219 | 326 | - | - | - |
| Potassium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 8820 | 7050 | - | - | - |
| *Selenium | <3.0 | - | 0.07 | 0.1 | 0.08 | 0.16 | 0.11 | <0.5 | <0.5 | - | <0.5 | <0.5 | <0.5 | - | 1.1 | <1 | <1 | - | - | - |
| Silver | <2.0 | - | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <1 | <1 | - | <1 | <1 | <1 | - | <1 | <1 | <1 | - | - | - |
| Sodium[i] | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **3970** | 822 | - | - | - |
| Strontium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 121 | 105 | - | - | - |
| Tellurium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | <2 | - | - | - |
| Thallium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <2 | <2 | - | - | - |
| Tin | <5.0 | - | <30 | <30 | <30 | <30 | <30 | <2 | <2 | - | <2 | <2 | <2 | - | 8 | <2 | <2 | - | - | - |
| Titanium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1150 | 1030 | - | - | - |
| *Vanadium | 78.6 | - | - | - | - | - | - | 45 | 41 | - | 82 | 91 | 70 | - | 41.8 | 101 | 97.5 | - | - | - |
| Zinc[pH] | 57.6 | - | 46.4 | 40.1 | 91.3 | **588** | **543** | 59 | 119 | - | 31 | 28 | 94 | - | 103 | 65.2 | 78.6 | - | - | - |
| Zirconium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5.6 | 5.8 | - | - | - |
| ***Inorganic Parameters*** | | | | | | | | | | | | | | | | | | | | |
| Elemental Sulphur (%) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2660 | 3030 | 1530 | 2900 | 2790 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amen
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; DW Drinking Wa
EH = generic standard for the protection of ecological health
HH = generic standard for the protection of human health
pH = standard is pH dependant
FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzeditalics = Laboratory Method Detection Limit above applicable standards
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*Background concentrations applied as detailed in Protocol 4 is applied to replace CSR Standards.
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site
Hardy = Hardy BBT Limited. 1990. Environmental Review for Town of Ladysmith Waterfront Development Slag Point Area,
EBA = EBA Environmental Ltd. 1994. Elk Falles Forest Industries Limited Phase II Environmental Assessment Ladysmith
Levelton[a] = Levelton Engineering Ltd. 2000a. Preliminary Site Investigation Stage 1 and Stage II Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, B.C. Dated August 25, 2000.
Levelton[b] = Levelton Engineering Ltd. 2000b. Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, B.C. Dated October 25, 2000.

**TABLE 2a**
**Historic Soil Sampling Results - Total Metals**
**Ladysmith Harbour, Ladysmith, BC**

| Location / SCN / Depth (m) / Date Sampled / Source / QA/QC | CSR Standards for PL | MCS | CSR Standards for CL | MCS | CSR Standards for IL | MCS | 7 / 3.5 / 07-May-93 / EBA | 10 / 2 / 07-May-93 / EBA | 11 / 0.8 / 27-Jun-93 / EBA | 12 / 0.7 / 27-Jun-93 / EBA |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Physical*** | | | | | | | | | | |
| pH | | | | | | | - | - | - | - |
| ***Total Metals*** | | | | | | | | | | |
| *Aluminum | 55000 | HH | 250000 | HH | 250000 | HH | - | - | - | - |
| Antimony | 20 | EH | **40** | EH | 40 | EH | - | - | - | - |
| Arsenic | 10 | AW-M/DW | **10** | AW-M | 10 | AW-M/DW | - | - | - | - |
| Barium | 350 | DW | **350** | DW | 350 | DW | - | - | - | - |
| Beryllium[pH] | 1-150 | AW-M | 1-350 | DW/T | 1-350 | DW | - | - | - | - |
| Bismuth | | | | | | | - | - | - | - |
| Cadmium[pH] | 1-30 | AW-M | **1-70** | DW/AW-M | 1-70 | AW-M/DW | - | - | - | - |
| Calcium | | | | | | | - | - | - | - |
| *Chromium (total) | 65 | AW-M/DW | **65** | DW/AW-M | 65 | AW-M/DW | - | - | - | - |
| *Cobalt | 30 | AW-M/DW | 30 | DW/AW-M | 30 | AW-M/DW | - | - | - | - |
| *Copper[pH] | 100-150 | AW-M/DW | **100-300** | AW-M/T | 100-300 | AW-M | - | - | - | - |
| *Iron | 70000 | HH | 150000 | HH | 150000 | HH | - | - | - | - |
| Lead[pH] | 120 | I | **120-150** | AW-M/DW | 120-1000 | DW | - | - | - | - |
| Magnesium | | | | | | | - | - | - | - |
| *Manganese | 5000 | DW/T | 5000 | DW/T | 5000 | DW/T | - | - | - | - |
| Mercury | 25 | I | 75 | I/T | 75 | T | - | - | - | - |
| Molybdenum | 15 | DW | **15** | DW | 15 | DW | - | - | - | - |
| Nickel[pH] | 70-150 | AW-M/DW | **70-250** | AW-M/DW | 70-250 | AW-M/DW | - | - | - | - |
| Phosphorus | | | | | | | - | - | - | - |
| Potassium | | | | | | | - | - | - | - |
| *Selenium | 4 | AW-M/DW | 4 | AW-M/DW | 4 | AW-M/DW | - | - | - | - |
| Silver | 20 | EH | 40 | EH | 40 | EH | - | - | - | - |
| Sodium[i] | 200 | T | **1000** | T | 1000 | T | - | - | - | - |
| Strontium | 20000 | HH | 150000 | HH | 150000 | HH | - | - | - | - |
| Tellurium | | | | | | | - | - | - | - |
| Thallium | | | | | | | - | - | - | - |
| Tin | 50 | EH | 300 | EH | 300 | EH | - | - | - | - |
| Titanium | | | | | | | - | - | - | - |
| *Vanadium | 200 | DW | 200 | DW | 200 | DW | - | - | - | - |
| Zinc[pH] | 150-200 | AW-M | **150-200** | AW-M | 150-200 | AW-M | - | - | - | - |
| Zirconium | | | | | | | - | - | - | - |
| ***Inorganic Parameters*** | | | | | | | | | | |
| Elemental Sulphur (%) | | | | | | | 2870 | 2990 | 879 | 948 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amer
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EH = generic standard for the protection of ecological health
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FDA = field duplicate available, FD = field duplicate
< = less than laboratory reporting limit; - = not analyzeditalics = Laboratory Method Detection Limit above applicable standards
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**TABLE 2b**
**Historic Soil Sampling Results - Hydrocarbons**
**Ladysmith Harbour, Ladysmith, BC**

| Location | CSR Standards for PL | MCS | CSR Standards for CL | MCS | CSR Standards for IL | MCS | BH05-1 | CPT 1 | CPT 2 | CPT 3 | CPT 3 | CPT 10 | CPT 10 | TP2 | TP3 | TP4 | TP4 | TP6 | TP7 | TP8 | TP10 | TP10 | TP11 | TP11 | TP12 | TP13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCN | | | | | | | 0019-08 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Depth (m) | | | | | | | 6.9 | 1.55 | 1.8 | 1 | 1.8 | 2 | 2 | 1 | 3 | 2 | 4 | 3 | 3 | | 2 | 2 | 1 | 1 | 3 | 1 |
| Date Sampled | | | | | | | 28-Mar-05 | 18-Sep-90 | ######## | 18-Sep-90 | 18-Sep-90 | 18-Sep-90 | 18-Sep-90 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 | 18-Jul-00 |
| Source | | | | | | | Golder | Hardy | Hardy | Hardy | Hardy | Hardy | Hardy | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] | Levelton[a] |
| QA/QC | | | | | | | | | | | | FDA | FD | | | | | | | | FDA | FD | FDA | FD | | |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Benzene | 0.035 | DW | **0.035** | DW | 6.5 | DW | - | **1.02** | - | - | - | - | - | - | *<0.04* | - | - | - | - | - | *<0.04* | *<0.04* | - | - | *<0.04* | - |
| Ethylbenzene | 15 | DW | 15 | DW | 15 | DW | - | 11.3 | - | - | - | - | - | - | <0.04 | - | - | - | - | - | <0.04 | <0.04 | - | - | <0.04 | - |
| Methyl t-butyl ether (MTBE) | 8000 | HH | 20000 | HH | 20000 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Styrene | 5 | EH | 50 | EH | 50 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Toluene | 6 | DW | **6** | DW | 6 | DW | - | **24** | - | - | - | - | - | - | <0.04 | - | - | - | - | - | <0.04 | <0.04 | - | - | <0.04 | - |
| meta- & para-Xylene | | | | | | | - | 74.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ortho-Xylene | | | | | | | - | 30.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Xylene | 6.5 | DW | **6.5** | DW | 6.5 | DW | - | **104.7** | - | - | - | - | - | - | <0.04 | - | - | - | - | - | <0.04 | <0.04 | - | - | <0.04 | - |
| Volatile Hydrocarbons (VH6-10) | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| VPH | 200 | HH/EH | 200 | EH/HH | 200 | EH/HH | - | - | - | - | - | - | - | - | <10 | - | - | - | - | - | <10 | <10 | - | - | <10 | - |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acenaphthene | 2000 | HH | 1500 | HH | 15000 | HH | 0.682 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Acenaphthylene | | | | | | | 0.619 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anthracene | 2.5 | T | 30 | T | 30 | T | 1.05 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benz(a)anthracene | 1 | EH | 10 | EH | 10 | EH | 0.757 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(a)pyrene | 10 | I | 30 | I | 50 | I | 0.492 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(b)fluoranthene | | | | | | | 0.572 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(g,h,i)perylene | | | | | | | 0.469 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(k)fluoranthene | 1 | EH | 10 | EH | 10 | EH | 0.120 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chrysene | 400 | HH | 4500 | HH | 4500 | HH | 0.982 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dibenz(a,h)anthracene | 1 | EH | 10 | EH | 10 | EH | 0.120 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Fluoranthene | 50 | T | 200 | T | 200 | T | 0.649 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Fluorene | 1000 | HH | 9500 | HH | 9500 | HH | 1.65 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Indeno(1,2,3-c,d)pyrene | 1 | EH | 10 | EH | 10 | EH | 0.106 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2-Methylnaphthalene | 100 | HH | 950 | HH | 950 | HH | 9.95 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Naphthalene | 0.6 | T | 20 | T | 20 | T | 4.88 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phenanthrene | 5 | EH | 50 | EH | 50 | EH | 9.47 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pyrene | 10 | EH | 100 | EH | 100 | EH | 0.813 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EPH10-19[a] | 1000 | | **2,000** | | 2,000 | | 1440 | - | - | - | - | - | - | <100 | <100 | **4,760** | **2,230** | <100 | 560 | - | <100 | <100 | <100 | <100 | <100 | <100 |
| EPH19-32[a] | 1000 | | 5000 | | 5,000 | | 1710 | - | - | - | - | - | - | <100 | <100 | 550 | 350 | <100 | <100 | - | <100 | <100 | <100 | <100 | <100 | <100 |
| LEPH | 1000 | EH/HH | **2,000** | EH/HH | 2,000 | EH/HH | 1420 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HEPH | 1000 | EH/HH | **5000** | EH/HH | 5,000 | EH/HH | 1710 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **General** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Light Aliphatic Hydrocarbons[b] | 1000 | | 2,000 | | 2,000 | | - | 475 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mineral Oil and Grease[b] | 1000 | | **2,000** | | 2,000 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Oil and Grease[b] | 1000 | | **2,000** | | 2,000 | | - | - | 317 | **2,740** | **3,130** | **2,000** | **2,050** | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Extractable Hydrocarbons[c] | 200 | | **200** | | 200 | | - | - | **439** | - | **2440** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total PCBs | 1.5 | T | 35 | I/T | 35 | I/T | - | - | - | - | - | - | - | - | - | - | - | - | - | < detection | - | - | - | - | - | < detection |

Notes:
Results are expressed in micrograms per gram (ug/g) unless othwise indicated.
SCN = sample control number
COC = Chain of Custody
QA/QC = quality assurance/quality control
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial).
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; AW = Groundwater Flow to Surface Water used by Aquatic Life, M = Marine; DW = Drinking Water
EH = generic standard for the protection of ecological health; HH = generic standard for the protection of human health
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019)
MCS = most conservative standard based on applicable site-specific standards
a. LEPH and HEPH criteria used as a conservative screen for EPH10-19 and EPH19-32, respectively.
b. LEPH criteria used as a conservate screen for Light Aliphatic Hydrocarbons, Mineral Oil and Grease, Oil and Grease.

c.. VPH criteria used as a conservative screen for Total Extractable Hydrocarbons.
FDA = Field duplicate available; FD = Field duplicate.
*italics* = Laboratory Method Detection Limit above applicable standards
< = less than laboratory reporting limit; - = not analyzed
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Levelton[a] = Levelton Engineering Ltd. 2000a. Preliminary Site Investigation Stage 1 and Stage II Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, District. Ladysmith, B.C. Dated August 25, 2000.Plan VIP64405, Oyster Land
Levelton[b] = Levelton Engineering Ltd. 2000b. Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District., Ladysmith, BC.
$EPH_{C10-19}$ = extractable petroleum hydrocarbons, carbon range 10-19
$EPH_{C19-32}$ = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
VPH = volitile petroleum hydrocarbons
VH (C6-C10) = volitile hydrocarbons, carbon range 6-10
PAH = polycyclic aromatic hydrocarbon
ppm = parts per milion

**TABLE 2b**
**Historic Soil Sampling Results - Hydrocarbons**
**Ladysmith Harbour, Ladysmith, BC**

| Location<br>SCN<br>Depth (m)<br>Date Sampled<br>Source<br>QA/QC | CSR Standards for PL | MCS | CSR Standards for CL | MCS | CSR Standards for IL | MCS | MW00-02<br>-<br>1.4<br>20-Sep-00<br>Levelton[b] | BH00-03<br>-<br>0.2<br>20-Sep-00<br>Levelton[b] | BH00-03<br>-<br>0.5<br>20-Sep-00<br>Levelton[b] | MW00-04<br>-<br>1.4<br>20-Sep-00<br>Levelton[b] | BH00-05<br>-<br>2.6<br>20-Sep-00<br>Levelton[b] | MW00-06<br>-<br>1.5<br>20-Sep-00<br>Levelton[b] | BH00-07<br>-<br>1.8<br>20-Sep-00<br>Levelton[b] | BH00-07<br>-<br>2.9<br>20-Sep-00<br>Levelton[b] | BH00-08<br>-<br>0.8<br>20-Sep-00<br>Levelton[b] | BH00-08<br>-<br>1.8<br>20-Sep-00<br>Levelton[b] | BH00-08<br>-<br>2.9<br>20-Sep-00<br>Levelton[b] | MW00-09<br>-<br>2.4<br>20-Sep-00<br>Levelton[b]<br>FDA | MW00-09<br>-<br>2.4<br>20-Sep-00<br>Levelton[b]<br>FD | BH00-10<br>-<br>1.4<br>20-Sep-00<br>Levelton[b] | BH00-10<br>-<br>3.5<br>20-Sep-00<br>Levelton[b] | MW00-11<br>-<br>4.6<br>21-Sep-00<br>Levelton[b] | BH00-12<br>-<br>2.1<br>21-Sep-00<br>Levelton[b] | BH00-13<br>-<br>1.2<br>21-Sep-00<br>Levelton[b] | BH00-14<br>-<br>1.4<br>21-Sep-00<br>Levelton[b] | 1<br>-<br>3<br>07-May-93<br>EBA[a] | 2<br>-<br>1.3<br>07-May-93<br>EBA[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Benzene | 0.035 | DW | **0.035** | DW | 6.5 | DW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | *<0.04* | - | - | - | - | - |
| Ethylbenzene | 15 | DW | 15 | DW | 15 | DW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.04 | - | - | - | - | - |
| Methyl t-butyl ether (MTBE) | 8000 | HH | 20000 | HH | 20000 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Styrene | 5 | EH | 50 | EH | 50 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Toluene | 6 | DW | **6** | DW | 6 | DW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.04 | - | - | - | - | - |
| meta- & para-Xylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ortho-Xylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Xylene | 6.5 | DW | **6.5** | DW | 6.5 | DW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.04 | - | - | - | - | - |
| Volatile Hydrocarbons (VH6-10) | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| VPH | 200 | HH/EH | 200 | EH/HH | 200 | EH/HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <10 | - | - | - | - | - |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acenaphthene | 2000 | HH | 1500 | HH | 15000 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Acenaphthylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anthracene | 2.5 | T | 30 | T | 30 | T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benz(a)anthracene | 1 | EH | 10 | EH | 10 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(a)pyrene | 10 | I | 30 | I | 50 | I | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(b)fluoranthene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(g,h,i)perylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(k)fluoranthene | 1 | EH | 10 | EH | 10 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chrysene | 400 | HH | 4500 | HH | 4500 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dibenz(a,h)anthracene | 1 | EH | 10 | EH | 10 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Fluoranthene | 50 | T | 200 | T | 200 | T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Fluorene | 1000 | HH | 9500 | HH | 9500 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Indeno(1,2,3-c,d)pyrene | 1 | EH | 10 | EH | 10 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2-Methylnaphthalene | 100 | HH | 950 | HH | 950 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Naphthalene | 0.6 | T | 20 | T | 20 | T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phenanthrene | 5 | EH | 50 | EH | 50 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pyrene | 10 | EH | 100 | EH | 100 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EPH10-19[a] | 1000 | | **2,000** | | 2,000 | | 430 | 1,350 | 875 | <250 | <250 | <250 | 770 | <250 | **2,350** | <250 | <250 | <250 | <250 | <250 | <250 | - | <250 | <250 | <250 | - | - |
| EPH19-32[a] | 1000 | | 5000 | | 5,000 | | 480 | 1,450 | 680 | <250 | <250 | <250 | 270 | <250 | 750 | <250 | <250 | <250 | <250 | <250 | <250 | - | <250 | <250 | <250 | - | - |
| LEPH | 1000 | EH/HH | **2,000** | EH/HH | 2,000 | EH/HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HEPH | 1000 | EH/HH | **5000** | EH/HH | 5,000 | EH/HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **General** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Light Aliphatic Hydrocarbons[b] | 1000 | | 2,000 | | 2,000 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mineral Oil and Grease[b] | 1000 | | **2,000** | | 2,000 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **3,400** | **5,500** |
| Oil and Grease[b] | 1000 | | **2,000** | | 2,000 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Extractable Hydrocarbons[c] | 200 | | **200** | | 200 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total PCBs | 1.5 | T | 35 | I/T | 35 | I/T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Notes:
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Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial).
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$EPH_{C19-32}$ = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
VPH = volitile petroleum hydrocarbons
VH (C6-C10) = volitile hydrocarbons, carbon range 6-10
PAH = polycyclic aromatic hydrocarbon
ppm = parts per milion

**TABLE 2b**
**Historic Soil Sampling Results - Hydrocarbons**
**Ladysmith Harbour, Ladysmith, BC**

| Location | CSR Standards for PL | MCS | CSR Standards for CL | MCS | CSR Standards for IL | MCS | 3 | 4 | 6 | 7 | 10 | 11 | 14 | 15 | 16 | 17 | 17 | 17 | 18 | 18 | 19 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCN | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Depth (m) | | | | | | | 3 | 3 | 4.5 | 3.5 | 2 | 0.8 | 0.6 | 0.6 | 0.6 | 1 | 1 | 1.5 | 1 | 1.5 | 1 | 1.5 |
| Date Sampled | | | | | | | 07-May-93 | 07-May-93 | 07-May-93 | 07-May-93 | 07-May-93 | 27-Jun-93 | 16-Jul-93 | 10-Aug-93 | 10-Aug-93 | 28-Jan-94 | 28-Jan-94 | 28-Jan-94 | 28-Jan-94 | 28-Jan-94 | 28-Jan-94 | 28-Jan-94 |
| Source | | | | | | | EBA[a] | EBA[a] | EBA[a] | EBA[a] | EBA[a] | EBA[a] | EBA[a] | EBA[a] | EBA[a] | EBA[b] | EBA[b] | EBA[b] | EBA[b] | EBA[b] | EBA[b] | EBA[b] |
| QA/QC | | | | | | | | | | | | | | | | FDA | FD | | | | | |
| **Non-Halogenated Volatiles** | | | | | | | | | | | | | | | | | | | | | | |
| Benzene | 0.035 | DW | **0.035** | DW | 6.5 | DW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ethylbenzene | 15 | DW | 15 | DW | 15 | DW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Methyl t-butyl ether (MTBE) | 8000 | HH | 20000 | HH | 20000 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Styrene | 5 | EH | 50 | EH | 50 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Toluene | 6 | DW | **6** | DW | 6 | DW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| meta- & para-Xylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ortho-Xylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Xylene | 6.5 | DW | **6.5** | DW | 6.5 | DW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Volatile Hydrocarbons (VH6-10) | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| VPH | 200 | HH/EH | 200 | EH/HH | 200 | EH/HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | |
| Acenaphthene | 2000 | HH | 1500 | HH | 15000 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Acenaphthylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anthracene | 2.5 | T | 30 | T | 30 | T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benz(a)anthracene | 1 | EH | 10 | EH | 10 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(a)pyrene | 10 | I | 30 | I | 50 | I | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(b)fluoranthene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(g,h,i)perylene | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Benzo(k)fluoranthene | 1 | EH | 10 | EH | 10 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chrysene | 400 | HH | 4500 | HH | 4500 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dibenz(a,h)anthracene | 1 | EH | 10 | EH | 10 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Fluoranthene | 50 | T | 200 | T | 200 | T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Fluorene | 1000 | HH | 9500 | HH | 9500 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Indeno(1,2,3-c,d)pyrene | 1 | EH | 10 | EH | 10 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2-Methylnaphthalene | 100 | HH | 950 | HH | 950 | HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Naphthalene | 0.6 | T | 20 | T | 20 | T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phenanthrene | 5 | EH | 50 | EH | 50 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pyrene | 10 | EH | 100 | EH | 100 | EH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Extractable Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | |
| EPH10-19[a] | 1000 | | **2,000** | | 2,000 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| EPH19-32[a] | 1000 | | 5000 | | 5,000 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LEPH | 1000 | EH/HH | **2,000** | EH/HH | 2,000 | EH/HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HEPH | 1000 | EH/HH | **5000** | EH/HH | 5,000 | EH/HH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **General** | | | | | | | | | | | | | | | | | | | | | | |
| Light Aliphatic Hydrocarbons[b] | 1000 | | 2,000 | | 2,000 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mineral Oil and Grease[b] | 1000 | | **2,000** | | 2,000 | | **3,200** | **2,400** | **2,500** | **2,300** | **2,400** | **16,000** | 1,100 | 470 | 960 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Oil and Grease[b] | 1000 | | **2,000** | | 2,000 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Extractable Hydrocarbons[c] | 200 | | **200** | | 200 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total PCBs | 1.5 | T | 35 | I/T | 35 | I/T | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Notes:
Results are expressed in micrograms per gram (ug/g) unless othwise indicated.
SCN = sample control number
COC = Chain of Custody
QA/QC = quality assurance/quality control
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial).
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants; AW = Groundwate
EH = generic standard for the protection of ecological health; HH = generic standard for the protection of human health
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019)
MCS = most conservative standard based on applicable site-specific standards
a. LEPH and HEPH criteria used as a conservative screen for EPH10-19 and EPH19-32, respectively.
b. LEPH criteria used as a conservate screen for Light Aliphatic Hydrocarbons, Mineral Oil and Grease, Oil and Grease.

c.. VPH criteria used as a conservative screen for Total Extractable Hydrocarbons.
FDA = Field duplicate available; FD = Field duplicate.
*italics* = Laboratory Method Detection Limit above applicable standards
< = less than laboratory reporting limit; - = not analyzed
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC. Dated June 30, 2005.
Hardy = Hardy BBT Limited. 1990. Environmental Review for Town of Ladysmith Waterfront Development Slag Point Area, Ladysmith, B.C. Dated October 1990.
EBA = EBA Environmental Ltd. 1994. Elk Falles Forest Industries Limited Phase II Environmental Assessment Ladysmith Harbour Leases Project Ladysmith, B.C. Dated January 1994.
EBA[b] = EBA Environmental Ltd. 1994b. Elk Falles Forest Industries Limited Supplemental Information Ladysmith Harbour Leases Project Ladysmith, BC. Dated February 4, 1994.
Levelton[a] = Levelton Engineering Ltd. 2000a. Preliminary Site Investigation Stage 1 and Stage II Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, District. Ladysmith, B.C. Dated August 25, 2000.Plan VIP64405, Oyster Land
Levelton[b] = Levelton Engineering Ltd. 2000b. Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District., Ladysmith, BC.
$EPH_{C10-19}$ = extractable petroleum hydrocarbons, carbon range 10-19
$EPH_{C19-32}$ = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
VPH = volitile petroleum hydrocarbons
VH (C6-C10) = volitile hydrocarbons, carbon range 6-10
PAH = polycyclic aromatic hydrocarbon
ppm = parts per milion

**TABLE 2c**
**Historic Soil Sampling Results - VOCs**
**Ladysmith Harbour, Ladysmith, BC**

| Location / SCN / Depth (m) / Soil Type / Date Sampled / Source / QA/QC | CSR Standards for PL | MCS | **CSR Standards for CL** | MCS | CSR Standards for IL | MCS | MW05-2 / 0020-08 / 1.8 / coal fill / 28-Mar-05 / Golder | MW05-3 / 0021-03 / 0.9 / coal fill / 28-Mar-05 / Golder | MW05-4 / 0022-01 / 1.7 / coal fill / 29-Mar-05 / Golder |
|---|---|---|---|---|---|---|---|---|---|
| **Chlorinated Aliphatics** | | | | | | | | | |
| Carbon Tetrachloride | **5** | EH | **50** | EH | **<u>50</u>** | EH | <0.10 | <0.10 | <0.10 |
| Chlorobenzene | 1 | EH | 10 | EH | 10 | | <0.10 | <0.10 | <0.10 |
| Chloroethane | | | | | | | <0.10 | <0.10 | <0.10 |
| Chloromethane | | | | | | | - | - | - |
| 1,2-Dichlorobenzene | 1 | EH | 10 | EH | 10 | EH | <0.10 | <0.10 | <0.10 |
| 1,3-Dichlorobenzene | 1 | EH | 10 | EH | 10 | EH | <0.10 | <0.10 | <0.10 |
| 1,4-Dichlorobenzene | 1 | EH | 10 | EH | 10 | EH | <0.10 | <0.10 | <0.10 |
| 1,1-Dichloroethane | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| 1,2-Dichloroethane | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| 1,2-Dichloroethene | 5 | EH | 50 | EH | 50 | EH | - | - | - |
| cis-1,2-Dichloroethylene | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| trans-1,2-Dichloroethylene | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| 1,1-Dichloroethene | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| Dichloromethane | 5 | EH | 50 | EH | 50 | EH | - | - | - |
| 1,2-dichloropropane | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| cis 1,3-dichloropropene | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| trans 1,3-dichloropropene | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| 1,1,1,2-tetrachloroethane | 550 | HH | 1500 | HH | 1500 | HH | <0.10 | <0.10 | <0.10 |
| 1,1,2,2-tetrachloroethane | 70 | HH | 150 | HH | 150 | HH | <0.10 | <0.10 | <0.10 |
| tetrachloroethylene (Perc) | 2.5 | AW | 2.5 | AW | 2.5 | AW | <0.10 | <0.10 | <0.10 |
| 1,1,1-trichloroethane | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| 1,1,2-trichloroethane | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| Trichloroethylene (TCE) | 0.3 | AW | 0.3 | AW | 0.3 | AW | <0.10 | <0.10 | <0.10 |
| Trichlorofluoromethane | 9000 | HH | 70000 | HH | 70,000 | HH | <0.10 | <0.10 | <0.10 |
| Vinyl Chloride | 2 | HH | 45 | HH | 45 | HH | <0.10 | <0.10 | <0.10 |
| **Trihalomethanes** | | | | | | | | | |
| Bromodichloromethane | 200 | HH | 550 | HH | 550 | HH | <0.10 | <0.10 | <0.10 |
| Bromoform | 650 | HH | 4,000 | HH | 4,000 | HH | <0.10 | <0.10 | <0.10 |
| Chloroform | 5 | EH | 50 | EH | 50 | EH | <0.10 | <0.10 | <0.10 |
| Dibromochloromethane | 150 | HH | 400 | HH | 400 | HH | <0.10 | <0.10 | <0.10 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation (“CSR”; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019)
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants;
AW = Groundwater Flow to Surface Water used by Aquatic Life, F = Fresh Water Aquatic Life and M = Marine Aquatic Life;
FDA = field duplicate available
FD = field duplicate
QA/QC = quality assurance/quality control
NS = No Standard
< = less than laboratory reporting limit; - = not analyzed
*italics* = Laboratory Method Detection Limit above applicable standards
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC. Dated June 30, 2005.

# TABLE 2d
## Historic Soil Sampling Results - Chlorinated Phenols
## Ladysmith Harbour, Ladysmith, BC

| Location / SCN / Depth (m) / Date Sampled / Source / QA/QC | CSR Standards for PL | MCS | **CSR Standards for CL** | MCS | CSR Standards for IL | MCS | 9 / 2 / 07-May-93 / EBA |
|---|---|---|---|---|---|---|---|
| ***Chlorinated Phenols*** | | | | | | | |
| Pentachlorophenol[pH] | 1.5-25 | DW | 1.5-55 | DW | 1.5-55 | DW | <0.005 |
| Tetracholorophenols | | | | | | | <0.005 |
| Trichlorophenols | | | | | | | <0.005 |

Notes:
Results are expressed in micrograms per gram (ug/g), unless otherwise indicated.
m bgs = metres below ground surface
SCN = sample control number
COC = Chain of Custody
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019)
Land Use abbreviations: PL (Urban Park Land); CL (Commercial); IL (Industrial)
MCS: most conservative standard based on applicable site-specific standards
Referenced site-specific factors include: I = Intake of Contaminated Soil; T = Toxicity to Invertebrates and Plants;
AW = Groundwater Flow to Surface Water used by Aquatic Life, F = Fresh Water Aquatic Life and M = Marine Aqua
FDA = field duplicate available
FD = field duplicate
pH = Standard is pH dependant.
QA/QC = quality assurance/quality control
NS = No Standard
< = less than laboratory reporting limit; - = not analyzed
*italics* = Laboratory Method Detection Limit above applicable standards
EBA = EBA Environmental Ltd. 1994. Elk Falles Forest Industries Limited Phase II

**TABLE 3a**
**Historic Groundwater Results - Dissolved Metals**
**Ladysmith Harbour, Ladysmith, BC**

| Location<br>SCN<br>Date<br>Source<br>QA/QC | **CSR Standards for DW** | CSR Standards for AW-M | MW05-2<br>0045-02<br>2005-04-13<br>Golder | MW05-3<br>0045-01<br>2005-04-13<br>Golder | MW05-4<br>0045-05<br>2005-04-13<br>Golder | MW05-5<br>0036-02<br>2005-04-14<br>Golder | MW05-6<br>0045-08<br>2005-04-13<br>Golder | MW05-7<br>0036-01<br>2005-04-14<br>Golder | MW05-8<br>0045-07<br>2005-04-13<br>Golder | MW05-9<br>0046-10<br>2005-04-14<br>Golder | MW05-11<br>0045-06<br>2005-04-13<br>Golder | MW05-12<br>0046-02<br>2005-04-14<br>Golder | MW05-16<br>0045-03<br>2005-04-13<br>Golder<br>FDA | MW05-17<br>0039-01<br>2005-04-14<br>Golder | MW05-18<br>0039-02<br>2005-04-14<br>Golder<br>FDA | MW05-19<br>0046-08<br>2005-04-14<br>Golder | MW05-20<br>0046-09<br>2005-04-14<br>Golder | MW05-22<br>0048-01<br>2005-04-21<br>Golder | MW05-24<br>0049-01<br>2005-04-25<br>Golder |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Physical** | | | | | | | | | | | | | | | | | | | |
| Hardness (as $CaCO_3$) | | | 345 | 1470 | 146 | 2510 | 566 | 3430 | 519 | 463 | 394 | 791 | 590 | 4290 | 4640 | 323 | 87.2 | 633 | 533 |
| pH | | | 7.18 | 6.51 | 7.58 | 7.77 | 7.45 | 7.75 | 7.31 | 7.37 | 7.11 | 6.60 | 6.79 | 7.73 | 7.79 | 7.29 | 8.59 | 6.90 | 6.70 |
| **Dissolved Metals** | | | | | | | | | | | | | | | | | | | |
| Aluminum | 9.5 | | <0.020 | <0.10 | <0.050 | <1.0 | <0.10 | <1.0 | 0.031 | <0.020 | <0.020 | <0.10 | <0.020 | <0.10 | <0.20 | <0.010 | <0.010 | <0.010 | <0.020 |
| Antimony | 0.006 | 2.5 | <0.0010 | <0.0050 | <0.0025 | *<0.050* | <0.0050 | *<0.050* | <0.0010 | <0.0010 | <0.0010 | <0.0050 | <0.0010 | <0.0050 | *<0.010* | <0.00050 | <0.00050 | <0.00050 | <0.0010 |
| Arsenic | 0.01 | 0.125 | <0.0020 | *<0.020* | <0.0050 | *<0.10* | <0.010 | *<0.10* | 0.0053 | <0.0060 | <0.0020 | <0.010 | <0.0020 | *<0.040* | *<0.060* | <0.0010 | <0.0010 | 0.0032 | 0.0024 |
| Barium | 1 | 5 | 0.124 | <0.20 | 0.074 | <0.20 | 0.075 | <0.20 | 0.132 | <0.20 | 0.244 | <0.20 | 0.071 | 0.29 | 0.34 | <0.20 | <0.20 | 0.100 | 0.228 |
| Beryllium | 0.008 | 1 | <0.0050 | *<0.050* | <0.0050 | *<0.050* | *<0.010* | *<0.050* | <0.0050 | *<0.050* | <0.0050 | *<0.050* | <0.0050 | *<0.050* | *<0.050* | *<0.050* | *<0.050* | <0.0050 | <0.0050 |
| Bismuth | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Boron | 5 | 12 | 0.37 | 2.1 | 1.11 | <1.0 | 1.23 | 3.0 | 0.51 | 1.5 | 0.21 | 1.1 | 0.29 | 2.2 | 2.0 | <1.0 | <1.0 | 0.36 | 0.37 |
| Cadmium | 0.005 | 0.015 | <0.00010 | <0.00050 | <0.00025 | <0.0050 | <0.00050 | <0.0050 | <0.00010 | <0.00010 | <0.00010 | <0.00050 | 0.00011 | <0.00050 | <0.0010 | 0.000061 | <0.000050 | 0.000064 | 0.00019 |
| Calcium | | | 88.0 | 101 | 22.8 | 244 | 72.3 | 237 | 157 | 67.2 | 135 | 225 | 181 | 262 | 297 | 99.4 | 15.1 | 179 | 160 |
| Chromium IV, III | 0.05, 6 | 0.015,0.56 | <0.0010 | <0.0050 | 0.0028 | <0.050 | <0.0050 | <0.050 | <0.0050 | <0.0010 | <0.0010 | <0.0050 | <0.0050 | <0.0050 | <0.010 | <0.00050 | <0.00050 | <0.00050 | <0.0020 |
| Cobalt | 0.02 | 0.04 | 0.0041 | *<0.0050* | 0.0050 | *<0.050* | *<0.0050* | *<0.050* | 0.0022 | 0.0050 | 0.0089 | 0.0115 | 0.0011 | *<0.0050* | *<0.010* | 0.00523 | 0.00424 | 0.00322 | 0.0024 |
| Copper | 1.5 | 0.02 | <0.0020 | <0.010 | <0.0050 | <0.10 | <0.010 | <0.10 | 0.0029 | 0.0046 | <0.0020 | <0.010 | <0.0020 | <0.010 | <0.020 | <0.0010 | 0.0013 | <0.0010 | <0.0020 |
| Iron | 6.5 | | 0.359 | <0.30 | <0.030 | <0.30 | <0.060 | <0.30 | 1.15 | <0.30 | 0.162 | 0.48 | <0.030 | <0.30 | <0.30 | <0.30 | <0.30 | 0.615 | 0.085 |
| Lead | 0.01 | 0.02 | <0.0020 | *<0.010* | <0.0050 | *<0.10* | <0.010 | *<0.10* | <0.0020 | <0.0020 | <0.0020 | <0.010 | <0.0020 | <0.010 | *<0.020* | <0.0010 | <0.0010 | <0.0010 | <0.0020 |
| Lithium | 0.033* | | *<0.050* | *<0.50* | *<0.050* | *<0.50* | *<0.10* | *<0.50* | *<0.050* | *<0.50* | *<0.050* | *<0.50* | *<0.050* | *<0.50* | *<0.50* | *<0.50* | *<0.50* | *<0.050* | *<0.050* |
| Magnesium | | | 30.4 | 295 | 21.5 | 461 | 93.6 | 690 | 31.0 | 71.7 | 13.5 | 55.7 | 33.4 | 884 | 946 | 18.3 | 12.0 | 44.9 | 32.4 |
| Manganese | **1.5** | | 0.092 | <0.10 | 0.021 | 0.33 | <0.020 | 0.28 | 0.272 | <0.10 | **1.58** | 0.73 | 0.053 | 0.77 | 0.86 | 0.13 | <0.10 | 0.263 | 0.728 |
| Mercury | 0.001 | 0.00025 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| Molybdenum | 0.25 | 10 | <0.0020 | <0.010 | 0.0063 | <0.10 | <0.010 | <0.10 | <0.0020 | 0.0027 | 0.0022 | <0.010 | <0.0020 | <0.010 | <0.020 | <0.0010 | <0.0010 | <0.0010 | <0.0020 |
| Nickel | 0.08 | 0.083 | <0.010 | <0.050 | <0.025 | <0.50 | <0.050 | <0.50 | <0.010 | <0.010 | 0.012 | <0.050 | <0.010 | <0.050 | <0.10 | <0.0050 | <0.0050 | <0.0050 | <0.010 |
| Phosphorus | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potassium | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Selenium | 0.01 | 0.02 | <0.0020 | *<0.060* | <0.0050 | *<0.10* | <0.010 | *<0.10* | <0.0020 | *<0.014* | <0.0020 | <0.010 | 0.0035 | *<0.12* | *<0.14* | <0.0010 | <0.0010 | <0.0010 | <0.0020 |
| Silicon | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Silver | 0.02 | 0.015 | <0.00010 | <0.00050 | <0.00025 | <0.0050 | <0.00050 | <0.0050 | <0.00010 | <0.00010 | <0.00010 | <0.00050 | <0.00010 | <0.00050 | <0.0010 | <0.000050 | <0.000050 | <0.000050 | <0.00010 |
| Sodium | **200**[i] | | 67.6 | **3240** | **532** | **4000** | **1050** | **5790** | 30.4 | **1060** | 15.1 | 33 | 10.4 | **6620** | **5420** | 31 | 50 | 3.4 | 24.4 |
| Strontium | 2.5 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tellurium | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Thallium | | 0.003 | <0.00040 | <0.0020 | <0.0010 | *<0.020* | <0.0020 | *<0.020* | <0.00040 | <0.00040 | <0.00040 | <0.0020 | <0.00040 | <0.0020 | *<0.0040* | <0.00020 | <0.00020 | <0.00020 | *<0.00040* |
| Tin | 2.5 | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Titanium | | 1 | <0.050 | <0.50 | <0.050 | <0.50 | <0.10 | <0.50 | <0.050 | <0.50 | <0.050 | <0.50 | <0.050 | <0.50 | <0.50 | <0.50 | <0.50 | <0.050 | <0.050 |
| Uranium | 0.02 | 0.085 | <0.00040 | <0.0020 | <0.0010 | <0.020 | <0.0020 | <0.020 | <0.00040 | 0.00081 | 0.00258 | <0.0020 | 0.00061 | <0.0020 | <0.0040 | 0.00052 | <0.00020 | 0.00096 | 0.00074 |
| Vanadium | 0.02 | | *<0.030* | *<0.30* | *<0.030* | *<0.30* | *<0.060* | *<0.30* | *<0.030* | *<0.30* | *<0.030* | *<0.30* | *<0.030* | *<0.30* | *<0.30* | *<0.30* | *<0.30* | *<0.030* | *<0.030* |
| Zinc | 3 | 0.1 | <0.0050 | <0.050 | <0.0050 | <0.050 | <0.010 | <0.050 | <0.0050 | <0.050 | <0.0050 | <0.050 | <0.0050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.0050 | <0.0050 |
| Zirconium | | | | | | | | | | | | | | | | | | | |

Notes:
All concentrations in milligrams per litre (mg/L), unless otherwise noted.
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019).
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
i= standard for sodium ion and chloride ion conservatively applied
V= Standard is valence dependent VI refers to chromium VI and III refers to chromium III
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
italics indicate the concentration exceeds the laboratory detection limit.
*Background concentration for lithium and cobalt as detailed in Technical Bulletin 3 is applied to replace CSR DW Standard.
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC. Dated June 30, 2005.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and AW-M |

**TABLE 3b**
**Historic Groundwater Results - Total Metals and Other Parameters**
**Ladysmith Harbour, Ladysmith, BC**

| Location<br>SCN<br>Date<br>Source<br>QA/QC | CSR Standards for DW | CSR Standards for AW-M | 4<br>93011006<br>1993-06-04<br>EBA[a] | 4<br>93015229<br>1993-07-16<br>EBA[a] | 17<br>467-16-1<br>1994-01-28<br>EBA[b]<br>FDA | 17<br>467-16-1<br>1994-01-28<br>EBA[b]<br>FD | 18<br>467-16-2<br>1994-01-28<br>EBA[b] | 19<br>467-16-3<br>1994-01-28<br>EBA[b] |
|---|---|---|---|---|---|---|---|---|
| **Physical** | | | | | | | | |
| Hardness (as $CaCO_3$) | | | 591 | - | - | - | - | - |
| pH | | | - | - | - | - | - | - |
| Salinity | | | - | - | 20100 | 16610 | 4290 | 14890 |
| **Total Metals*** | | | | | | | | |
| Aluminum | 9.5 | | 9.18 | - | - | - | - | - |
| Antimony | 0.006 | 2.5 | <0.02 | - | - | - | - | - |
| Arsenic | **0.01** | 0.125 | 0.004 | - | **0.060** | - | **0.080** | **0.130** |
| Barium | 1 | 5 | 0.184 | - | 0.715 | - | 0.713 | 2.287 |
| Beryllium | 0.008 | 1 | <0.001 | - | - | - | - | - |
| Bismuth | | | <0.02 | - | - | - | - | - |
| Boron | 5 | 12 | 0.36 | - | - | - | - | - |
| Cadmium | **0.005** | 0.015 | <0.002 | - | **0.006** | - | 0.005 | **0.042** |
| Calcium | | | 175 | - | - | - | - | - |
| Chromium (IV, III) | **0.05,6[V]** | 0.015,0.56[V] | 0.027 | - | 0.035 | - | 0.043 | **0.159** |
| Cobalt | **0.02** | 0.04 | 0.009 | - | **0.062** | - | **0.100** | **0.167** |
| Copper | **1.5** | 0.02 | 0.110 | - | 0.584 | - | 0.705 | **1.529** |
| Iron | **6.5** | | **10.8** | - | - | - | - | - |
| Lead | **0.01** | 0.02 | **0.03** | - | **0.21** | - | **0.170** | **2.060** |
| Lithium | 0.033* | | - | - | - | - | - | - |
| Magnesium | | | 37.4 | - | - | - | - | - |
| Manganese | 1.5 | | 0.457 | - | - | - | - | - |
| Mercury | **0.001** | 0.00025 | 0.00065 | - | **0.002** | - | **0.003** | **0.009** |
| Molybdenum | 0.25 | 10 | <0.004 | - | 0.045 | - | 0.020 | 0.043 |
| Nickel | **0.08** | 0.083 | 0.04 | - | **0.149** | - | **0.150** | **0.342** |
| Phosphorus | | | 0.21 | - | - | - | - | - |
| Potassium | | | 12.4 | - | - | - | - | - |
| Selenium | 0.01 | 0.02 | <0.005 | - | <0.005 | - | <0.005 | <0.005 |
| Silicon | | | 3.8 | - | - | - | - | - |
| Silver | 0.02 | 0.015 | <0.03 | - | <0.003 | - | <0.003 | 0.006 |
| Sodium | 200[i] | | 66.8 | 68 | - | - | - | - |
| Strontium | 2.5 | | 1.13 | - | - | - | - | - |
| Tellurium | | | <0.02 | - | - | - | - | - |
| Thallium | | 0.003 | *<0.03* | - | - | - | - | - |
| Tin | 2.5 | | <0.02 | - | <0.010 | - | <0.010 | <0.010 |
| Titanium | | 1 | 0.066 | - | - | - | - | - |
| Uranium | 0.02 | 0.085 | - | - | - | - | - | - |
| Vanadium | **0.02** | | **0.033** | - | - | - | - | - |
| Zinc | 3 | 0.1 | 0.08 | - | 0.440 | - | 0.400 | 1.360 |
| Zirconium | | | <0.003 | - | - | - | - | - |
| ***Other Parameters*** | | | | | | | | |
| Sulphur | | | 32.6 | - | - | - | - | - |
| Sulfate | 500 | 1280-4290[H] | - | 103 | - | - | - | - |
| Chloride | 250[i] | 1500[i] | - | 36.9 | - | - | - | - |

Notes:
All concentrations in milligrams per litre (mg/L), unless otherwise noted.
Standards for dissolved metals shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019).
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
H = standard is Hardness dependent,  i= standard for sodium ion conservatively applied
V= Standard is valence dependent VI refers to chromium VI and III refers to chromium III
*italics* indicate the concentration exceeds the laboratory detection limit.
*data for total metals is conservatively screened against CSR standards for dissolved metals.
*Background concentration for lithium and cobalt as detailed in Technical Bulletin 3 is applied to replace CSR DW Standard.
EBA[a] = EBA Environmental Ltd. 1994a. Elk Falles Forest Industries Limited Phase II Environmental Assessment Ladysmith Harbour Leases Project Ladysmith, B.C. Dated January 1994.
EBA[b] = EBA Environmental Ltd. 1994b. Elk Falles Forest Industries Limited Supplemental Information Ladysmith Harbour Leases Project Ladysmith, BC. Dated February 4, 1994.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and AW-M |

**TABLE 3c**
**Historic Groundwater Results - Hydrocarbons**
**Ladysmith Harbour, Ladysmith, BC**

| Location / SCN / Date / Source / QA/QC | CSR Standards for DW | CSR Standards for AW Marine | MW05-4 0045-05 2005-04-13 Golder | MW05-5 0036-02 2005-04-14 Golder | MW05-6 0045-08 2005-04-13 Golder | MW05-7 0036-01 2005-04-14 Golder | MW05-8 0045-07 2005-04-13 Golder | MW05-9 0046-10 2005-04-14 Golder | MW05-16 0045-03 2005-04-13 Golder FDA | MW05-17 0039-01 2005-04-14 Golder | MW05-18 0039-02 2005-04-14 Golder FDA | MW05-22 0048-01 2005-04-21 Golder | MW05-24 0049-01 2005-04-25 Golder | MW00-02 009079-02 2000-09-25 Levelton | MW00-04 009079-01 2000-09-25 Levelton | MW00-06 009079-03 2000-09-25 Levelton | MW00-09 009079-04 2000-09-25 Levelton | 4 93011006 1993-06-04 EBA[a] | 4 93013268 1993-06-25 EBA[a] | 17 467-16-1 1994-01-28 EBA[b] | 18 467-16-2 1994-01-28 EBA[b] | 19 467-16-3 1994-01-28 EBA[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Monoaromatic Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | |
| Benzene | 0.005 | 1 | <0.00050 | - | <0.00050 | - | - | <0.00050 | - | - | - | <0.00050 | <0.00050 | - | - | - | - | - | - | - | - | - |
| Ethylbenzene | 0.14 | 2.5 | <0.00050 | - | <0.00050 | - | - | <0.00050 | - | - | - | <0.00050 | <0.00050 | - | - | - | - | - | - | - | - | - |
| Styrene | 0.8 | 0.72 | <0.0010 | - | <0.0010 | - | - | <0.0010 | - | - | - | <0.0010 | <0.0010 | - | - | - | - | - | - | - | - | - |
| Toluene | 0.06 | 2.0 | <0.0010 | - | <0.0010 | - | - | <0.0010 | - | - | - | <0.0010 | <0.0010 | - | - | - | - | - | - | - | - | - |
| meta- & para-Xylene | | | <0.00050 | - | <0.00050 | - | - | <0.00050 | - | - | - | <0.00050 | <0.00050 | - | - | - | - | - | - | - | - | - |
| ortho-Xylene | | | <0.00050 | - | <0.00050 | - | - | <0.00050 | - | - | - | <0.00050 | <0.00050 | - | - | - | - | - | - | - | - | - |
| Total Xylene | 0.09 | 0.3 | <0.0010 | - | <0.0010 | - | - | <0.0010 | - | - | - | <0.0010 | <0.0010 | - | - | - | - | - | - | - | - | - |
| VHw6-10 | 15 | 15 | <0.10 | - | <0.10 | - | - | <0.10 | - | - | - | <0.10 | <0.10 | - | - | - | - | - | - | - | - | - |
| VPHw | | 1.5 | <0.10 | - | <0.10 | - | - | <0.10 | - | - | - | <0.10 | <0.10 | - | - | - | - | - | - | - | - | - |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | | |
| Acenaphthene | 0.25 | 0.06 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Acenaphthylene | | | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Acridine | | 0.0005 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Anthracene | 1 | 0.001 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Benz(a)anthracene | 0.00007 | 0.0001 | *<0.000050* | *<0.000050* | *<0.000050* | *<0.000050* | *<0.000050* | *<0.000050* | *<0.000050* | *<0.000050* | *<0.000050* | *<0.000050* | *<0.000050* | - | - | - | - | - | - | - | - | - |
| Benzo(a)pyrene | 0.00001 | 0.0001 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | - | - | - | - | - | - | - | - | - |
| Benzo(b)fluoranthene | 0.00007 | | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Benzo(g,h,i)perylene | | | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Benzo(k)fluoranthene | | | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Chrysene | 0.007 | 0.001 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Dibenzo(a,h)anthracene | 0.00001 | | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Fluoranthene | 0.15 | 0.002 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Fluorene | 0.15 | 0.12 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Indeno(1,2,3-c,d)pyrene | | | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Naphthalene | 0.08 | 0.01 | <0.000050 | <0.000050 | <0.000050 | 0.000066 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Phenanthrene | | 0.003 | <0.000050 | <0.000050 | <0.000050 | 0.000126 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Pyrene | 0.1 | 0.0002 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| Quinoline | 0.00005 | 0.034 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | - | - | - | - | - | - | - | - | - |
| EPHw10-19 | 5 | 5 | <0.30 | - | <0.30 | - | <0.30 | <0.30 | <0.30 | - | - | <0.30 | <0.30 | 0.910 | <0.100 | 0.105 | 0.285 | - | - | - | - | - |
| EPHw19-32 | | | <1.0 | - | <1.0 | - | <1.0 | <1.0 | <1.0 | - | - | <1.0 | <1.0 | 1.400 | <0.100 | 0.260 | 0.590 | - | - | - | - | - |
| LEPHw | | 0.5 | <0.30 | - | <0.30 | - | <0.30 | <0.30 | <0.30 | - | - | <0.30 | <0.30 | - | - | - | - | - | - | - | - | - |
| HEPHw | | | <1.0 | - | <1.0 | - | <1.0 | <1.0 | <1.0 | - | - | <1.0 | <1.0 | - | - | - | - | - | - | - | - | - |
| Mineral Oil and Grease | | 0.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 7 | *<1* | 45 | *<5* | 7 |

Notes:
All concentrations in micrograms per litre (mg/L), unless otherwise noted.
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019).
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
EPHC10-19 = extractable petroleum hydrocarbons, carbon range 10-19
EPHC19-32 = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
PAH = Polycyclic Aromatic Hydrocarbons
VPH = volatile petroleum hydrocarbons
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
*italics* indicate the concentration exceeds the laboratory detection limit.
LEPH criteria used as a conservate screen for Mineral Oil and Grease and EHw10-19.
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC. Dated June 30, 2005.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and AW-M |

# TABLE 3d
## Historical Groundwater Results - Phenols
## Ladysmith Harbour, Ladysmith, BC

| Location<br>SCN<br>Date Sampled<br>Source<br>QA/QC | CSR Standards for DW | CSR Standards for AW Marine | MW05-4<br>0045-05<br>2005-04-13<br>Golder | MW05-5<br>0036-02<br>2005-04-14<br>Golder | MW05-6<br>0045-08<br>2005-04-13<br>Golder | MW05-7<br>0036-01<br>2005-04-14<br>Golder | MW05-8<br>0045-07<br>2005-04-13<br>Golder | MW05-9<br>0046-10<br>2005-04-14<br>Golder | MW05-16<br>0045-03<br>2005-04-13<br>Golder<br>FDA | MW05-17<br>0039-01<br>2005-04-14<br>Golder | MW05-18<br>0039-02<br>2005-04-14<br>Golder<br>FDA | MW05-22<br>0048-01<br>2005-04-21<br>Golder | MW05-24<br>0049-01<br>2005-04-25<br>Golder |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Physical*** | | | | | | | | | | | | | |
| pH | | | 7.58 | 7.77 | 7.45 | 7.75 | 7.31 | 7.37 | 6.79 | 7.73 | 7.79 | 6.90 | 6.70 |
| ***Phenolic Compounds*** | | | | | | | | | | | | | |
| 2,3,4-trichlorophenol | | 0.0025-0.32* | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| 2,3,5-trichlorophenol | | 0.0025-0.34* | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| 2,3,6-trichlorophenol | | 0.008-1.08* | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| 2,4,5-trichlorophenol | 0.4 | 0.0025-0.30* | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| 2,4,6-trichlorophenol | 0.005 | 0.006-0.8* | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| 3,4,5-trichlorophenol | | 0.001-0.128* | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| 2,3,4,5-tetrachlorophenol | | 0.002-0.26* | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| 2,3,4,6-tetrachlorophenol | 0.1 | 0.0055-0.72* | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| 2,3,5,6-tetrachlorophenol | | 0.0025-0.34* | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| pentachlorophenol | 0.06 | 0.001-0.0110* | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |

Notes:
All concentrations in micrograms per litre (mg/L), unless otherwise noted.
Standards shown from the Contaminated Sites Regulation (“CSR”; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019).
< = less than laboratory reporting limit; - = not analyzed
Land Use abbreviations: AW (Aquatic Life), M = marine; DW (Drinking Water)
For chlorophenol standards, refer to Technical Guidance Document #9
*The standards varies as a function of pH, Temperature and Chlorophenol Isomer
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
*italics* indicate the concentration exceeds the laboratory detection limit.
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC. Dated June 30, 2005.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and AW-M |

**TABLE 4a**
**Results of Groundwater Analyses**
**Ladysmith Harbour, Ladysmith, BC**
**Metals and Anions**

| Location | CSR Standards for DW | CSR Standards for AW-M | MW00-2 | MW00-04 | MW00-09 | MW00-11 | MW05-02 | MW05-04 | MW05-08 | MW05-09 | MW05-12 | MW05-17 | MW05-20 | MW05-22 | MW09-1 | MW09-2 | MW09-3 | MW09-03 | MW09-4 | MW09-5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | | | 2009-11-18 | 2009-12-11 | 2009-12-11 | 2009-12-11 | 2009-11-24 | 2009-11-24 | 2009-11-24 | 2009-11-24 | 2009-11-24 | 2009-11-24 | 2009-11-24 | 2009-11-24 | 2009-11-18 | 2009-11-18 | 2009-11-18 | 2009-12-11 | 2009-11-19 | 2009-11-19 |
| SCN | | | 21367-04 | 21382-03 | 21382-02 | 21382-01 | 21369-04 | 21369-05 | 21369-02 | 21369-03 | 21369-08 | 21369-01 | 21369-07 | 21369-06 | 21367-01 | 21367-02 | 21367-03 | 21382-04 | 21367-07 | 21367-08 |
| QA/QC | | | | | | | | | | | | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | | | | | | |
| pH (pH units) | | | 7.55 | 6.66 | 6.33 | 7.33 | 7.04 | 7.06 | 6.74 | 7.23 | 6.6 | 7.51 | 8.4 | 6.59 | 7.97 | 7.36 | 7.69 | 7.31 | 7.64 | 7.6 |
| Temperature (°C) | | | 10.8 | 8.69 | 9.21 | 10.4 | 9.4 | 10.62 | 10.9 | 13.61 | 12.61 | 11.32 | 9.4 | 11.12 | 10.29 | 10.44 | 10.44 | 11.7 | 12.8 | 10.33 |
| Conductivity (µS/cm) | | | 242 | 230 | 96 | 386 | 531 | 510 | 1054 | 9547 | 1331 | 33734 | 900 | 1032 | 301 | 370 | 390 | 355 | 460 | 410 |
| Redox (mV) | | | 31.6 | -62.7 | 144.2 | 18.7 | -15.9 | -34 | -39.2 | 17.3 | 110.9 | -219.6 | -121.6 | -61.6 | -130.6 | -80 | -121.6 | -116.9 | 45.3 | -50.4 |
| Dissolved Oxygen (%) | | | 11.7 | 2.91 | 4.41 | 2.67 | 10.9 | 9.4 | 13.9 | 18.6 | 21.1 | 14.4 | 60.2 | 9.6 | 36 | 23.6 | 14.3 | 1.56 | 8.9 | 11 |
| **Laboratory Parameters** | | | | | | | | | | | | | | | | | | | | |
| pH (lab) | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Conductivity (µS/cm_) | | | - | - | - | - | 464 | 639 | 775 | 12000 | 1100 | 14900 | 209 | 1060 | - | - | - | - | - | - |
| Salinity (Low Level) (g/L) | | | - | - | - | - | 0.22 | 0.31 | 0.38 | 6.89 | 0.55 | 8.7 | < 0.2 | 0.53 | - | - | - | - | - | - |
| Hardness $CaCO_3$ | | | 125 | 101 | 56 | 198 | 233 | 307 | 435 | 944 | 790 | 1570 | 86 | 688 | 106 | 151 | 144 | - | 206 | 175 |
| Bicarbonate Alkalinity $HCO_3$ | | | - | - | - | - | 262 | 393 | 449 | 709 | 752 | 181 | 78.9 | 645 | - | - | - | - | - | - |
| Carbonate Alkalinity $CO_3$ | | | - | - | - | - | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | - | - | - | - | - | - |
| Hydroxide Alkalinity OH | | | - | - | - | - | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | - | - | - | - | - | - |
| Total Alkalinity $CaCO_3$ | | | - | - | - | - | 215 | 322 | 368 | 581 | 617 | 148 | 64.7 | 528 | - | - | - | - | - | - |
| Dissolved Bromide Br | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dissolved Chloride Cl | **250** | 1500 | - | - | - | - | 12 | 14.2 | 21.6 | **2700** | 10.9 | **4010** | 17.4 | 6.1 | - | - | - | - | - | - |
| Dissolved Fluoride F | 1.5 | 15 | - | - | - | - | < 0.25 | < 0.1 | < 0.25 | < 0.5 | < 0.1 | < 0.5 | < 0.05 | < 0.1 | - | - | - | - | - | - |
| Dissolved Nitrate N | 10 | 400 | - | - | - | - | < 0.25 | < 0.1 | < 0.25 | < 0.5 | 1.15 | < 0.5 | 1.91 | 0.15 | - | - | - | - | - | - |
| Nitrite N | 1 | 0.2-2[Cl] | - | - | - | - | < 0.002 | < 0.002 | < 0.002 | < 0.002 | 0.023 | < 0.002 | < 0.002 | < 0.002 | - | - | - | - | - | - |
| Nitrate and Nitrite N | 10 | 400 | - | - | - | - | < 0.25 | < 0.1 | < 0.25 | < 0.5 | 1.13 | < 0.5 | 1.91 | 0.15 | - | - | - | - | - | - |
| Dissolved Sulphate $SO_4$ | **500** | 1280-4290[H] | - | - | - | - | 14.6 | 15.1 | 23.8 | **561** | 103 | 466 | 5.72 | 85.2 | - | - | - | - | - | - |
| **Dissolved Metals** | | | | | | | | | | | | | | | | | | | | |
| aluminum | 9.5 | | 0.017 | 0.086 | 0.071 | 0.005 | 0.015 | 0.013 | 0.093 | 0.023 | 0.014 | 0.019 | 0.014 | 0.01 | 0.079 | 0.013 | 0.036 | - | 0.011 | 0.026 |
| antimony | 0.006 | 2.5 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | 0.0018 | < 0.0005 | 0.0009 | - | < 0.0005 | < 0.0005 |
| arsenic | **0.01** | 0.125 | 0.009 | 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.001 | < 0.001 | 0.003 | 0.002 | 0.004 | < 0.001 | < 0.001 | 0.005 | 0.003 | 0.004 | - | < 0.001 | 0.003 |
| barium | 1 | 5 | 0.026 | 0.044 | 0.059 | 0.032 | 0.05 | 0.034 | 0.091 | 0.043 | 0.051 | 0.1 | 0.036 | 0.14 | 0.042 | 0.024 | 0.04 | - | 0.043 | 0.16 |
| beryllium | 0.008 | 1 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | - | < 0.0005 | < 0.0005 |
| bismuth | | | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | 0.0007 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | 0.0005 | - | < 0.0005 | < 0.0005 |
| boron | 5 | 12 | 0.04 | 0.12 | 0.03 | 0.13 | 0.15 | 0.23 | 0.59 | 1.9 | 1.13 | 0.79 | 0.04 | 0.32 | 0.04 | 0.07 | 0.08 | - | 0.12 | 0.05 |
| cadmium | 0.005 | 0.015 | < 0.00005 | 0.00066 | 0.00024 | < 0.00005 | < 0.00005 | < 0.00005 | < 0.00005 | 0.00012 | < 0.00005 | < 0.00005 | < 0.00005 | 0.00009 | < 0.00005 | < 0.00005 | < 0.00005 | - | 0.00014 | < 0.00005 |
| calcium | | | 36.8 | 31.6 | 16.6 | 54.1 | 71.7 | 74.6 | 142 | 143 | 227 | 110 | 30.5 | 215 | 31.3 | 41.9 | 42.3 | - | 58.4 | 49.5 |
| cesium | | | <0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.0005 | <0.0005 | <0.0005 | - | <0.0005 | <0.0005 |
| chromium (IV,III) | 0.05,6[V] | 0.015,0.56[V] | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 |
| cobalt | 0.02 | 0.04 | < 0.0005 | 0.014 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | 0.001 | < 0.0005 | 0.0007 | 0.0014 | 0.0049 | 0.0029 | - | 0.0035 | 0.001 |
| copper | 1.5 | 0.02 | 0.0009 | 0.0036 | 0.0021 | 0.0009 | 0.0012 | 0.0047 | 0.016 | 0.013 | 0.0027 | 0.0011 | 0.0045 | 0.003 | 0.0038 | 0.0025 | 0.0005 | - | 0.0014 | 0.0007 |
| iron | **6.5** | | 1.69 | 4.25 | 0.08 | 0.49 | 0.72 | < 0.05 | 0.18 | < 0.05 | 0.08 | < 0.05 | < 0.05 | 0.14 | 0.36 | 0.18 | 0.75 | - | 0.09 | 0.7 |
| lanthanum | | | <0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.0005 | <0.0005 | <0.0005 | - | <0.0005 | <0.0005 |
| lead | 0.01 | 0.02 | < 0.00025 | 0.0003 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | 0.0046 | < 0.00025 | < 0.00025 | - | < 0.00025 | < 0.00025 |
| lithium | **0.033*** | | < 0.0005 | 0.0006 | 0.0009 | 0.0079 | 0.012 | 0.0099 | 0.016 | **0.059** | 0.029 | **0.068** | 0.0011 | 0.028 | < 0.0005 | < 0.0005 | 0.0017 | - | < 0.0005 | 0.001 |
| magnesium | | | 8.04 | 5.42 | 3.5 | 15.1 | 13 | 29.3 | 19.7 | 143 | 53.6 | 314 | 2.26 | 36.5 | 6.61 | 11.2 | 9.38 | - | 14.5 | 12.3 |
| manganese | **1.5** | | 0.689 | 1.31 | 0.353 | 0.934 | 0.059 | 0.127 | 0.01 | 0.0036 | 0.185 | 0.205 | < 0.0005 | 0.092 | 1.05 | **2.37** | 1.29 | - | 1.11 | 0.572 |
| mercury | 0.001 | 0.00025 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | 0.00005 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | - | < 0.00002 | < 0.00002 |
| molybdenum | 0.25 | 10 | 0.0007 | 0.0006 | < 0.0005 | < 0.0005 | 0.0008 | 0.001 | < 0.0005 | 0.0037 | 0.0006 | 0.0023 | < 0.0005 | < 0.0005 | 0.018 | 0.0023 | 0.0095 | - | 0.0027 | 0.001 |
| nickel | 0.08 | 0.083 | 0.001 | 0.007 | < 0.001 | < 0.001 | < 0.001 | 0.001 | 0.003 | 0.002 | 0.002 | 0.003 | < 0.001 | < 0.001 | 0.003 | 0.003 | 0.004 | - | 0.006 | 0.001 |
| phosphorus | | | < 0.075 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | 0.26 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | - | < 0.075 | < 0.075 |
| potassium | | | 1.19 | 1.51 | 0.91 | 1.01 | 6.39 | 14 | 5.49 | 67.2 | 6.65 | 80.5 | 0.72 | 4.35 | 4.42 | 1.22 | 3.54 | - | 1.64 | 0.88 |
| rhenium | | | <0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.0005 | <0.0005 | <0.0005 | - | <0.0005 | <0.0005 |
| rubidium | | | 0.0007 | 0.0008 | 0.0011 | 0.0005 | 0.0027 | 0.0043 | 0.0018 | 0.021 | 0.0026 | 0.0064 | < 0.0005 | 0.0022 | 0.004 | 0.001 | 0.0023 | - | 0.0013 | 0.001 |
| selenium | 0.01 | 0.02 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.002 | < 0.001 | < 0.001 | < 0.001 | - | < 0.001 | < 0.001 |
| silicon | | | 12.5 | 4.9 | 6.8 | 10.8 | 3.9 | 2.8 | 4.9 | 4 | 4.4 | 4 | 2.1 | 3.7 | 7 | 12 | 7.2 | - | 12.7 | 12.9 |
| silver | 0.02 | 0.015 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | - | < 0.0002 | < 0.0002 |
| sodium | **200[i]** | | 12.5 | 11 | 7.25 | 23.6 | 15.9 | 24.4 | 26.4 | **1820** | 20.7 | **2170** | 7.58 | 4.59 | 29.2 | 11.9 | 28.8 | - | 26.4 | 12 |
| strontium | **2.5** | | 0.207 | 0.23 | 0.18 | 0.668 | 1.1 | 0.657 | 1.07 | 1.49 | **2.68** | 2.37 | 0.191 | **3.23** | 0.187 | 0.252 | 0.198 | - | 0.441 | 0.287 |
| sulphur | | | <5 | < 5 | < 5 | < 5 | 5 | < 5 | 10 | 209 | 44 | 168 | < 5 | 34 | 10 | <5 | 13 | - | <5 | <5 |
| tellurium | | | <0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | <0.001 | - | <0.001 | <0.001 |
| thallium | | 0.003 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | - | < 0.0001 | < 0.0001 |
| thorium | | | 0.0004 | < 0.00025 | < 0.00025 | < 0.00025 | 0.0003 | 0.0004 | 0.0006 | 0.0008 | 0.0004 | 0.0019 | 0.0003 | 0.0004 | 0.0006 | 0.0004 | 0.0005 | - | 0.0003 | 0.0003 |
| tin | 2.5 | | <0.0006 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | 0.0037 | < 0.0005 | < 0.0005 | <0.0006 | <0.0006 | <0.0006 | - | <0.0006 | <0.0006 |
| titanium | | 1 | < 0.001 | 0.002 | 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.002 | 0.002 | < 0.001 | 0.004 | < 0.001 | < 0.001 | 0.003 | < 0.001 | 0.002 | - | < 0.001 | < 0.001 |
| tungsten | | | 0.005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | 0.007 | 0.005 | 0.005 | - | 0.005 | 0.005 |
| uranium | 0.02 | 0.085 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | 0.0003 | < 0.00025 | 0.001 | 0.0007 | 0.0008 | < 0.00025 | 0.0008 | < 0.00025 | < 0.00025 | 0.0005 | - | 0.0004 | < 0.00025 |
| vanadium | 0.02 | | 0.0007 | 0.005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | 0.0006 | 0.0008 | 0.0007 | 0.0006 | < 0.0005 | < 0.0005 | 0.0016 | 0.0007 | 0.001 | - | 0.001 | < 0.0005 |
| zinc | 3 | 0.1 | 0.008 | 0.19 | 0.008 | < 0.005 | < 0.005 | 0.009 | < 0.005 | 0.005 | < 0.005 | < 0.005 | 0.005 | 0.006 | 0.016 | 0.008 | < 0.005 | - | < 0.005 | 0.006 |
| zirconium | | | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | - | < 0.0005 | < 0.0005 |

Notes:
All concentrations in milligrams per litre (mg/L), unless otherwise noted.
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019).
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
H = standard is Hardness dependent, Cl = standard is chloride dependent, i= standard for sodium ion conservatively applied
V= Standard is valence dependent VI refers to chromium VI and III refers to chromium III
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
italics indicate the concentration exceeds the laboratory detection limit.
*Background concentration for lithium and coblat as detailed in Technical Bulletin 3 is applied to replace CSR DW Standard.

| | |
|---|---|
| 1 | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| 1 | Exceeds CSR Standards for DW and AW-M |

**TABLE 4a**
**Results of Groundwater Analyses**
**Ladysmith Harbour, Ladysmith, BC**
**Metals and Anions**

| Location | CSR Standards for DW | CSR Standards for AW-M | MW09-07 | MW09-7 | MW09-07 | MW09-08 | MW09-08 | MW09-08 | MW09-8 | MW09-8 | MW09-9 | MW09-9 | MW09-10 | MW09-11 | MW09-16 | MW11-01 | MW11-01 | MW11-02 | MW11-02 | Sea Water | WHARF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | | | 2011-02-16 | 2009-11-20 | 2011-02-22 | 2011-02-16 | 2011-02-16 | 2011-02-22 | 2009-11-20 | 2009-11-20 | 2009-11-25 | 2009-11-25 | 2009-11-19 | 2009-11-19 | 2009-11-20 | 2011-02-16 | 2011-02-22 | 2011-02-16 | 2011-02-22 | 2009-11-20 | 2011-02-22 |
| SCN | | | 0531-01 | 21368-07 | 0532-01 | 0531-02 | 0531-03 | 0532-02 | 21368-05 | 21368-06 | 21369-09 | 21369-10 | 21367-05 | 21367-06 | 21368-02 | 0531-04 | 0532-03 | 0531-05 | 0532-04 | 21368-01 | 0532-05 |
| QA/QC | | | | | | FDA | FD | | FDA | FD | FDA | FD | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | | | | | | | | | | |
| pH (pH units) | | | 6.34 | 7.22 | 6.49 | 6.99 | 6.99 | 6.68 | 6.92 | 6.92 | 6.75 | 6.75 | 8.13 | 7.88 | 7.62 | 7.69 | 6.76 | 8.05 | 7.87 | - | - |
| Temperature (°C) | | | 6.6 | 11.33 | 6.2 | 7.77 | 7.77 | 6.84 | 9.66 | 9.66 | 10.3 | 10.3 | 11.49 | 11.31 | 10.51 | 6.6 | 5.1 | 10.2 | 10.03 | - | - |
| Conductivity (µS/cm) | | | 2960 | 1420 | 4100 | 8360 | 8360 | 33841 | 14210 | 14210 | 402 | 402 | 401 | 410 | 347 | 4223 | 41100 | 402 | 437 | - | - |
| Redox (mV) | | | - | 13 | - | -95.9 | -95.9 | 65.9 | 45.1 | 45.1 | -54.8 | -54.8 | 6.7 | 12.6 | 24.7 | 192.9 | - | 158.7 | 51.3 | - | - |
| Dissolved Oxygen (%) | | | - | 8.91 | - | - | - | 2.325 | 6.7 | 6.7 | 7.87 | 7.87 | 10.9 | 7.1 | 10.7 | - | - | - | - | - | - |
| **Laboratory Parameters** | | | | | | | | | | | | | | | | | | | | | |
| pH (lab) | | | 7.15 | - | 7.11 | 7.50 | 7.55 | 7.53 | - | - | - | - | - | - | - | 7.78 | 7.57 | 7.95 | 8.27 | - | 7.70 |
| Conductivity (µS/cm_) | | | | - | | | | | 18900 | 22400 | - | - | - | - | 436 | | | | | 13100 | |
| Salinity (Low Level) (g/L) | | | | - | | | | | 11.3 | 13.5 | - | - | - | - | 0.21 | | | | | 7.57 | |
| Hardness $CaCO_3$ | | | 185 | 102 | 1010 | 694 | 684 | 3850 | 1480 | 1890 | 149 | 149 | 149 | 145 | 32 | 425 | 4330 | 83.5 | 73.2 | 1030 | 4710 |
| Bicarbonate Alkalinity $HCO_3$ | | | 187 | - | 153 | 133 | 129 | 119 | 112 | 123 | - | - | - | - | 105 | 106 | 116 | 107 | 140 | 43.1 | 123 |
| Carbonate Alkalinity $CO_3$ | | | <2.0 | - | <2.0 | <2.0 | <2.0 | <2.0 | < 0.5 | < 0.5 | - | - | - | - | < 0.5 | <2.0 | <2.0 | <2.0 | <2.0 | < 0.5 | <2.0 |
| Hydroxide Alkalinity OH | | | <2.0 | - | <2.0 | <2.0 | <2.0 | <2.0 | < 0.5 | < 0.5 | - | - | - | - | < 0.5 | <2.0 | <2.0 | <2.0 | <2.0 | < 0.5 | <2.0 |
| Total Alkalinity $CaCO_3$ | | | 187 | - | 153 | 133 | 129 | 119 | 91.7 | 100 | - | - | - | - | 86.3 | 106 | 116 | 107 | 140 | 35.3 | 123 |
| Dissolved Bromide Br | | | <1.0 | - | 5.5 | 5.9 | 5.2 | 28.8 | - | - | - | - | - | - | - | 5.0 | 35.6 | <0.050 | <0.050 | - | 39.0 |
| Dissolved Chloride Cl | 250 | 1500 | 384 | - | 2170 | 2340 | 2150 | 10800 | 5410 | 6480 | - | - | - | - | 76.4 | 2000 | 12800 | 9.04 | 18.1 | 3470 | 14500 |
| Dissolved Fluoride F | 1.5 | 15 | <0.40 | - | <0.40 | <0.40 | <0.40 | 0.404 | < 1.25 | < 2.5 | - | - | - | - | < 0.25 | <0.40 | 0.513 | 0.122 | 0.261 | < 1.25 | 0.714 |
| Dissolved Nitrate N | 10 | 400 | <0.10 | - | <0.10 | <0.10 | <0.10 | <0.50 | < 1.25 | < 2.5 | - | - | - | - | < 0.25 | <0.10 | <0.50 | 0.0871 | <0.0050 | < 1.25 | <0.50 |
| Nitrite N | 1 | 0.2-2[Cl] | <0.020 | - | <0.020 | <0.020 | <0.020 | <0.10 | < 0.002 | < 0.002 | - | - | - | - | 0.005 | 0.025 | <0.10 | 0.0026 | <0.0010 | < 0.002 | <0.10 |
| Nitrate and Nitrite N | 10 | 400 | - | - | - | - | - | - | < 1.25 | < 2.5 | - | - | - | - | < 0.25 | - | - | - | - | < 1.25 | - |
| Dissolved Sulphate $SO_4$ | 500 | 1280-4290[H] | 59 | - | 314 | 290 | 264 | 1510 | 686 | 843 | - | - | - | - | 20.5 | 279 | 1790 | 25.8 | 48.7 | 476 | 2030 |
| **Dissolved Metals** | | | | | | | | | | | | | | | | | | | | | |
| aluminum | 9.5 | | <0.050 | 0.017 | <0.20 | <0.20 | <0.20 | <1.0 | 0.012 | 0.014 | 0.011 | 0.016 | 0.014 | 0.012 | 0.046 | <0.10 | <1.0 | 0.021 | 0.013 | 0.059 | <1.0 |
| antimony | 0.006 | 2.5 | <0.0025 | < 0.0005 | <0.010 | <0.010 | <0.010 | <0.050 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.0050 | <0.050 | 0.00555 | 0.00993 | < 0.0005 | <0.050 |
| arsenic | 0.01 | 0.125 | <0.0050 | 0.002 | <0.020 | <0.020 | <0.020 | <0.10 | 0.011 | 0.014 | 0.001 | 0.001 | 0.002 | 0.01 | 0.003 | <0.010 | <0.10 | 0.0109 | 0.0304 | 0.009 | <0.10 |
| barium | 1 | 5 | 0.138 | 0.12 | 0.751 | <0.040 | <0.040 | <0.20 | 0.18 | 0.21 | 0.012 | 0.012 | 0.034 | 0.041 | 0.014 | 0.027 | <0.20 | <0.020 | <0.020 | 0.017 | <0.20 |
| beryllium | 0.008 | 1 | <0.0050 | < 0.0005 | <0.010 | <0.010 | <0.010 | <0.050 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.0050 | <0.050 | <0.0050 | <0.0050 | < 0.0005 | <0.050 |
| bismuth | | | <0.20 | < 0.0005 | <0.40 | <0.40 | <0.40 | <2.0 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.20 | <2.0 | <0.20 | <0.20 | < 0.0005 | <2.0 |
| boron | 5 | 12 | 0.28 | 0.13 | 0.52 | 0.66 | 0.65 | 2.5 | 0.91 | 1.06 | 0.07 | 0.06 | 0.06 | 0.05 | 0.12 | 0.44 | 2.9 | <0.10 | <0.10 | 0.72 | 3.4 |
| cadmium | 0.005 | 0.015 | <0.00025 | 0.0001 | <0.0010 | <0.0010 | <0.0010 | <0.0050 | < 0.00005 | < 0.00005 | 6.00E-05 | 0.00007 | < 0.00005 | < 0.00005 | < 0.00005 | <0.00050 | <0.0050 | 0.000055 | <0.000050 | 0.00018 | <0.0050 |
| calcium | | | 17.8 | 15 | 90.3 | 50.0 | 49.1 | 262 | 136 | 169 | 41.4 | 41.5 | 39.2 | 42.6 | 5.25 | 35.6 | 305 | 26.1 | 20.0 | 78 | 323 |
| cesium | | | | < 0.0005 | | | | | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.0005 | <0.0005 | < 0.0005 | | | | | < 0.0005 | |
| chromium (IV,III) | 0.05,6[V] | 0.015,0.56[V] | <0.0025 | < 0.001 | <0.010 | <0.010 | <0.010 | <0.050 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.0050 | <0.050 | <0.00050 | <0.0010 | < 0.001 | <0.050 |
| cobalt | 0.02 | 0.04 | <0.0025 | 0.0035 | <0.010 | <0.010 | <0.010 | <0.050 | 0.0014 | 0.0016 | 0.0035 | 0.0035 | 0.0028 | 0.0026 | 0.0011 | <0.0050 | <0.050 | <0.00050 | <0.00050 | < 0.0005 | <0.050 |
| copper | 1.5 | 0.02 | <0.0050 | 0.0025 | <0.020 | <0.020 | <0.020 | <0.10 | 0.0018 | 0.0019 | 0.0014 | 0.0012 | 0.0011 | 0.0024 | 0.0019 | <0.010 | <0.10 | 0.0047 | <0.0010 | 0.0018 | <0.10 |
| iron | 6.5 | | 2.97 | 0.35 | 7.68 | 0.087 | 0.088 | <0.30 | 0.35 | 0.64 | < 0.05 | < 0.05 | 1.64 | 0.94 | 0.46 | <0.030 | <0.30 | <0.030 | <0.030 | 0.06 | <0.30 |
| lanthanum | | | | < 0.0005 | | | | | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.0005 | <0.0005 | < 0.0005 | | | | | < 0.0005 | |
| lead | 0.01 | 0.02 | <0.0050 | 0.0003 | <0.020 | <0.020 | <0.020 | <0.10 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00025 | <0.010 | <0.10 | <0.0010 | <0.0010 | < 0.00025 | <0.10 |
| lithium | 0.033* | | <0.050 | 0.0021 | <0.10 | <0.10 | <0.10 | <0.50 | 0.035 | 0.039 | 0.0008 | 0.0012 | < 0.0005 | 0.0006 | 0.0021 | <0.050 | <0.50 | <0.050 | <0.050 | 0.026 | <0.50 |
| magnesium | | | 34.1 | 15.7 | 191 | 138 | 136 | 775 | 277 | 357 | 11.1 | 10.9 | 12.4 | 9.25 | 4.57 | 81.6 | 866 | 4.46 | 5.66 | 202 | 948 |
| manganese | 1.5 | | 0.506 | 0.731 | 1.48 | 0.295 | 0.289 | <0.10 | 1.04 | 1.4 | 2.45 | 2.47 | 1.32 | 3.77 | 0.271 | 0.751 | 1.01 | 0.224 | 0.070 | 0.0091 | <0.10 |
| mercury | 0.001 | 0.00025 | <0.00020 | < 0.00002 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | < 0.00002 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | < 0.00002 | <0.00020 |
| molybdenum | 0.25 | 10 | <0.0050 | 0.0007 | <0.020 | <0.020 | <0.020 | <0.10 | 0.0054 | 0.0064 | 0.0061 | 0.006 | 0.0009 | 0.0033 | 0.0018 | <0.010 | <0.10 | 0.0031 | 0.0045 | 0.0028 | <0.10 |
| nickel | 0.08 | 0.083 | <0.025 | 0.005 | <0.10 | <0.10 | <0.10 | <0.50 | 0.006 | 0.006 | 0.005 | 0.004 | 0.003 | 0.003 | 0.002 | <0.050 | <0.50 | <0.0050 | <0.0050 | 0.002 | <0.50 |
| phosphorus | | | 0.40 | < 0.075 | <0.60 | <0.60 | <0.60 | <3.0 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | < 0.075 | <0.30 | <3.0 | <0.30 | <0.30 | < 0.075 | <3.0 |
| potassium | | | 15.7 | 8.42 | 42.6 | 54.2 | 53.3 | 221 | 85.7 | 104 | 0.79 | 0.78 | 0.88 | 1.2 | 3.91 | 35.4 | 254 | <2.0 | <2.0 | 66.4 | 301 |
| rhenium | | | - | < 0.0005 | - | - | - | - | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.0005 | <0.0005 | < 0.0005 | - | - | - | - | < 0.0005 | - |
| rubidium | | | - | 0.0029 | - | - | - | - | 0.03 | 0.034 | 0.0005 | 0.0005 | 0.0007 | 0.001 | 0.0012 | - | - | - | - | 0.024 | - |
| selenium | 0.01 | 0.02 | <0.0050 | < 0.001 | <0.040 | <0.040 | <0.040 | <0.20 | < 0.001 | 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.020 | <0.20 | <0.0010 | <0.0010 | < 0.001 | <0.20 |
| silicon | | | 7.72 | 5.2 | 6.60 | 4.88 | 4.77 | 2.71 | 2.6 | 2.4 | 10.9 | 10.9 | 12.5 | 13.7 | 5.6 | 5.20 | 2.23 | 5.04 | 6.62 | 2.3 | 1.82 |
| silver | 0.02 | 0.015 | <0.00025 | < 0.0002 | <0.0010 | <0.0010 | <0.0010 | <0.0050 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | <0.00050 | <0.0050 | <0.000050 | <0.000050 | < 0.0002 | <0.0050 |
| sodium | 200[i] | | 287 | 97.8 | 1210 | 1270 | 1250 | 6310 | 2800 | 3450 | 12.5 | 12.9 | 11 | 18.1 | 73.4 | 869 | 7520 | 33.6 | 70.1 | 1910 | 8590 |
| strontium | 2.5 | | 0.299 | 0.209 | 1.50 | 0.839 | 0.827 | 4.79 | 2.8 | 3.43 | 0.248 | 0.256 | 0.304 | 0.35 | 0.051 | 0.524 | 5.37 | 0.209 | 0.289 | 1.71 | 5.75 |
| sulphur | | | - | 10 | - | - | - | - | 249 | 310 | < 5 | < 5 | <5 | <5 | < 5 | - | - | - | - | 166 | - |
| tellurium | | | - | < 0.001 | - | - | - | - | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.001 | <0.001 | < 0.001 | - | - | - | - | < 0.001 | - |
| thallium | | 0.003 | <0.0010 | < 0.0001 | <0.0040 | <0.0040 | <0.0040 | <0.020 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | <0.0020 | <0.020 | <0.00020 | <0.00020 | < 0.0001 | <0.020 |
| thorium | | | - | 0.0005 | - | - | - | - | 0.0012 | 0.0013 | 0.0003 | 0.0003 | 0.0004 | 0.0004 | 0.0005 | - | - | - | - | 0.0011 | - |
| tin | 2.5 | | <0.030 | < 0.0005 | <0.060 | <0.060 | <0.060 | <0.30 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | <0.0006 | <0.0006 | < 0.0005 | <0.030 | <0.30 | <0.030 | <0.030 | < 0.0005 | <0.30 |
| titanium | | 1 | <0.050 | 0.001 | <0.10 | <0.10 | <0.10 | <0.50 | 0.004 | 0.005 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.002 | <0.050 | <0.50 | <0.050 | <0.050 | 0.003 | <0.50 |
| tungsten | | | - | < 0.0005 | - | - | - | - | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | 0.005 | 0.005 | < 0.0005 | - | - | - | - | < 0.0005 | - |
| uranium | 0.02 | 0.085 | <0.0010 | < 0.00025 | <0.0040 | <0.0040 | <0.0040 | <0.020 | 0.001 | 0.0012 | 0.0003 | 0.0003 | < 0.00025 | 0.0003 | < 0.00025 | <0.0020 | <0.020 | 0.00190 | 0.00252 | 0.0006 | <0.020 |
| vanadium | 0.02 | | <0.030 | < 0.0005 | <0.060 | <0.060 | <0.060 | <0.30 | < 0.0005 | < 0.0005 | 0.0009 | 0.0008 | 0.0007 | 0.0015 | 0.0015 | <0.030 | <0.30 | <0.030 | <0.030 | < 0.0005 | <0.30 |
| zinc | 3 | 0.1 | 0.0081 | 0.011 | 0.013 | <0.010 | <0.010 | <0.050 | < 0.005 | < 0.005 | 0.005 | 0.005 | < 0.005 | 0.01 | 0.005 | <0.0050 | <0.050 | <0.0050 | <0.0050 | < 0.005 | <0.050 |
| zirconium | | | | < 0.0005 | | | | | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | | | | | < 0.0005 | |

Notes:
All concentrations in milligrams per litre (mg/L), unless otherwise noted.
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
H = standard is Hardness dependent, Cl = standard is chloride dependent, i= sta
V= Standard is valence dependent VI refers to chromium VI and III refers to chrc
FDA = field duplicate available; FD = field duplicate; SCN = sample control num
italics indicate the concentration exceeds the laboratory detection limit.
*Background concentration for lithium and coblat as detailed in Technical Bulleti

| | |
|---|---|
| 1 | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| 1 | Exceeds CSR Standards for DW and AV |

**TABLE4b**
**Results of Groundwater Monitoring Analyses**
**Ladysmith Harbour, Ladysmith, BC**
**Hydrocarbons**

| Location | CSR Standards for DW | CSR Standards for AW-M | MW00-2 | MW00-04 | MW00-09 | MW00-11 | MW05-02 | MW05-04 | MW05-08 | MW05-09 | MW05-12 | MW05-17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCN | | | 21367-04 | 21382-03 | 21382-02 | 21382-01 | 21369-04 | 21369-05 | 21369-02 | 21369-03 | 21369-08 | 21369-01 |
| Date | | | 18-Nov-09 | 10-Dec-09 | 10-Dec-09 | 10-Dec-09 | 25-Nov-09 | 25-Nov-09 | 25-Nov-09 | 25-Nov-09 | 25-Nov-09 | 25-Nov-09 |
| QA/QC | | | | | | | | | | | | |
| **Parameters** | | | | | | | | | | | | |
| pH (field) (pH units) | | | 7.55 | 6.66 | 6.33 | 7.33 | 7.04 | 7.06 | 6.74 | 7.23 | 6.6 | 7.51 |
| Temperature (°C) | | | 10.8 | 8.69 | 9.21 | 10.4 | 9.4 | 10.62 | 10.9 | 13.61 | 12.61 | 11.32 |
| Conductivity (µS/cm) | | | 242 | 230 | 96 | 386 | 531 | 510 | 1054 | 9547 | 1331 | 33734 |
| Redox (mV) | | | 31.6 | -62.7 | 144.2 | 18.7 | -15.9 | -34 | -39.2 | 17.3 | 110.9 | -219.6 |
| Dissolved Oxygen (%) | | | 11.7 | 2.91 | 4.41 | 2.67 | 10.9 | 9.4 | 13.9 | 18.6 | 21.1 | 14.4 |
| hardness (mg/L) | | | 125 | 101 | 56 | 198 | 233 | 307 | 435 | 944 | 790 | 1570 |
| **Monoaromatic Hydrocarbons** | | | | | | | | | | | | |
| benzene | **5** | 1,000 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| ethylbenzene | 140 | 2,500 | 0.2 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| styrene | 800 | 720 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| toluene | **60** | 2,000 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| ortho-Xylene | | | - | - | - | - | - | - | - | - | - | - |
| meta- & para-Xylene | | | - | - | - | - | - | - | - | - | - | - |
| total xylene | **90** | 300 | 1.3 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| Methyl t-butyl ether (MTBE) | 95 | 4400 | - | - | - | - | - | - | - | - | - | - |
| $VH_{w6-10}$ | 15,000 | 15,000 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 |
| $VPH_w$ | | 1,500 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | |
| acenaphthene | 250 | 60 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| acenaphthylene | | | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| acridine | | 0.5 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| anthracene | 1000 | 1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| benzo(a)anthracene | 0.07 | 1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| benzo(a)pyrene | **0.01** | 0.1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | *< 0.02* | *< 0.02* | *< 0.02* | *< 0.02* | *< 0.02* | *< 0.02* |
| benzo(b)fluoranthene | **0.07** | | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| benzo(g,h,i)perylene | | | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| benzo(k)fluoranthene | | | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| chrysene | 7 | 1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| dibenzo(a,h)anthracene | 0.1 | | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| fluoranthene | 150 | 2 | < 0.04 | < 0.04 | < 0.04 | < 0.04 | < 0.08 | < 0.08 | < 0.08 | < 0.08 | < 0.08 | < 0.08 |
| fluorene | 150 | 120 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| indeno(1,2,3-c,d)pyrene | | | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| naphthalene | 80 | 10 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.6 | < 0.6 | < 0.6 | < 0.6 | < 0.6 | < 0.6 |
| phenanthrene | | 3 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| pyrene | 100 | 0.2 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.04 | < 0.04 | < 0.04 | < 0.04 | < 0.04 | < 0.04 |
| quinoline | 0.5 | 34 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | *< 1* | *< 1* | *< 1* | *< 1* | *< 1* | *< 1* |
| **Other Hydrocarbons** | | | | | | | | | | | | |
| $EPHw_{10-19}$ | 5,000 | 5,000 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 |
| $EPHw_{19-32}$ | | | 600 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 |
| LEPHw | | 500 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 |
| HEPH | | | 600 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 | < 250 |

| Location | MW05-20 | MW05-22 | MW09-1 | MW09-2 | MW09-3 | MW09-03 | MW09-4 | MW09-5 | MW09-6 |
|---|---|---|---|---|---|---|---|---|---|
| SCN | 21369-07 | 21369-06 | 21367-01 | 21367-02 | 21367-03 | 21382-04 | 21367-07 | 21367-08 | 21368-03 |
| Date | 25-Nov-09 | 25-Nov-09 | 18-Nov-09 | 18-Nov-09 | 18-Nov-09 | 10-Dec-09 | 19-Nov-09 | 19-Nov-09 | 20-Nov-09 |
| QA/QC | | | | | | | | | |
| **Parameters** | | | | | | | | | |
| pH (field) (pH units) | 8.4 | 6.59 | 7.97 | 7.36 | 7.69 | 7.31 | 7.64 | 7.6 | 6.76 |
| Temperature (°C) | 9.4 | 11.12 | 10.29 | 10.44 | 10.44 | 11.7 | 12.8 | 10.33 | 11.2 |
| Conductivity (µS/cm) | 900 | 1032 | 301 | 370 | 390 | 355 | 460 | 410 | 411 |
| Redox (mV) | -121.6 | -61.6 | -130.6 | -80 | -121.6 | -116.9 | 45.3 | -50.4 | 31 |
| Dissolved Oxygen (%) | 60.2 | 9.6 | 36 | 23.6 | 14.3 | 1.56 | 8.9 | 11 | - |
| hardness (mg/L) | 86 | 688 | 106 | 151 | 144 | - | 206 | 175 | - |
| **Monoaromatic Hydrocarbons** | | | | | | | | | |
| benzene | < 0.1 | < 0.1 | **56** | < 0.1 | < 0.1 | - | < 0.1 | 0.2 | - |
| ethylbenzene | < 0.1 | < 0.1 | 87 | 0.3 | < 0.1 | - | < 0.1 | < 0.1 | - |
| styrene | < 0.1 | < 0.1 | < 1 | < 0.1 | < 0.1 | - | < 0.1 | < 0.1 | - |
| toluene | < 0.1 | < 0.1 | **198** | 0.2 | < 0.1 | - | < 0.1 | 0.2 | - |
| ortho-Xylene | - | - | - | - | - | - | - | - | - |
| meta- & para-Xylene | - | - | - | - | - | - | - | - | - |
| total xylene | < 0.1 | < 0.1 | **1,200** | 2.1 | 0.4 | - | < 0.1 | < 0.1 | - |
| Methyl t-butyl ether (MTBE) | - | - | - | - | - | - | - | - | - |
| $VH_{w6-10}$ | < 100 | < 100 | 5,300 | < 100 | < 100 | - | < 100 | < 100 | - |
| $VPH_w$ | < 100 | < 100 | 3,800 | < 100 | < 100 | - | < 100 | < 100 | - |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | |
| acenaphthene | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 | - | < 0.1 | < 0.1 | < 0.1 |
| acenaphthylene | < 0.2 | < 0.2 | < 0.1 | < 0.1 | < 0.1 | - | < 0.1 | < 0.1 | < 0.1 |
| acridine | < 0.1 | < 0.1 | < 0.05 | < 0.05 | < 0.05 | - | < 0.05 | < 0.05 | < 0.05 |
| anthracene | < 0.02 | < 0.02 | 0.01 | < 0.01 | < 0.01 | - | < 0.01 | 0.02 | < 0.01 |
| benzo(a)anthracene | < 0.02 | < 0.02 | < 0.01 | < 0.01 | < 0.01 | - | < 0.01 | 0.01 | < 0.01 |
| benzo(a)pyrene | *< 0.02* | *< 0.02* | < 0.01 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 |
| benzo(b)fluoranthene | < 0.02 | < 0.02 | < 0.01 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 |
| benzo(g,h,i)perylene | < 0.02 | < 0.02 | 0.01 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 |
| benzo(k)fluoranthene | < 0.02 | < 0.02 | < 0.01 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 |
| chrysene | < 0.02 | < 0.02 | < 0.01 | < 0.01 | < 0.01 | - | < 0.01 | 0.01 | < 0.01 |
| dibenzo(a,h)anthracene | < 0.02 | < 0.02 | < 0.01 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 |
| fluoranthene | < 0.08 | < 0.08 | < 0.04 | < 0.04 | < 0.04 | - | < 0.04 | 0.05 | < 0.04 |
| fluorene | < 0.1 | < 0.1 | < 0.05 | < 0.05 | 0.06 | - | < 0.05 | 0.06 | < 0.05 |
| indeno(1,2,3-c,d)pyrene | < 0.02 | < 0.02 | 0.01 | < 0.01 | < 0.01 | - | < 0.01 | < 0.01 | < 0.01 |
| naphthalene | < 0.6 | < 0.6 | 8.9 | 0.4 | 0.4 | - | < 0.3 | 0.5 | < 0.3 |
| phenanthrene | < 0.1 | < 0.1 | 0.06 | < 0.05 | 0.06 | - | < 0.05 | 0.12 | < 0.05 |
| pyrene | < 0.04 | < 0.04 | < 0.02 | < 0.02 | < 0.02 | - | < 0.02 | 0.04 | 0.03 |
| quinoline | *< 1* | *< 1* | < 0.5 | < 0.5 | < 0.5 | - | < 0.5 | < 0.5 | < 0.5 |
| **Other Hydrocarbons** | | | | | | | | | |
| $EPHw_{10-19}$ | < 250 | < 250 | 370 | < 250 | < 250 | - | < 250 | < 250 | < 250 |
| $EPHw_{19-32}$ | < 250 | < 250 | < 250 | < 250 | < 250 | - | < 250 | < 250 | < 250 |
| LEPHw | < 250 | < 250 | 360 | < 250 | < 250 | - | < 250 | < 250 | < 250 |
| HEPH | < 250 | < 250 | < 250 | < 250 | < 250 | - | < 250 | < 250 | < 250 |

Notes:
All concentrations in micrograms per litre (µg/L), unless otherwise noted.
Standards shown from the Contaminated Sites Regulation (“CSR”; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019).
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
EPHC10-19 = extractable petroleum hydrocarbons, carbon range 10-19
EPHC19-32 = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
PAH = Polycyclic Aromatic Hydrocarbons
VPH = volatile petroleum hydrocarbons
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
*italics* indicate the concentration exceeds the laboratory detection limit.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and AW-M |

**TABLE4b**
**Results of Groundwater Monitoring Analyses**
**Ladysmith Harbour, Ladysmith, BC**
**Hydrocarbons**



| Location | CSR Standards for DW | CSR Standards for AW-M | MW09-07 | MW09-07 | MW09-7 | MW09-08 | MW09-08 | MW09-8 | MW09-8 | MW09-08 | MW09-9 | MW09-9 | MW09-10 | MW09-11 | MW09-16 | MW11-01 | MW11-01 | MW11-02 | MW11-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCN | | | 0531-01 | 0532-01 | 21368-07 | 0531-02 | 0531-03 | 21368-05 | 21368-06 | 0532-02 | 21369-09 | 21369-10 | 21367-05 | 21367-06 | 21368-02 | 0531-04 | 0532-03 | 0531-05 | 0532-04 |
| Date | | | 16-Feb-11 | 22-Feb-11 | 20-Nov-09 | 16-Feb-11 | 16-Feb-11 | 20-Nov-09 | 20-Nov-09 | 22-Feb-11 | 25-Nov-09 | 25-Nov-09 | 19-Nov-09 | 19-Nov-09 | 20-Nov-09 | 16-Feb-11 | 22-Feb-11 | 16-Feb-11 | 22-Feb-11 |
| QA/QC | | | | | | FDA | FD | FDA | FD | | FDA | FD | | | | | | | |
| **Parameters** | | | | | | | | | | | | | | | | | | | |
| pH (field) (pH units) | | | 6.34 | 6.49 | 7.22 | 6.99 | 6.99 | 6.92 | 6.92 | 6.68 | 6.75 | 6.75 | 8.13 | 7.88 | 7.62 | 7.69 | 6.76 | 8.05 | 7.87 |
| Temperature (°C) | | | 6.6 | 6.2 | 11.33 | 7.77 | 7.77 | 9.66 | 9.66 | 6.84 | 10.3 | 10.3 | 11.49 | 11.31 | 10.51 | 6.6 | 5.1 | 10.2 | 10.03 |
| Conductivity (µS/cm) | | | 2960 | 4100 | 1420 | 8360 | 8360 | 14210 | 14210 | 33841 | 402 | 402 | 401 | 410 | 347 | 4223 | 41100 | 402 | 437 |
| Redox (mV) | | | - | - | 13 | -95.9 | -95.9 | 45.1 | 45.1 | 65.9 | -54.8 | -54.8 | 6.7 | 12.6 | 24.7 | 192.9 | - | 158.7 | 51.3 |
| Dissolved Oxygen (%) | | | - | - | 8.91 | - | - | 6.7 | 6.7 | 2.325 | 7.87 | 7.87 | 10.9 | 7.1 | 10.7 | - | - | - | - |
| hardness (mg/L) | | | 185 | - | 102 | 694 | 684 | 1480 | 1890 | - | 149 | 149 | 149 | 145 | 32 | 425 | - | 83.5 | - |
| **Monoaromatic Hydrocarbons** | | | | | | | | | | | | | | | | | | | |
| benzene | **5** | 1,000 | 1.07 | 1.45 | 1 | <0.50 | <0.50 | < 0.1 | < 0.1 | <0.50 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | - | <0.50 | <0.50 | <0.50 | <0.50 |
| ethylbenzene | 140 | 2,500 | 0.59 | <0.50 | 2.3 | <0.50 | <0.50 | < 0.1 | < 0.1 | <0.50 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | - | <0.50 | <0.50 | <0.50 | <0.50 |
| styrene | 800 | 720 | <0.50 | <0.50 | < 0.1 | <0.50 | <0.50 | < 0.1 | < 0.1 | <0.50 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | - | <0.50 | <0.50 | <0.50 | <0.50 |
| toluene | **60** | 2,000 | <1.0 | <1.0 | < 0.1 | <1.0 | <1.0 | < 0.1 | < 0.1 | <1.0 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | - | <1.0 | <1.0 | <1.0 | <1.0 |
| ortho-Xylene | | | <0.50 | <0.50 | - | <0.50 | <0.50 | - | - | <0.50 | - | - | - | - | - | <0.50 | <0.50 | <0.50 | <0.50 |
| meta- & para-Xylene | | | <0.50 | <0.50 | - | <0.50 | <0.50 | - | - | <0.50 | - | - | - | - | - | <0.50 | <0.50 | <0.50 | <0.50 |
| total xylene | **90** | 300 | <0.71 | <0.71 | 0.5 | <0.71 | <0.71 | < 0.1 | < 0.1 | <0.71 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | - | <0.71 | <0.71 | <0.71 | <0.71 |
| Methyl t-butyl ether (MTBE) | 95 | 4400 | <1.0 | <1.0 | - | <1.0 | <1.0 | - | - | <1.0 | - | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| $VH_{w6-10}$ | 15,000 | 15,000 | 140 | 240 | 170 | <100 | <100 | < 100 | < 100 | <100 | < 100 | < 100 | < 100 | < 100 | - | <100 | <100 | <100 | <100 |
| $VPH_w$ | | 1,500 | 140 | 240 | 170 | <100 | <100 | < 100 | < 100 | <100 | < 100 | < 100 | < 100 | < 100 | - | <100 | <100 | <100 | <100 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | | | | | | | | |
| acenaphthene | 250 | 60 | 0.252 | 0.257 | < 0.1 | 0.898 | 0.931 | < 0.1 | < 0.1 | 0.128 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | 0.098 | <0.050 | <0.050 | <0.050 |
| acenaphthylene | | | <0.050 | <0.050 | < 0.1 | <0.050 | <0.050 | < 0.1 | < 0.1 | <0.050 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | 0.084 | <0.050 | <0.050 | <0.050 |
| acridine | | 0.5 | <0.070 | <0.050 | < 0.05 | <0.13 | <0.13 | < 0.05 | < 0.05 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.060 | <0.050 | <0.050 | <0.050 |
| anthracene | 1000 | 1 | <0.050 | <0.050 | < 0.01 | <0.10 | <0.10 | 0.06 | 0.05 | <0.050 | 0.05 | 0.04 | < 0.01 | < 0.01 | < 0.01 | 0.145 | <0.050 | <0.050 | <0.050 |
| benzo(a)anthracene | 0.07 | 1 | <0.050 | <0.050 | < 0.01 | <0.050 | <0.050 | 0.05 | 0.04 | <0.050 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | 0.369 | <0.050 | <0.050 | <0.050 |
| benzo(a)pyrene | **0.01** | 0.1 | *<0.020* | <0.010 | < 0.01 | *<0.030* | <0.010 | **0.03** | **0.03** | *<0.020* | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | **0.399** | <0.020 | <0.010 | <0.020 |
| benzo(b)fluoranthene | **0.07** | | <0.050 | <0.050 | < 0.01 | <0.050 | <0.050 | **0.09** | 0.07 | <0.050 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | **0.467** | <0.050 | <0.050 | <0.050 |
| benzo(g,h,i)perylene | | | <0.050 | <0.050 | < 0.01 | <0.050 | <0.050 | 0.03 | 0.04 | <0.050 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | 0.267 | <0.050 | <0.050 | <0.050 |
| benzo(k)fluoranthene | | | <0.050 | <0.050 | < 0.01 | <0.050 | <0.050 | 0.03 | 0.03 | <0.050 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | 0.184 | <0.050 | <0.050 | <0.050 |
| chrysene | 7 | 1 | <0.050 | <0.050 | < 0.01 | <0.050 | <0.050 | 0.1 | 0.08 | <0.050 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | 0.446 | <0.050 | <0.050 | <0.050 |
| dibenzo(a,h)anthracene | 0.1 | | <0.050 | <0.050 | < 0.01 | <0.050 | <0.050 | 0.01 | < 0.01 | <0.050 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | 0.054 | <0.050 | <0.050 | <0.050 |
| fluoranthene | 150 | 2 | <0.050 | <0.050 | < 0.04 | <0.050 | <0.050 | 0.22 | 0.2 | <0.050 | < 0.04 | < 0.04 | < 0.04 | < 0.04 | < 0.04 | 0.929 | <0.050 | <0.050 | <0.050 |
| fluorene | 150 | 120 | 0.279 | 0.235 | 0.05 | <0.050 | <0.050 | < 0.05 | < 0.05 | <0.050 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.081 | <0.050 | <0.050 | <0.050 |
| indeno(1,2,3-c,d)pyrene | | | <0.050 | <0.050 | < 0.01 | <0.050 | <0.050 | 0.03 | 0.03 | <0.050 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | 0.292 | <0.050 | <0.050 | <0.050 |
| naphthalene | 80 | 10 | <0.82 | <0.37 | < 0.3 | <0.64 | <0.29 | < 0.3 | < 0.3 | <0.050 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | <0.96 | <0.050 | <0.43 | <0.070 |
| phenanthrene | | 3 | 0.193 | <0.050 | < 0.05 | <0.050 | <0.050 | 0.12 | 0.12 | <0.050 | 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.399 | <0.050 | <0.050 | <0.050 |
| pyrene | 100 | 0.2 | <0.050 | <0.050 | 0.02 | 0.054 | 0.056 | **0.23** | **0.23** | <0.050 | 0.03 | 0.03 | < 0.02 | < 0.02 | < 0.02 | **0.854** | <0.050 | <0.050 | <0.050 |
| quinoline | 0.5 | 34 | 0.138 | <0.31 | < 0.5 | <0.050 | <0.050 | < 0.5 | < 0.5 | <0.050 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | <0.050 | <0.050 | <0.050 | <0.050 |
| **Other Hydrocarbons** | | | | | | | | | | | | | | | | | | | |
| $EPHw_{10-19}$ | 5,000 | 5,000 | <430 | <250 | < 250 | <340 | <280 | < 250 | < 250 | <250 | < 250 | < 250 | < 250 | < 250 | < 250 | <250 | <250 | <250 | <250 |
| $EPHw_{19-32}$ | | | <380 | <250 | < 250 | <510 | <250 | 300 | 260 | <250 | < 250 | < 250 | < 250 | < 250 | 280 | 1280 | <250 | <350 | 330 |
| LEPHw | | 500 | <430 | <250 | < 250 | <340 | <280 | < 250 | < 250 | <250 | < 250 | < 250 | < 250 | < 250 | < 250 | <250 | <250 | <250 | <250 |
| HEPH | | | <380 | <250 | < 250 | <510 | <250 | 300 | 260 | <250 | < 250 | < 250 | < 250 | < 250 | 280 | 1280 | <250 | <350 | 330 |

Notes:
All concentrations in micrograms per litre (µg/L), unless otherwise noted.
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
EPHC10-19 = extractable petroleum hydrocarbons, carbon range 10-19
EPHC19-32 = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
PAH = Polycyclic Aromatic Hydrocarbons
VPH = volatile petroleum hydrocarbons
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
*italics* indicate the concentration exceeds the laboratory detection limit.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and |

**TABLE 4c**
**Results of Groundwater Monitoring Analyses**
**Ladysmith Harbour, Ladysmith, BC**
**VOCs**

| Location<br>SCN<br>Date<br>QA/QC | CSR Stanards for DW | CSR standards for AW-M | MW09-1<br>21367-01<br>2009-11-18 | MW09-2<br>21367-02<br>2009-11-18 | MW09-3<br>21367-03<br>2009-11-18 | MW00-2<br>21367-04<br>2009-11-18 | MW09-10<br>21367-05<br>2009-11-19 | MW09-11<br>21367-06<br>2009-11-19 | MW09-4<br>21367-07<br>2009-11-19 | MW09-5<br>21367-08<br>2009-11-19 | MW09-16<br>21368-02<br>2009-11-20 | MW09-6<br>21368-03<br>2009-11-20<br>FDA | MW09-6<br>21368-04<br>2009-11-20<br>FD | MW09-07<br>0531-01<br>2011-02-16 | MW09-07<br>0532-01<br>2011-02-22 | MW09-08<br>0531-02<br>2011-02-16<br>FDA | MW09-08<br>0531-03<br>2011-02-16<br>FD | MW09-8<br>21368-05<br>2009-11-20<br>FDA | MW09-8<br>21368-06<br>2009-11-20<br>FD | MW09-7<br>21368-07<br>2009-11-20 | MW05-17<br>21369-01<br>2009-11-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameters** | | | | | | | | | | | | | | | | | | | | | |
| pH (field) (pH units) | | | 7.97 | 7.36 | 7.69 | 7.55 | 8.13 | 7.88 | 7.64 | 7.6 | 7.62 | 6.76 | 6.76 | 6.34 | 6.49 | 6.99 | 6.99 | 6.92 | 6.92 | 7.22 | 7.51 |
| Temperature (°C) | | | 10.29 | 10.44 | 10.44 | 10.8 | 11.49 | 11.31 | 12.8 | 10.33 | 10.51 | 11.2 | 11.2 | 6.6 | 6.2 | 7.77 | 7.77 | 9.66 | 9.66 | 11.33 | 11.32 |
| Conductivity (µS/cm) | | | 301 | 370 | 390 | 242 | 401 | 410 | 460 | 410 | 347 | 411 | 411 | 2960 | 4100 | 8360 | 8360 | 14210 | 14210 | 1420 | 33734 |
| Redox (mV) | | | -130.6 | -80 | -121.6 | 31.6 | 6.7 | 12.6 | 45.3 | -50.4 | 24.7 | 31 | 31 | - | - | -95.9 | -95.9 | 45.1 | 45.1 | 13 | -219.6 |
| Dissolved Oxygen (%) | | | 36 | 23.6 | 14.3 | 11.7 | 10.9 | 7.1 | 8.9 | 11 | 10.7 | - | - | - | - | - | - | 6.7 | 6.7 | 8.91 | 14.4 |
| hardness (mg/L) | | | 106 | 151 | 144 | 125 | 149 | 145 | 206 | 175 | 32 | - | - | 185 | - | 694 | 684 | 1480 | 1890 | 102 | 1570 |
| **Halogenated Hydrocarbons** | | | | | | | | | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 8000 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| 1,1,2,2-Tetrachloroethane | 0.8 | | - | - | - | - | - | - | - | < 0.2 | - | - | - | *<1.0* | *<1.0* | *<1.0* | *<1.0* | < 0.2 | - | - | - |
| 1,1,2-Trichloroethane | 3 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <2.0 | *<4.0* | <1.0 | <1.0 | < 0.1 | - | - | - |
| 1,1-Dichloroethane | 30 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| 1,1-Dichloroethylene | 14 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| 1,2-Dibromoethane | 0.5 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | - | - | - | - | < 0.1 | - | - | - |
| 1,2-Dichlorobenzene | 200 | 420 | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| 1,2-Dichloroethane | 5 | 1000 | - | - | - | - | - | - | - | < 0.4 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.4 | - | - | - |
| 1,2-Dichloropropane | 4.5 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| 1,3-Dichlorobenzene | | 1,500 | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| 1,4-Dichlorobenzene | 5 | 260 | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| 2-Butanone | 2500 | | - | - | - | - | - | - | - | < 5 | - | - | - | - | - | - | - | < 5 | - | - | - |
| 2-Hexanone | 20 | | - | - | - | - | - | - | - | < 20 | - | - | - | - | - | - | - | < 20 | - | - | - |
| 4-Methyl-2-pentanone | | | - | - | - | - | - | - | - | < 2 | - | - | - | - | - | - | - | < 2 | - | - | - |
| Bromodichloromethane | 100 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| Bromoform | 100 | | - | - | - | - | - | - | - | < 0.2 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.2 | - | - | - |
| Bromomethane | 5.5 | | - | - | - | - | - | - | - | < 0.8 | - | - | - | - | - | - | - | < 0.8 | - | - | - |
| Carbon Tetrachloride | 2 | 130 | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| Chlorobenzene | 80 | 250 | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| Chloroethane | | | - | - | - | - | - | - | - | < 0.4 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.4 | - | - | - |
| Chloroform | 100 | 20 | - | - | - | - | - | - | - | < 0.3 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.3 | - | - | - |
| Chloromethane | | | - | - | - | - | - | - | - | < 0.4 | - | - | - | <5.0 | <5.0 | <5.0 | <5.0 | < 0.4 | - | - | - |
| cis-1,2-Dichloroethylene | 8 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| cis-1,3-Dichloropropene | 1.5 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| Dibromochloromethane | 100 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| Dibromomethane | | | - | - | - | - | - | - | - | < 0.2 | - | - | - | <5.0 | <5.0 | <5.0 | <5.0 | < 0.2 | - | - | - |
| Dichlorodifluoromethane | 800 | | - | - | - | - | - | - | - | < 0.2 | - | - | - | - | - | - | - | < 0.2 | - | - | - |
| Methylene Chloride | 50 | 980 | - | - | - | - | - | - | - | < 6 | - | - | - | - | - | - | - | < 6 | - | - | - |
| Tetrachloroethylene | 30 | 1,100 | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| trans-1,2-Dichloroethylene | 80 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| trans-1,3-Dichloropropene | 1.5 | | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| Trichloroethylene | 5 | 200 | - | - | - | - | - | - | - | < 0.1 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.1 | - | - | - |
| Trichlorofluoromethane | 1000 | | - | - | - | - | - | - | - | < 0.2 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.2 | - | - | - |
| Vinyl Chloride | 2 | | - | - | - | - | - | - | - | < 0.2 | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 | < 0.2 | - | - | - |

Notes:
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Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, updated to 16 April 2019).
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
*italics* indicate the concentration exceeds the laboratory detection limit.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and AW-M |

**TABLE 4c**
**Results of Groundwater Monitoring Analyses**
**Ladysmith Harbour, Ladysmith, BC**
**VOCs**

| Location / SCN / Date / QA/QC | CSR Stanards for DW | CSR standards for AW-M | MW05-08 21369-02 2009-11-25 | MW05-09 21369-03 2009-11-25 | MW05-02 21369-04 2009-11-25 | MW05-04 21369-05 2009-11-25 | MW05-22 21369-06 2009-11-25 | MW05-20 21369-07 2009-11-25 | MW05-12 21369-08 2009-11-25 | MW09-08 0532-02 2011-02-22 | MW09-9 21369-09 2009-11-25 FDA | MW09-9 21369-10 2009-11-25 FD | MW00-11 21382-01 2009-12-10 | MW00-09 21382-02 2009-12-10 | MW00-04 21382-03 2009-12-10 | MW09-03 21382-04 2009-12-10 | MW11-01 0531-04 2011-02-16 | MW11-01 0532-03 2011-02-22 | MW11-02 0531-05 2011-02-16 | MW11-02 0532-04 2011-02-22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameters** | | | | | | | | | | | | | | | | | | | | |
| pH (field) (pH units) | | | 6.74 | 7.23 | 7.04 | 7.06 | 6.59 | 8.4 | 6.6 | 6.68 | 6.75 | 6.75 | 7.33 | 6.33 | 6.66 | 7.31 | 7.69 | 6.76 | 8.05 | 7.87 |
| Temperature (°C) | | | 10.9 | 13.61 | 9.4 | 10.62 | 11.12 | 9.4 | 12.61 | 6.84 | 10.3 | 10.3 | 10.4 | 9.21 | 8.69 | 11.7 | 6.6 | 5.1 | 10.2 | 10.03 |
| Conductivity (µS/cm) | | | 1054 | 9547 | 531 | 510 | 1032 | 900 | 1331 | 33841 | 402 | 402 | 386 | 96 | 230 | 355 | 4223 | 41100 | 402 | 437 |
| Redox (mV) | | | -39.2 | 17.3 | -15.9 | -34 | -61.6 | -121.6 | 110.9 | 65.9 | -54.8 | -54.8 | 18.7 | 144.2 | -62.7 | -116.9 | 192.9 | - | 158.7 | 51.3 |
| Dissolved Oxygen (%) | | | 13.9 | 18.6 | 10.9 | 9.4 | 9.6 | 60.2 | 21.1 | 2.325 | 7.87 | 7.87 | 2.67 | 4.41 | 2.91 | 1.56 | - | - | - | - |
| hardness (mg/L) | | | 435 | 944 | 233 | 307 | 688 | 86 | 790 | - | 149 | 149 | 198 | 56 | 101 | - | 425 | - | 83.5 | - |
| **Halogenated Hydrocarbons** | | | | | | | | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 8000 | | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,1,2,2-Tetrachloroethane | 0.8 | | - | - | - | - | - | - | - | *<1.0* | < 0.1 | < 0.1 | - | - | - | - | *<1.0* | *<1.0* | *<1.0* | *<1.0* |
| 1,1,2-Trichloroethane | 3 | | - | - | - | - | - | - | - | <1.0 | < 0.2 | < 0.2 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,1-Dichloroethane | 30 | | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,1-Dichloroethylene | 14 | | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,2-Dibromoethane | 0.5 | | - | - | - | - | - | - | - | - | < 0.1 | < 0.1 | - | - | - | - | - | - | - | - |
| 1,2-Dichlorobenzene | 200 | 420 | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,2-Dichloroethane | 5 | 1000 | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,2-Dichloropropane | 4.5 | | - | - | - | - | - | - | - | <1.0 | < 0.4 | < 0.4 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,3-Dichlorobenzene | | 1,500 | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,4-Dichlorobenzene | 5 | 260 | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| 2-Butanone | 2500 | | - | - | - | - | - | - | - | - | < 0.1 | < 0.1 | - | - | - | - | - | - | - | - |
| 2-Hexanone | 20 | | - | - | - | - | - | - | - | - | < 5 | < 5 | - | - | - | - | - | - | - | - |
| 4-Methyl-2-pentanone | | | - | - | - | - | - | - | - | - | < 2 | < 2 | - | - | - | - | - | - | - | - |
| Bromodichloromethane | 100 | | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Bromoform | 100 | | - | - | - | - | - | - | - | <1.0 | < 0.2 | < 0.2 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Bromomethane | 5.5 | | - | - | - | - | - | - | - | - | < 0.8 | < 0.8 | - | - | - | - | - | - | - | - |
| Carbon Tetrachloride | 2 | 130 | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Chlorobenzene | 80 | 250 | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Chloroethane | | | - | - | - | - | - | - | - | <1.0 | < 0.4 | < 0.4 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Chloroform | 100 | 20 | - | - | - | - | - | - | - | <1.0 | < 0.3 | < 0.3 | - | - | - | - | <1.0 | <1.0 | 24.1 | 3.7 |
| Chloromethane | | | - | - | - | - | - | - | - | <5.0 | < 0.4 | < 0.4 | - | - | - | - | <5.0 | <5.0 | <5.0 | <5.0 |
| cis-1,2-Dichloroethylene | 8 | | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| cis-1,3-Dichloropropene | 1.5 | | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Dibromochloromethane | 100 | | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Dibromomethane | | | - | - | - | - | - | - | - | <5.0 | < 0.2 | < 0.2 | - | - | - | - | <5.0 | <5.0 | <5.0 | <5.0 |
| Dichlorodifluoromethane | 800 | | - | - | - | - | - | - | - | - | < 0.2 | < 0.2 | - | - | - | - | - | - | - | - |
| Methylene Chloride | 50 | 980 | - | - | - | - | - | - | - | - | < 6 | < 6 | - | - | - | - | - | - | - | - |
| Tetrachloroethylene | 30 | 1,100 | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| trans-1,2-Dichloroethylene | 80 | | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| trans-1,3-Dichloropropene | 1.5 | | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Trichloroethylene | 5 | 200 | - | - | - | - | - | - | - | <1.0 | < 0.1 | < 0.1 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Trichlorofluoromethane | 1000 | | - | - | - | - | - | - | - | <1.0 | < 0.2 | < 0.2 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |
| Vinyl Chloride | 2 | | - | - | - | - | - | - | - | <1.0 | < 0.2 | < 0.2 | - | - | - | - | <1.0 | <1.0 | <1.0 | <1.0 |

Notes:
All concentrations in micrograms per litre (µg/L), unless otherwise noted.
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96,
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
*italics* indicate the concentration exceeds the laboratory detection limit.

| | |
|---|---|
| 1 | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| 1 | Exceeds CSR Standards for DW and |

# TABLE 6a
## Historic Seepage Water Results
## - LEPH, HEPH, and PAHs
## Ladysmith Harbour, Ladysmith, BC

| Location<br>SCN<br>Date<br>Source<br>QA/QC | CSR Standards for DW | CSR Standards for AW-M | Seeps (M505-2)<br>0046-03<br>14-Apr-2005<br>Golder |
|---|---|---|---|
| ***Polycyclic Aromatic Hydrocarbons*** | | | |
| Acenaphthene | **0.25** | 0.06 | 0.000056 |
| Acenaphthylene | | | <0.000050 |
| Acridine | | 0.0005 | 0.000069 |
| Anthracene | **1** | 0.001 | 0.000116 |
| Benz(a)anthracene | **0.00007** | 0.001 | **0.000147** |
| Benzo(a)pyrene | **0.00001** | 0.001 | **0.000086** |
| Benzo(b)fluoranthene | **0.00007** | | **0.000133** |
| Benzo(g,h,i)perylene | | | 0.000054 |
| Benzo(k)fluoranthene | | | <0.000050 |
| Chrysene | **0.007** | 0.001 | 0.000251 |
| Dibenzo(a,h)anthracene | **0.0001** | | <0.000050 |
| Fluoranthene | **0.15** | 0.002 | 0.000161 |
| Fluorene | **0.15** | 0.120 | 0.000093 |
| Indeno(1,2,3-c,d)pyrene | | | <0.000050 |
| Naphthalene | **0.08** | 0.01 | 0.000251 |
| Phenanthrene | | 0.003 | 0.00100 |
| Pyrene | **0.1** | 0.0002 | 0.000164 |
| Quinoline | **0.0005** | 0.034 | <0.000050 |
| | | | |
| EPHw10-19 | **5** | 5 | 0.38 |
| EPHw19-32 | | | <1.0 |
| LEPHw | | 0.5 | 0.38 |
| HEPHw | | | <1.0 |

Notes:
All concentrations in micrograms per litre (mg/L), unless otherwise noted.
Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, January 24, 2019).

Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
EPHC10-19 = extractable petroleum hydrocarbons, carbon range 10-19
EPHC19-32 = extractable petroleum hydrocarbons, carbon range 19-32
LEPH = light extractable petroleum hydrocarbons
HEPH = heavy extractable petroleum hydrocarbons
PAH = Polycyclic Aromatic Hydrocarbons
VPH = volatile petroleum hydrocarbons
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
*italics* indicate the concentration exceeds the laboratory detection limit.
LEPH criteria used as a conservate screen for Mineral Oil and Grease and EHw10-19.

Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC. Dated June 30, 2005.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and AW-M |

# TABLE 5b
## Historic Seepage Water Results - Total Metals
## Ladysmith Harbour, Ladysmith, BC

| Location<br>SCN<br>Date<br>Source<br>QA/QC | CSR Standards for DW | CSR Standards for AW-M | Seeps (M505-2)<br>0046-03<br>14-Apr-2005<br>Golder |
|---|---|---|---|
| ***Physical*** | | | |
| Hardness (as $CaCO_3$) | | | 4210 |
| pH | | | 7.7 |
| ***Total Metals*** | | | |
| Aluminum | **9.5** | | <2.0 |
| Antimony | **0.006** | 2.5 | *<0.10* |
| Arsenic | **0.01** | 0.125 | *<0.20* |
| Barium | **1** | 5 | <0.40 |
| Beryllium | **0.008** | 1 | *<0.10* |
| Boron | **5** | 12 | 3.1 |
| Cadmium | **0.005** | 0.015 | *<0.010* |
| Calcium | | | 277 |
| Chromium | **0.05,6[V]** | 0.015,0.56[V] | *<0.10* |
| Cobalt | **0.001** | 0.04 | *<0.10* |
| Copper | **1.5** | 0.02 | *<0.20* |
| Iron | **6.5** | | <0.60 |
| Lead | **0.01** | 0.02 | <0.20 |
| Lithium | **0.033*** | | *<1.0* |
| Magnesium | | | 854 |
| Manganese | **1.5** | | <0.20 |
| Mercury | **0.001** | 0.00025 | <0.00020 |
| Molybdenum | **0.25** | 10 | <0.20 |
| Nickel | **0.080** | 0.083 | *<1.0* |
| Selenium | **0.01** | 0.02 | *<0.20* |
| Silver | **0.02** | 0.015 | <0.010 |
| Sodium | **200[i]** | | **7530** |
| Thallium | | 0.003 | *<0.040* |
| Titanium | | 1 | <1.0 |
| Uranium | **0.02** | 0.085 | *<0.040* |
| Vanadium | **0.02** | | *<0.60* |
| Zinc | **3** | 0.1 | <0.10 |

Notes:
All concentrations in milligrams per litre (mg/L), unless otherwise noted.

Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, January 24, 2019).
Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)
i= standard for sodium ion conservatively applied
V= Standard is valence dependent VI refers to chromium VI and III refers to chromium III
FDA = field duplicate available; FD = field duplicate; SCN = sample control number
italics indicate the concentration exceeds the laboratory detection limit.
*Background concentration for lithium as detailed in BC CSR Technical Bulletin 3 is applied to replace CSR DW Standard.
Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC. Dated June 30, 2005.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and AW-M |

# TABLE 6
## Historical Porewater Results - Total and Dissolved Metals
## Ladysmith Harbour, Ladysmith, BC

| Location / Date / Source | CSR Standards for DW | CSR Standards for AW-M | E6 R2 Feb-05 G3 | F6 R2 Feb-05 G3 | F7 R2 Feb-05 G3 | I8 R2 Feb-05 G3 | J8 R2 Feb-05 G3 | J7 R2 Feb-05 G3 | N7 R3 Feb-05 G3 |
|---|---|---|---|---|---|---|---|---|---|
| ***Porewater Total Metals*** | | | | | | | | | |
| Arsenic | | | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Cadmium | | | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| Copper | | | <10 | <10 | <10 | <10 | <10 | <10 | 0.22 |
| Lead | | | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Mercury | | | 0.00022 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | 0.00022 | 0.00061 |
| Molybdenum | | | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Nickel | | | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Zinc | | | 0.151 | 0.475 | 0.075 | 0.165 | 0.080 | 0.190 | 0.243 |
| ***Porewater Dissolved Metals*** | | | | | | | | | |
| Arsenic | 0.010 | 0.125 | *<10* | *<10* | *<10* | *<10* | *<10* | *<10* | *<10* |
| Cadmium | 0.005 | 0.015 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 |
| Copper | 1.5 | 0.020 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Lead | 0.010 | 0.020 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Mercury | 0.001 | 0.00025 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| Molybdenum | 0.250 | 10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Nickel | 0.080 | 0.083 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Zinc | 3.00 | 0.100 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | 0.07 | <0.050 |

Notes:

All concentrations in milligrams per litre (mg/L), unless otherwise noted.

Standards shown from the Contaminated Sites Regulation ("CSR"; BC Reg. 375/96, O.C. 1480/96 and M271/2004, including amendments up to BC Reg. 13/2019, January 24, 2019).

Abbreviations: AW (Aquatic Life), M = Marine; DW (Drinking Water)

FDA = field duplicate available; FD = field duplicate; SCN = sample control number

*italics* indicate the concentration exceeds the laboratory detection limit.

Golder = Golder Associates Ltd. 2005. Report on Supplemental Stage 1 Preliminary Site Investigation and Detailed Site Investigation Lot 16G Ladysmith Harbour Ladysmith, BC. Dated June 30, 2005.

| | |
|---|---|
| **1** | Exceeds CSR Standards for DW |
| 1 | Exceeds CSR Standards for AW-M |
| **1** | Exceeds CSR Standards for DW and AW-M |

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golder.com

20 February 2020 Project No. 18109842-002-L-Rev0

**Jake Belobaba, RPP, MCIP**
Town of Ladysmith
132C Roberts St
Ladysmith, BC V9G 1A2

**REGULATORY PATH TO CLOSURE**
**LOTS 1, 4 AND 5, TOWN OF LADYSMITH**

Mr. Belobaba:

The following outlines the possible regulatory path forward for developing the Town of Ladysmith (the Town) property adjacent to Ladysmith Harbour, including Lots 1, 4 and 5 (the Site). We have attached BC ENV Fact Sheet 9, Highlights for Developers for further information on the site development process.

It should be noted that the regulatory requirements change frequently, and we understand there are changes planned for the regulations in 2020. The information provided here is based on current requirements and the anticipated upcoming changes to the Site Profile Process.

Based on the presence of contamination, investigation and remediation activities in accordance with the BC Ministry of Environment and Climate Change Strategy (ENV) will be required if development is planned. The first section of this letter presents the current CSR requirements for the development process, followed by our opinion of probable costs for implementing the next stages of investigation and remediation for the Site.

## 1.0 SITE PROFILE

Applying for a development permit will include completion of a Site Profile form. The Site Profile flags potential sources of contamination at a site and results in the municipality forwarding the site profile to ENV. ENV will then suspend (place a 'freeze' on) the local governments ability to approve certain applications, including demolition permit, rezoning, subdividing or development. ENV has draft revisions to the Site Profile process which will not allow a Municipality to opt out of the regulatory process.

Triggers for completion of a Site Profile are as follows:

- Applying for a permit for:
- Subdivision
- Zoning

- Development or development variance
- Soil removal
- Demolition
- Decommissioning a site, which includes soil removal
- You are taking over a property as a trustee, receiver or liquidator
- You are selling property that has, or has had a Schedule 2 activity on it

Completing a Site Profile for this Site would identify the known presence of contaminated media, resulting in the Site Profile form being forwarded to ENV and a subsequent freeze placed on the permits described above.

Note that the contamination identified at the Site remains a source of liability for the current and future land owners until it has been addressed via the pathway outlined in Section 3.0. Therefore, for the purposes of developing this regulatory path, we would recommend that the Town of Ladysmith obtain a Certificate of Compliance for the Site, or for individual parts of the Site as they are developed or consider obtaining a Voluntary Remediation Agreement. It is recommended that the Town of Ladysmith seek legal council for understanding of the potential future liabilities following remediation. The following section outlines the processes for obtaining an Instrument or Voluntary Remediation Agreement.

There are a variety of situations which require authorizations before redevelopment of a parcel. Typically, a Site would undergo investigation and remediation activities, and obtain a Certificate of Compliance for the entire area comprising the Site. However, it is understood that the Town of Ladysmith would remediate and develop the property in phases, potential subdividing portions for sale in advance of the remainder.

There are generally four possible paths to obtain a release of the 'freeze' from the Director at ENV, regulatory closure and redevelopment of the Site in phases, including

1) Obtaining a notice from the ENV Director granting a release.
2) Obtaining a Protocol 6 Pre Approval from ENV to redevelop the Site in phases
3) Obtaining an Approval in Principal.
4) Obtaining a Voluntary Remediation Agreement.

The following outlines the options for regulatory path to closure under a phased development.

## 1.1 ENV Director Grants a Release

Given that the Town wishes to develop the Site in Phases, site investigation and remediation activities are required to be completed in order to apply for release of development permits, including

- Preliminary Site Investigation (PSI)
- Detailed Site Investigation (DSI)
- Site Risk Classification report

- It is assumed that the Site will not be designated as High Risk
- Either:
  - Remediation plan that concludes remediation to applicable standards is achievable and once completed, the Site will be eligible for a Certificate of Compliance
  - Remediation to numerical standards (i.e. excavation and removal of contaminated soils, with confirmatory sampling), or
  - Risk based remediation activities including a risk assessment consisting of: a) developing problem formulation, b) exposure assessment, c) effects assessment, d) risk assessment characterization, and e) uncertainty analysis.
- Written opinion from an Approved Professional Roster review (of above documents).

It is understood that ENV has drafted changes to the Site Profile process, with notable changes on how multi phased developments are completed. Once implemented, sites undergoing phased development would no longer be eligible for releases of local government applications under redevelopment activities when there is a change of proposed activity at the Site. These changes may come into effect in 2020 and as a result, the release process may not be viable option for the Town's schedule.

## 1.2 Protocol 6 PreApproval to Redevelop the Site in Phases

An application would be made to ENV to obtain Pre-Approval to redevelop the Site in phases. Golder recommends that dialogue with ENV about the phased development and extent of areas requiring remediation be an ongoing process. An application would include

- Preliminary Site Investigation (PSI) for the entire site
- Detailed Site Investigation (DSI) for the entire site.
- If a DSI was not yet completed, a detailed plan and schedule for completing the activities
- Site Risk Classification Report
  - It is assumed that the Site will not be designated as High Risk
  - A high-risk designation does not mean that there are unacceptable risks to human health or the environment. The high-risk designation indicates that there are concentrations present at a magnitude that requires engagement with ENV. The general expectation is that action will be taken to resolve the high-risk issues irrespective of whether a CSR regulatory instrument is being pursued. Resolution involves reclassification of the issue as either "not high-risk" (i.e., upper cap material is removed) or "high-risk, risk-managed" (i.e., risks are evaluated and appropriate management or monitoring actions taken).
- Either:
  - Remediation plan that outlines the necessary remedial activities for each of the phases of the site which would concludes remediation to applicable standards is achievable and once completed, the Site will be eligible for a Certificate of Compliance

  - Remediation to numerical standards (i.e. excavation and removal of contaminated soils, with confirmatory sampling), or
  - Risk based remediation activities including a risk assessment consisting of: a) developing problem formulation, b) exposure assessment, c) effects assessment, d) risk assessment characterization, and e) uncertainty analysis.
- Written opinion from an Approved Professional Roster review (of above documents).

As part of the application, ENV would require a commitment from the Owner of the Site that the work would be completed in accordance with the remediation plan and that once completed, the site would be eligible for a Certificate of Compliance. Note that providing financial security would provide ENV with greater certainty on the commitment to follow the remediation plan. It is also noted, whether the Town provide financial security or not, ENV may require it prior to providing a pre approval to develop the Site in phases.

## 1.3 Approval In Principal

An Approval in Principal (AiP) is an ENV instrument when a remediation plan has been reviewed and approved. An AiP based on the recommendation of an Approved Professional must be able to meet the requirements of the remediation plan in 5 years.

An application would be made to obtain an AiP and would be prepared in such a way to redevelop the site in phases. Golder recommends that dialogue with ENV about the phased development and extent of areas requiring remediation be an ongoing process.

An application would include

- Preliminary Site Investigation (PSI) for the entire site
- Detailed Site Investigation (DSI) for the entire site.
- If a DSI was not yet completed, a detailed plan and schedule for completing the activities
- Site risk classification report
  - It is assumed that the Site will not be designated as High Risk
- Remediation plan that outlines the necessary remedial activities for each of the phases of the site which would concludes remediation to applicable standards is achievable and once completed, the Site will be eligible for a Certificate of Compliance
- Preparation of an application including the above documents and additional documents including Contaminated Site Application form and Summary of Site Condition.
- Review and recommendation from an Approved Professional Roster review (of above documents) to ENV to issue an AiP.

Following the issuance of the AiP, the Town would follow through on the remediation plan outlined as part of the application.

If the phased development were to require a time period of greater than 5 years, a pre-approval application to ENV would be required prior to Approved Professional Roster Review or that the AiP application be submitted to ENV for their review. Once issued, if material changes were made to the phased development or remediation plan, an application for an amendment to the AiP would be required.

Following completion of remediation of the phased developments, a Confirmation of Remediation Report would be prepared to support an application for a Certificate of Compliance for each sub area of the Site.

Municipalities are typically exempt from financial security requirements, except when thy are part of a pool of responsible persons. Therefore, it is noted that ENV could require financial security prior to issuing an AiP.

## 1.4 Voluntary Remediation Agreement

Based on our understanding, ENV has issued one VRA in BC and the VRA provision has since some into question and ENV does not consider this as an option in recent years. ENV recommends that parties consider indemnification under the financial Administration Act for seeking a cap of liabilities on Site. In consideration of this information, Golder recommends that the Town of Ladysmith consult legal council to obtain guidance on seeking cap for environmental liabilities on Site.

Notwithstanding, a VRA would require similar scope of work as described in prior options. For your information, a VRA application would include

- Detailed Site Investigation (DSI) for the entire site.
- Site Risk Classification Report
  - It is assumed that the Site will not be designated as High Risk
- A remediation plan
- A detailed description of the responsible person’s past and present activities on the Site, including the amount and characteristics of contamination at he Site that the attributable to their activities
- An estimate of the responsible person’s share of the total cost of remediation and justification for the estimate
- The name and address for any other person the Town of Ladysmith believes may be a responsible person in accordance with the EMA
- A statement describing the responsible person’s ability and plans to conduct and finance the remediation

## 2.0 OPINON OF PROBABLE COSTS

As noted above, there are various pathways to meet your business goals for the Site. Regardless of this, each path will require a completed DSI for the entire Site, development of a remedial plan and implementation of remediation. Not only is it a regulatory requirement, but from a business perspective, the DSI will characterize and delineate the nature and extent of the contamination. With that established, we will be able to determine the most cost-effective approach to remediate the delineated volume of contamination and obtain the necessary Ministry instrument(s) as per your development plans.

The following provides an outline of the opinion of probable costs to complete a preliminary supplemental investigation, complete detailed site investigation, develop a remediation plan, and implement remediation for the Site.

Please note that a DSI is usually carried out in steps due to the fact that drilling can sometimes delineate or identify new contamination, the latter necessitating additional work to complete delineation. Data for the Site was generally last collected over 10 years ago, therefore, we recommend proceeding with a preliminary supplement investigation prior to finalizing the DSI program.

Based on the historic data, soil contamination is relatively well understood, therefore we recommend completing delineation of the soil contamination as the first step. As for the groundwater, because its chemistry can vary over time and the last round of data was collected approximately ten years ago, this is not likely representative of current conditions. Therefore we recommend redeveloping and resampling the existing wells to document existing conditions and whether or not we can potentially refute some of the historic contamination, thereby limiting future drilling/sampling requirements. Following the review of the data, additional investigation requirement would be identified for completing DSI requirements.

The preliminary supplement scope of work would include the following tasks:

- Development of a health and safety plan and onsite utility locate
- Drilling of up to 30 boreholes
- Development and groundwater sampling of up to 20 existing and accessible monitoring wells
- Laboratory analysis
- Preparation of a data report consisting of a figures and tables of analytical results
- Completion of site risk classification
- Preparation of data gap and recommendations of scope of work to complete DSI

This portion of the recommended preliminary supplemental investigation work (soil delineation and groundwater resampling) noted above is estimated at approximately $95,000 before taxes.

Table 1 provides an opinion of probable cost for completing the remaining tasks to obtain ENV closure, and assumes that risk assessment is a viable option, with limited near surface soil remediation (excavation).

**Table 1: Opinion of Probable Costs**

| Task | Estimate |
|---|---|
| Preliminary supplemental investigation | $95,000 |
| DSI | $100,000 – $300,000 |
| Risk Assessment<br>Limited Soil Remediation | $50,000 - $75,000<br>$0 - $100,000 |
| Develop Remedial Plan | $40,000 - $70,000 |
| Approved Professional Review (1) | $30,000 |
| CSAP Fees (1)<br>AiP<br>COC (each) | <br>$15,000<br>$2,000 |
| ENV Fees (1)<br>AiP and SOSC<br>COC and SOSC (each) | <br>$5,000<br>$8,000 |
| Range of Opinion of Probable Cost | $480,000 – $700,000 |

Note: Costs do not include ENV applications or approvals, with the exception of obtaining a regulatory instrument. Opinion of probable cost do not include contingency or taxes. Table does not present ENV fees for obtaining a Voluntary Remediation Agreement.
(1) not applicable for Voluntary Remediation Agreement

## 3.0 CLOSE

We trust that this meets your requirements at this time. Should you have any questions, please do not hesitate to contact Dawn Flotten at 604-296-4377.

Yours very truly,

**Golder Associates Ltd.**

Dawn Flotten, PEng
*Principal, Environmental Engineer*

Guy Gordon, MSc, PGeo
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DMF/GG/lih

Attachments: Fact Sheet 9, Highlights for Developers

# Highlights for Developers

During the development of the provincial contaminated sites regime, the development industry expressed concerns about uncertain legal requirements for cleaning up contaminated sites. This uncertainty increases the risks developers face, and translates into project delays, higher project costs, and fewer redevelopment projects being completed. In response, the *Environmental Management Act* and Contaminated Sites Regulation were written to set clear rules for contaminated sites management, enhancing business predictability. A number of flexible provisions help developers minimize remediation costs.

### Meaning of "contaminated site" and "remediation" clarified

The Act and Regulation provide certainty by specifying standards to define "contaminated site" and acceptable "remediation." Developers may use a variety of generic and site-specific factors to decide whether a site is legally considered to be contaminated. They also have the right to choose from a variety of standards when undertaking remediation.

### Screening development applications

In the absence of legislative guidance in recent years, local governments adopted a wide range of methods to screen development applications for possible contamination. The *site profile* system is designed to bring uniformity to local government reviews.

### What is a site profile?

A site profile is a screening form for identifying potentially contaminated sites. It is a summary created from readily available information about a site – including its past and present uses and basic land descriptions – and should not require the assistance of a consultant to complete. Developers must provide site profiles in specified instances, most notably when applying for zoning, subdivision, demolition, and relocation of soil.

### When is a site profile required?

Specific industrial or commercial land uses trigger site profile submissions. Those uses, as listed in the Regulation, are ones that tend to leave contamination (for example, service stations). The list is sometimes attached to the site profile form for those individuals needing to complete and submit a site profile.

### Site profile exemptions

Under the Contaminated Sites Regulation, developers are exempt from providing site profiles for several situations, such as where:

- an accurate site profile already exists in the Site Registry (see Fact Sheet 20);
- the site has already been determined to be a contaminated site;
- the site's remediation has already been approved (for example, by a Certificate of Compliance); or
- a local government has opted out of administering the site profile system.

### Site investigations

Site investigations are the key means of gathering information to determine if a site is contaminated. They must be done by experienced consultants. Developers can have them done without government involvement.

Under the contaminated sites legislation, a Director of Waste Management from the ministry may order a site investigation, prompted by a site profile or other information the Director may receive.

**The Site Registry**
The Site Registry was created to provide the public with easy access to reported information about sites, including their basic characteristics, legal events that have occurred, and milestones in the remediation process. The registry is, in part, a "record of decisions" about sites that have been evaluated, whether or not they are clean or contaminated. Anyone may access the registry by computer through BC OnLine.

### Independent remediation

Procedures for independent remediation are in place so developers can clean up sites with minimal supervision by the ministry. Independent remediation may occur where liability is not in dispute, investigation and remediation procedures are routine, and engineering or environmental consultants have been engaged to apply the regulations and any additional guidelines or requirements. The ministry must be notified at the start and at the completion of remediation, and this information will be entered on the Site Registry. A developer who uses independent remediation may still apply for a Certificate of Compliance at a later date.

### Liability for developers

A current owner or operator – including developer – of a site may be responsible for remediation at a contaminated site. However, there are several exemption situations which could be relevant to developers who may be "responsible persons":

*Innocent acquisition exemption* – On acquisition, a person diligently undertook inquiries, did not find contamination, and did not contribute further to the contamination.

*Migration of a substance from offsite* – A person is immune when a site has been contaminated, because the migration of a substance occurred from offsite.

*Environmental consultant immunity* – Consultants acting for a developer are immune from liability where they assist the developer in the remediation of the site, provided they are not negligent in their actions.

*Immunity from future liability* – A person who remediates and obtains a Certificate of Compliance can use the certificate as a defence in private cost-recovery lawsuits. This immunity applies where another person subsequently proposes to change the use of a remediated site or undertake further cleanup.

The Contaminated Sites Regulation provides further exemptions that may be relevant to developers. Of note are those exemptions pertaining to sureties, construction contractors, and transporters of contaminated soil.

### Cost recovery provisions

The Act and Regulation authorize a person to recover costs from a responsible person (or persons) where those costs are associated with remediation. That is, a developer who undertakes remediation may recover costs from other responsible persons — for example, past polluters.

### Minor contributor status

If a developer cannot obtain an exemption from liability, as described above, he or she may be entitled to obtain *minor contributor status*. The Province recognizes the need to treat people who only contributed a minor portion of the contamination on site in a fair and expeditious manner. Minor contributor status can also cap and shield a person against private cost recovery lawsuits, also limiting liability.

### Voluntary Remediation Agreement

This type of agreement with the ministry may be particularly attractive to a developer who wishes to settle liability expeditiously. Under such an agreement, the developer accepts the terms of remediation, including scheduling and a cap on remediation costs. A Voluntary Remediation Agreement can also form the basis for private financial transactions.

### Approval in Principle

Developers urged the ministry to provide interim approval, or Approval in Principle, to enable them to seek appropriate financing and municipal development approvals. A Director may grant an Approval in Principle by approving a remediation plan which, if implemented, would lead to remediation that meets applicable standards. Investigation results, an evaluation of remediation options, public consultation input, and remediation plans would be reviewed and, if satisfactory to a Director, may lead to an Approval in Principle being issued.

### Certificate of Compliance

A developer can seek approval of remediation in the form of a Certificate of Compliance. Such a certificate may be issued by a Director when a site has been cleaned up according to a remediation plan and meets numerical remediation standards in the Contaminated Sites Regulation.

The ministry recognizes that, at some sites or for some types of contamination, remediation that meets numerical standards may not be technically feasible or financially justified. The legislation allows onsite management of contaminants, provided these contaminants are managed according to prescribed risk standards. A Director may also issue a Certificate of Compliance where the remediation meets risk-based standards in the Regulation.

### Security

The *Environmental Management Act* and Contaminated Sites Regulation establish a hierarchy of security: restrictive covenants under the *Land Titles Act* can be imposed only where an entry on the Site Registry is not adequate to achieve effective remediation; and financial security can only be imposed where restrictive covenants are not adequate. The Regulation specifies circumstances under which a Director must discharge the relevant security.

### Contaminated Soil Relocation Agreement

Such an agreement regulates the movement of soils from contaminated sites, taking into account the soil quality and environmental conditions at the deposit site. While local bylaws to regulate soil deposit are allowed, they must not conflict with provincial standards if immunity provisions under this legislation are to apply to those local governments.

### Public review

Not all contaminated sites raise significant public concerns. However, a Director may require a responsible person to carry out public consultation and review of remediation in cases where there is significant public interest.
For those sites, public consultations could achieve better public understanding of proposed remediation, as well as provide useful commentary with which to evaluate remediation alternatives.

Addressing industry concerns, the Regulation bars a Director from ordering public consultation for remediation for which an Approval in Principle or Certificate of Compliance have already been issued.

### Contaminated sites fees

The contaminated site legislation authorizes the provincial and local governments to collect fees to offset their costs of contaminated sites regulation and administration. See Fact Sheet 25, "Fees for Contaminated Sites Services," for more information on fees.

*Note: This summary is solely for the convenience of the reader. The current legislation and regulations should be consulted for complete information.*

*For more information, contact the Environmental Management Branch at site@gov.bc.ca*

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE

# ISLAND RAIL CORRIDOR CONDITION ASSESSMENT

## SUMMARY REPORT

wsp

# SIGNATURES

PRIMARY CONTACT

Ben Prashaw, P.Eng, PMP
Rail & Transit Lead, British Columbia &
Northern Alberta,

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# DEFINITIONS

| Abbreviation | Definition |
|---|---|
| **AC** | Alternative Current |
| **AREMA** | American Railway Engineering and Maintenance-of-Way Association |
| **BIL** | Base Insulation Level |
| **Cumulative** | Total sum amount of previous and current costings |
| **DC** | Direct Current |
| **DMU** | Diesel Maintenance Unit |
| **E&N** | Esquimalt and Nanaimo |
| **EMC** | Electromagnetic Compatibility |
| **ICF** | Island Corridor Foundation |
| **IRC** | Island Rail Corridor |
| **LRT** | Light Rail Transit |
| **LRV** | Light Rail Vehicle |
| **kip** | Kilopound |
| **MoTI** | Ministry of Transport and Infrastructure British Columbia |
| **MTPA** | Mega Tonnes per Annum |
| **MUP** | Multi-Use Path |
| **OCS** | Overhead Contact System |
| **OCCS** | Occupancy Control System |
| **PMP** | Pest Management Plan |
| **Rail Defect** | An identifiable imperfection of the internal structure or surface of the rail section |
| **RDC** | Rail Diesel Car |
| **ROW** | Right of Way |
| **RTC** | Rail Traffic Controller |
| **SVI** | Southern Railway of Vancouver Island |
| **t/an** | Tonnes per Annum |
| **TPDS** | Traction Power Distribution System |
| **TPSS** | Traction Power Supply system |

# 1 EXECUTIVE SUMMARY

The British Columbia Ministry of Transportation and Infrastructure (MoTI) engaged WSP Canada Group Ltd. (WSP) to conduct a detailed evaluation of the base asset condition of the Island Rail Corridor on Vancouver Island. The assessment scope included the entire length of the rail corridor, Victoria to Courtney (Victoria subdivision), Parksville to Port Alberni (Port Alberni subdivision), Wellcox Spur and Wellcox Yard. The assessment of the corridor covered railway infrastructure, grade crossings, bridges and rockfall activity.

As part of the condition assessment MoTI also requested that WSP examine the cost to upgrade infrastructure to resume normal rail freight and passenger service. This includes the cost of upgrading the rail line to meet the standards needed to implement a Commuter Service with frequent train service between Victoria and Langford as well as Inter-City service between Victoria and Courtney. This information is contained in the separate Island Rail Corridor Commuter Rail Assessment Report.

The corridor is owned by the Island Rail Corridor Foundation (ICF) and operated by Southern Railway of Vancouver (SVI). SVI operates the freight corridor within 10 miles (16 km) of Nanaimo. No passenger service currently operates on the corridor.

The MoTI does not own the corridor but wants to understand its current condition and anticipated costs associated with various improvements. No commitments have been made to advance the improvements discussed in this report. If these improvements were to proceed, it has not been established if the MoTI or another party would deliver the work.

## Corridor Condition

The corridor condition assessment builds upon previous studies, and in particular the 2009, Hatch Mott MacDonald, Evaluation of the E&N Rail Corridor: Baseline Report (HMM report) to reduce duplication and to focus on an updated assessment of the corridor. The HMM report concluded that the condition of the Island Rail Corridor was not in compliance with BC Safety Authority Railway Regulations and Rules respecting Track Safety. VIA passenger rail service was discontinued in 2011.

Between June and August 2019, site investigations were undertaken to assess the condition of the Island Rail Corridor. The inspections on the Victoria subdivision (including Wellcox spur) were completed by a hi-rail vehicle, while walking inspections were primarily employed on the Port Alberni Subdivision due to accessibility and safety concerns ranging from vegetation growth to downed trees along the subdivision. During the site investigation a Good/Fair/Poor rating was applied at each inspection element to grade the overall condition of each component of the railway.

Overall summarized results indicate that the railway corridor is in Poor to Fair condition, with the Victoria subdivision in a Poor to Fair condition and the Port Alberni in a Poor condition. The main issues contributing to the condition of the railway include but are not limited to:

- Uncontrolled vegetation within and adjacent to the rail corridor;
- Number of decayed ties exceed Transport Canadas "Rules Respecting Track Safety - 2012" regulations for Class 2 and Class 3 Track; and
- Single shoulder plates and angle joint bars are older technology and negatively impact track performance.

In summary, the road bed and track structure of the corridor is generally in a Poor to Fair condition. Bridges along the corridor range between Poor to Good depending on the age, location and type of bridge. At-grade crossings are in a Fair condition, however in some cases, crossings are overgrown with vegetation and/or require improved warning systems.

## Improvements

Identified improvements are recommended based on a phased approach developed as part of this study. The phased approach entails three improvement phases:

- **Initial:** Re-establishes minimum freight and passenger service
- **Intermediate:** Upgrades higher freight loading for increased freight and passenger volumes and speeds
- **Ultimate:** Supports higher freight and passenger volumes

The phasing rational is based on carrying out improvement works on the railway to meet Technical Safety BC and Transport Canada maximum allowable operating speeds. In each phase, a rail traffic volume Use Case is assigned and provides a corresponding track class speed and load characteristics. Furthermore, breaking the corridor into six different segments allows flexibility for phased improvements to be implemented based on demand changes. Each phase is summarized below:

Initial Phase Improvement: includes costs to upgrade infrastructure to re-establish a minimum rail freight and passenger service along the rail corridor.

| **Initial Phase: Class 2 Track Standard Restoration** | |
|---|---|
| **Use Case:** | • 2-4 passenger trains per day<br>• 2-4 freight trains (10-20 car trains) per day |
| **Track Characteristics:** | Class 2 Track Standard (25 mph Freight, 30 mph passenger). * |
| **Load Case:** | Not suitable for sustained 286k lb car loading |

*Speeds refer to maximum safe allowable operating speed as per Technical Safety BC and Transport Canada's regulations

Intermediate Phase Improvement: includes costs to upgrade infrastructure beyond the Initial Phase. This phase will support higher freight loading (286k lb rail car loading) which will accommodate increased freight and passenger volumes and increased speeds.

| **Intermediate Phase: Class 3 Track Standard Restoration and 286lb Upgrade** | |
|---|---|
| **Use Case:** | • 4 passenger trains/d up to 8 trains/d<br>• 4 freight trains (10-20 car trains)/d up to 4 million tonnes per annum (MTPA) or 133 cars/d total.<br>• Once passenger/freight train volumes increase above Initial Phase Use Case or,<br>• Higher operating speeds are desired.<br>• Assumes improvements for Initial Phase have already been completed. |
| **Track Characteristics:** | Class 3 Track Standard (40 mph Freight, 60 mph passenger). * |
| **Load Case:** | Suitable for sustained 286k lb car loading |

*Speeds refer to maximum safe allowable operating speed as per Technical Safety BC and Transport Canada's regulations

Ultimate Phase Improvement: includes costs to upgrade infrastructure beyond the Intermediate Phase. This phase will support higher freight and passenger volumes than the Intermediate Phase. This phase is optimal for the implementation of a commuter rail service. Further information on commuter rail is provided in the Island Rail Corridor Commuter Rail Assessment Report.

| **Ultimate Phase: Ballast Program** | |
|---|---|
| **Use Case:** | • To be implemented during higher passenger volumes at or above 8 trains/d and<br>• Higher freight volumes. If current volumes increase above 4MTPA or 133 cars/d. (Current freight volumes assumed to be 110,000t/yr or 4 cars/d).<br>• Assumes improvements for Intermediate Phase have already been completed. |
| **Track Characteristics:** | Class 3 Track Standard (40 mph Freight, 60 mph passenger). * |
| **Load Case:** | Suitable for sustained 286k lb car loading |

*Speeds refer to maximum safe allowable operating speed as per Technical Safety BC and Transport Canada's regulations

## Cost Estimate

Conceptual cost estimates were developed in support of the three Improvement Phases evaluated: Initial, Intermediate, and Ultimate. These phased cost estimates are separated between Victoria Subdivision and Port Alberni Subdivision and further divided into six geographical segments.

Table 1: Cost for Combining Sequential Phases, shows WSP's 2020 Cost Estimate breakdown for the Improvement Phases combined sequentially (in 2020 dollars). The estimate provides costs to rehabilitate the corridor with phased approach. Further information on commuter rail costs for reinstatement is provided in the Island Rail Corridor Commuter Rail Assessment Report.

**Table 1: Cost for Combining Sequential Phases**

| Costs for Combining Sequential Phases (includes MoTI contingencies) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Segment 1 (Victoria to Langford) | Segment 2 (Langford to Duncan) | Segment 3 (Duncan to Nanaimo) | Segment 4 (Nanaimo to Parksville) | Segment 5 (Parksville to Courtenay) | Sub Total (Victoria Subdivision) | Sub Total (Port Alberni Subdivision, Segment 6) | Island Rail Corridor Total |
| **Initial Phase** | $14,513,749 | $47,748,423 | $64,038,799 | $32,611,106 | $68,397,313 | **$227,309,391** | $99,139,001 | **$326,448,391** |
| **Intermediate = Initial + Intermediate** | $28,281,783 | $81,035,713 | $114,912,185 | $60,376,966 | $121,031,367 | **$405,638,013** | $146,385,919 | **$552,023,932** |
| **Ultimate = Initial + Intermediate + Ultimate** | $35,469,950 | $114,569,344 | $150,660,506 | $82,979,158 | $164,694,045 | **$548,373,004** | $180,405,300 | **$728,778,304** |
| **Commuter Rail Service** | $595,029,867 | N/A | | | | | | **$595,029,867** |

# 2 BACKGROUND

The Southern Railway of Vancouver Island (SVI), is a short line railway in British Columbia, Canada. It consists of two subdivisions (track sections) illustrated in Figure 1: Island Rail Corridor Subdivision Map:

- Victoria Subdivision a 225 km (139.8 mi) track between Victoria and Courtenay, with a short spur from just south of Nanaimo to Wellcox Yard and barge ramp on the Nanaimo waterfront; and
- Port Alberni Subdivision a 64 km (39.7 mi) branch line from Parksville to Port Alberni.

The corridor is owned by the Island Corridor Foundation (ICF) and operated under contract by the Southern Railway of Vancouver Island (SVI). The barge ramp is owned by Seaspan Ferries Corporation (Seaspan). Both SVI and Seaspan are part of the Washington Group of Companies.

SVI currently connects with two main marine facilities in the Vancouver Lower Mainland. They connect to CPR via rail barge between Nanaimo and Tilbury (Lower Mainland) which has interchange capability with three other North American Class 1 railways (Canadian National Railway, Burlington Northern Santa Fe Railway and Union Pacific Rail Road). The second main rail marine connection is with the Annacis Rail Marine Terminal (ARMT) located on Annacis Island in Delta, BC and serviced by Southern Railway of BC (SRY). SRY, a sister company of SVI has interchange capability and with the three Class 1 railways previously mentioned plus Canadian Pacific Railway. VIA Rail passenger services along the Victoria subdivision ceased operation in 2011. Subsequent to the termination of the service, some railway assets were sold or leased to the public (stations, yard & property). No passenger trains currently run on the Island Rail Corridor.

Public interest has been expressed for the re-opening of Inter-City passenger rail and/or a Commuter Service. Tourist train company Rocky Mountaineer has expressed interest in offering a service on the island. The ICF has also expressed their interest in restoring passenger service and expanding freight movement on the island.


**Figure 1: Island Rail Corridor Subdivision Map**

## Island Rail Corridor History

The Vancouver Island Railway was originally constructed by Sir Robert Dunsmuir (then premier of BC and owner of the then E&N Railway) in 1886 from Esquimalt to Nanaimo. Known then as the Esquimalt and Nanaimo Railway (E&N), the railway initially ran 115km (71.4miles) between Esquimalt and Nanaimo until the city of Victoria was incorporated in 1888 when the railway was extended to downtown Victoria. The original cost of constructing the railway was $626,000 per mile. Upon completion, passengers were able to board a train and travel from Victoria to Ladysmith for $1.25 taking just over 2 hours to complete the journey.

In 1905 Robert Dunsmuir's son sold the railway to the Canadian Pacific Railway (CPR). The railway was then extended north of Nanaimo to Parksville and Courtenay, and west to Port Alberni with 44 stations (8 on the Port Alberni Subdivision and 36 on the Victoria Subdivision).

In 1978 VIA took over the operation of passenger trains on the Victoria subdivision (passenger operations on the Port Alberni subdivision ceased in 1953), with ownership of the corridor still belonging to CPR. In 1999, shortline operator RailAmerica purchased the route from Nanaimo to Port Alberni, and leased the balance of the line from CPR. Despite the purchase by RailAmerica freight traffic continued to decline.

The Island Corridor Foundation (ICF) took over ownership of the corridor (Victoria and Port Alberni Subdivisions, Wellcox Spur and Wellcox Yard) in 2006 when it came to agreements with both CPR and RailAmerica to assume all rail assets in exchange for CPR and RailAmerica receiving federal tax credits. Southern Railway of Vancouver of Island (SVI) was appointed as railway service provider for the system by the ICF in 2006. In 2011, VIA passenger service stopped running, due to safety concerns with the track and bridge conditions. The SVI continued to operate a freight rail service until 2012. SVI continue to maintain the Victoria Subdivision and Wellcox Spur to operate a freight rail service within a 10 miles (16km) radius around Wellcox Yard in Nanaimo. SVI continues to monitor and inspect the Victoria Subdivision and Wellcox assets.

## Island Corridor Foundation (ICF) Governance

The Island Rail Corridor is owned by the ICF. The ICF is a non-profit society with a twelve-person Board of Directors. Five directors represent the Regional Districts, five directors represent First Nations, and two are members at large. Membership is limited to local governments (five Regional Districts) and fourteen First Nation governments whose territories are wholly or partly within the geographic area of the corridor.

# 3 INTRODUCTION

The British Columbia Ministry of Transportation and Infrastructure (MoTI) engaged WSP Canada Group Ltd. (WSP) and their sub-consultants Bunt & Associates Transportation Planning and Engineering (crossing condition assessments) and Advicas Group Consultants Inc. (rockfall quantity surveying) to conduct a condition assessment, provide restoration improvements and all in costing for reinstatement of rail operations on the Island Rail Corridor between Victoria and Courtenay and Parksville to Port Alberni. The assessment of the corridor includes, railway infrastructure, grade crossings, bridges and rockfall activity. WSP was also engaged to assess the viability and cost of an Inter-City railway service between Victoria and Courtenay and a Commuter Service between Victoria and Langford.

As part of the Island Rail Corridor Condition Assessment, WSP has conducted field investigations with the support of Southern Railway of Vancouver Island (SVI) and the Island Corridor Foundation (ICF) and has drawn on both party's experience and knowledge base to understand the operations of the Island Rail Corridor. This report analyzes the current condition of the Victoria and Port Alberni subdivisions and provides remediation improvements to bring the corridor back into service.

The aim of this report is to expand on previous studies undertaken on the condition of the railway corridor and summarise findings and outcomes from the field investigations. The Island Rail Corridor Condition Assessment report and Island Rail Corridor Commuter Rail Assessment report provide remediation improvements to reinstate the corridor in a phased approach.

## 3.1 CURRENT CORRIDOR OPERATION STATUS

SVI operate a freight rail service on the Island Rail Corridor within a 10 mile (16km) radius of Wellcox Yard at Nanaimo Port. Freight is transported to/from downtown Nanaimo via Seaspan Ferries Corporation (Seaspan) largely from Annacis Island's ARMT, owned and operated by Southern Railway of BC (SRY – a sister company of SVI). SRY has an interchange in New Westminster with Canadian National Rail (CN), Canadian Pacific Rail (CPR) and Burlington North Santa Fe (BNSF) (connects with UN Pacific) which allows for movement of freight anywhere within North America.

SVI have approximately 1200 railcars travelling to/from Vancouver Island per year. Most rail cars travel loaded to Vancouver Island where they are transloaded into truck at Wellcox Yard for distribution or delivered to clients for off loading. The empty railcars are returned to the mainland by rail-barge over the Nanaimo marine facility. Cargo shipped between Wellcox Yard and Annacis Island largely includes, animal feed, forest products, aggregates, fertilizer and propane. All goods shipped (except propane) are transloaded to/from truck in Wellcox Yard. Approximately 250-300 cars of propane are shipped to/from the Island each year. Approximately seven cars shipped each week, during winter months and up to eight to ten cars during the winter. Propane is the only cargo transported by rail beyond Nanaimo.

SVI still provides a minimum level of maintenance through the entire Victoria Subdivision between Courtney and Victoria.

## 3.2 PREVIOUS STUDIES

This section focuses on reviewing previous studies completed around the condition of the Island Rail Corridor. The studies were reviewed to understand the previous condition of the Island Rail Corridor and identify focus areas and gaps in the outcomes.

The following studies were reviewed:

- Evaluation of the E&N Railway Corridor (2009-2010)
  - Foundation Report
  - Baseline Report Reference Report
  - Commuter Rail
  - Freight Analysis
  - Passenger Analysis
  - Tourist Train Analysis
  - Development Strategies for the Island Corridor Foundation
- Bridge Inspection and Assessment - E&N Railway (2012)
- Victoria Rail Rapid Transit Project (2011)
- Track and Geotechnical Condition Esquimalt & Nanaimo Railway Assessment Report (2003)

The following cost estimates were reviewed:

- ICF Budget Estimating Report
- Evaluation of the E&N Railway Corridor

| | Evaluation of the E&N Railway Corridor |
|---|---|
| **Report Authors** | Hatch Mott MacDonald / IBI Group |
| **Agency** | BC Ministry of Transportation and Infrastructure |
| **Date of Publication** | 2009-2010 |
| **General Content** | The study focused on the viability of the Island Rail Corridor (E&N Corridor) on Vancouver Island. The report reviewed previous studies and worked with relevant stakeholders to determine business opportunities on the Island Rail Corridor.<br>The report assessed the following viability of opportunities:<br>• Freight Analysis<br>• Intercity passenger Analysis<br>• Tourist Excursion Train Analysis<br>• Commuter Rail Analysis<br>As part of the viability study, the condition of the corridor was also assessed to provide costing and the assessment of each business opportunity. The following was assessed as part of the condition assessment:<br>• Track<br>• Structures |

| | |
|---|---|
| | • Fencing<br>• Communications<br>• Signaling<br>• Grade crossings<br>• Barge ramp<br>• Stations and facilities |
| **Outcome of Study** | The study recommended, given that there are a variety of business opportunities that could emerge in this corridor, that a corridor strategy be developed in partnership with the Island Corridor Foundation as a next step in this study. The objective of the corridor strategy would be to determine what conditions and economic circumstances need to be in place to preserve the corridor for future use and encourage and enhance the potential opportunities that are available. |

| | **Bridge Inspection and Assessment - E&N Railway** |
|---|---|
| **Report Authors** | Associated Engineering |
| **Agency** | BC Ministry of Transportation and Infrastructure |
| **Date of Publication** | 2012 |
| **General Content** | The purpose of the study was to assess the condition of 48 bridges on the Victoria Subdivision on the Island Rail Corridor (E&N Railway). No bridges were assessed on the Port Alberni subdivision. The bridges were assessed in order to determine the load carrying capacity of the bridges and to determine an estimated cost to restore or replace the bridges in support of 2021, 2031 & 2041 operations. |
| **Outcome of Study** | The study identified the condition of the 48 bridges on the Victoria Subdivision as well as the remediation and restoration cost to support the 2021, 2031 and 2041 operations. |

| | **Victoria Rail Rapid Transit Project** |
|---|---|
| **Report Authors** | BC Transit & CRD |
| **Agency** | BC Transit's Victoria Regional Rapid Transit |
| **Date of Publication** | 2011 |
| **General Content** | The study is concept study which outlines the need for a rapid transit corridor between the West Shore (region immediately west of Victoria) and Downtown Victoria. The study includes discussions on progress to date, alignment options, recommended rail technologies (including a cost benefit analysis) and associated costs. |
| **Outcome of Study** | The study identified an approved alignment and cost for an LRT system from West Shore to Downtown. The study also listed the benefits associated with the option and future steps. |

| | Track and Geotechnical Condition Esquimalt & Nanaimo Railway Assessment Report |
|---|---|
| **Report Authors** | Earth Tech |
| **Agency** | Vancouver Island Rail Company |
| **Date of Publication** | 2003 |
| **General Content** | The assessment study looked at the condition of the track structure and geotechnical condition of the Victoria subdivision but did not assess the Port Alberni subdivision. The study looked at the following components:<br>• Rock stability<br>• Slope Stability<br>• Erosion<br>• Culverts<br>• Track ties<br>• Ballast<br>• Vegetation<br>• Rails<br>• Crossing |
| **Outcome of Study** | The study identified a number of concerns and difficulties within the Island Rail Corridor. The concerns included, rock stability, defective ties and vegetation within the ballast. The ties and vegetation concerns were noted along the subdivision, while the rock stability was noted between Langford and the Malahat pass. |

## 3.3 FIRST NATIONS & STAKEHOLDERS

The Island Rail Corridor is owned by the ICF and is operated and maintained under contract by SVI. The corridor runs through 14 First Nations Territories and 14 municipalities who comprise of 5 regional districts. Consultation and Engagement was not conducted as part of this Condition Assessment, but further advancement of works on the Island Rail Corridor would require consultation. First Nations and Stakeholders identified at this stage include but are not limited to the lists below. For locations of the First Nations identified below please refer to Figure 2: First Nations & Community Map.

First Nations:

- Esquimalt Nation
- Songhees Nation
- Malahat Nation
- Cowichan Tribes
- Lake Cowichan First Nation
- Halalt First Nation
- Stz'uminus First Nation
- Penelakut Tribe
- Snunymuxw First Nation
- Snaw-Naw-As First Nation
- Qualicum First Nation
- Hupačasath First Nation
- Tseshaht First Nation
- K'ómoks First Nation

Stakeholders:

- Island Corridor Foundation
- Southern Railway of Vancouver Island
- Federal Government
- Provincial Government
- 5 Regional Districts
  - Capital Regional District
  - Cowichan Valley Regional District
  - Regional District of Nanaimo
  - Comox Valley Regional District
  - Alberni-Clayoquot Regional District
- 14 Municipalities
- General Public
- Local Industry
- Technical Safety BC

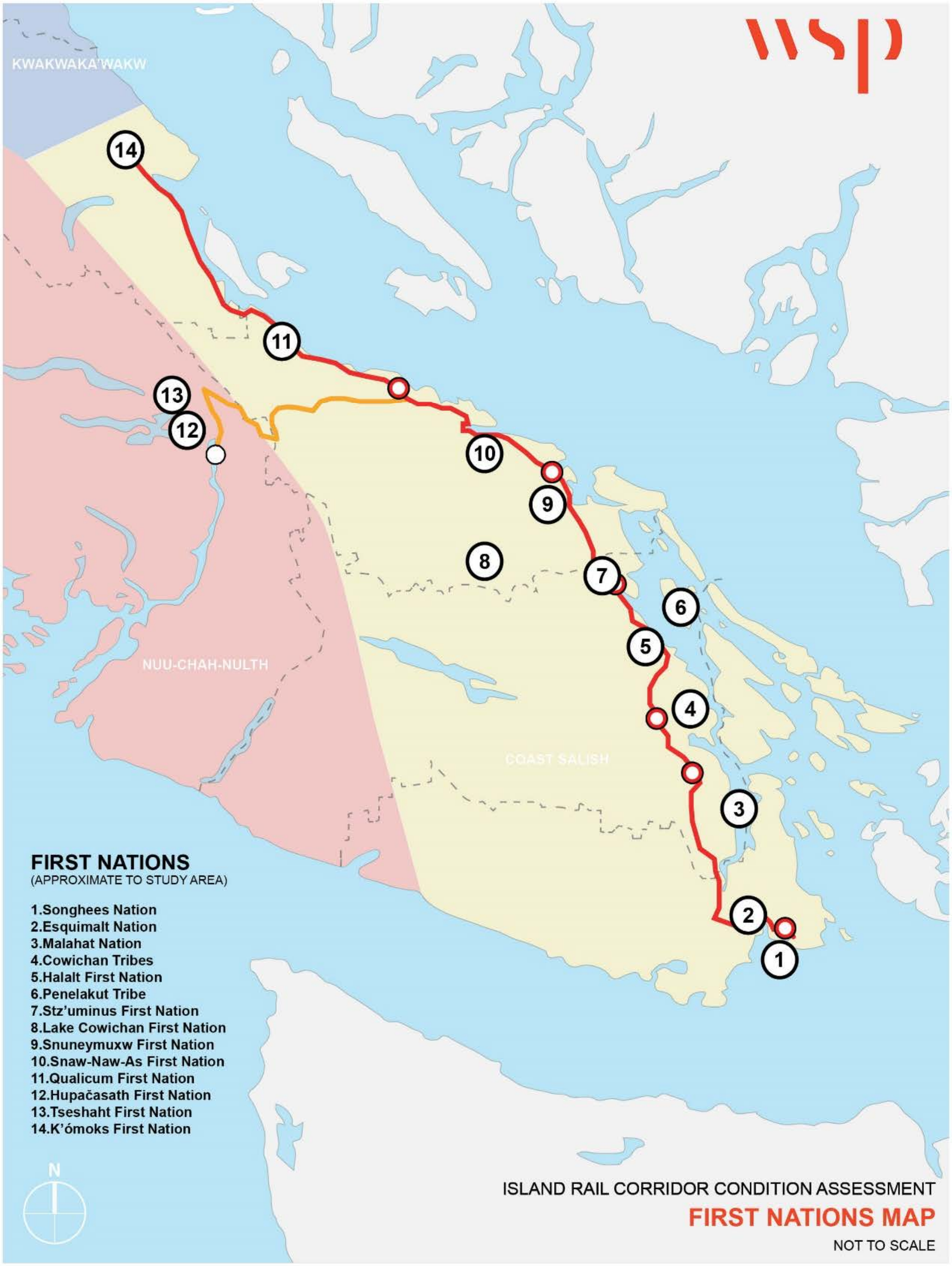



**Figure 2: First Nations & Community Map**

# 4 APPROACH AND METHODOLOGY

## 4.1 ASSESSMENT SCOPE AND CRITERIA

MoTI prescribed the following physical plant and the right of way to be assessed as part of this undertaking:

- Road bed
- Main Line Track Geometry Details
- Main Line Track Substructures (switches, ties and other track material)
- Bridges, Trestles, Tunnels, Culverts and Similar Structures
- Yard Tracks
- Industrial Sidings and Spurs (either owned or operated on)
- Communications Equipment
- Fencing and Similar Structures
- Barge Ramps
- Grade Crossings
- Grade Crossing Protection
- Pedestrian Crossings
- Wire Crossings
- Pipe Crossings
- Yard and Mainline Clearances

## 4.2 METHODOLOGY

After confirming the project parameters with the MoTI, WSP undertook the Island Rail Corridor Condition Assessment with the following methodology:

1. Compile and Review Existing and Provided Material
2. Workshops and Meetings
3. Conduct Gap Analysis
4. Perform Site Investigation
5. Analyze Investigation Results
6. Develop Improvements

## Step 1: Compile and Review Existing Information

An assessment of previous studies, provided by MoTI and the ICF, was undertaken to understand areas, conditions and outcomes of previous investigations. Refer to Section 3.2 Previous Studies, for details on previous studies assessed.

## Step 2: Workshops & Meetings

A workshop was undertaken on 15th July 2019, with MoTI, SVI and the ICF to confirm assessment items, identify missing studies and initial coordination for field investigations. A consultation meeting was also held with Technical Safety BC on the 18th of August 2019, which confirmed the Island Rail Corridor was a provincially regulated railway and Transport Canada's federal Grade Crossing Regulations and Standards would be used for grade crossing condition assessments.

## Step 3: Conduct Gap Analysis

A gap analysis was undertaken to determine missing or incomplete areas from previous studies that was required further investigation.

## Step 4: Perform Site Investigation

Site investigations were completed between June and August 2019. The project team leads led the site investigation in assessing the initial condition of the corridor. The teams included, bridges and structures, track, crossings and rockfall.

## Step 5: Analyze Investigation Results (By Segments)

Upon completion of the site investigations, the corridor condition was analysed in further detail. To aid in analysis, the corridor was broken down into six (6) segments, as shown in the below Figure 3: Segment Map. The segments are defined as:

- Segment 1: Victoria to Langford – mile 0.00 to 10.0
- Segment 2: Langford to Duncan – mile 10.0 to 39.7
- Segment 3: Duncan to Nanaimo – mile 39.7 to 72.5
- Segment 4: Nanaimo to Parksville – mile 72.5 to 95.2
- Segment 5: Parksville to Courtenay – mile 95.2 to 139.7
- Segment 6: Port Alberni subdivision – mile 0.00 to 39.4

During the Analyze Investigation stage, the viability of an Inter-City railway service between Victoria and Courtenay and Commuter Service between Victoria and Langford were assessed. For further details on Inter-City railway service between Victoria and Courtenay and Commuter Service between Victoria and Langford refer to the Island Rail Corridor Commuter Rail Assessment report.

## Step 6: Develop Improvements

Once the Analyze Investigation stage was complete, potential improvement options and associated cost estimates were developed for the rehabilitation of the Island Rail Corridor.


**Figure 3: Segment Map**

# 5 CORRIDOR CONDITION

During the Site Investigation and Analysis phases of this project, both the Victoria and Port Alberni subdivisions (including Wellcox spur) were inspected by hi-rail and walking between June and August 2019. Some sections of the Port Alberni subdivision were not accessible by hi-rail or by foot due to vegetation growth and downed trees along the subdivision.

Representatives from SVI, accompanied WSP for the inspections of the track and drainage, bridges and rockfall inspections, both of whom shared their knowledge of the corridor with WSP. In addition to WSP's visual site assessments, this section of the report draws from their experience with the maintenance and operations of the corridor.

The below sections of the report show the observations noted from the site investigations and discussion with SVI and the review of the 2009, Hatch Mott MacDonald, Evaluation of the E&N Railway Corridor: Baseline Report (HMM report). The HMM report was an accepted report layout by MoTI; for purposes of presenting updated conditions from the 2009 report, a similar format is presented in the following sections.

During the site investigation a Good, Fair, Poor rating was applied at each inspection to grade the overall condition of the road bed. An example and definition of the ratings can be found in Section 5.1: Road bed.

## 5.1 ROAD BED

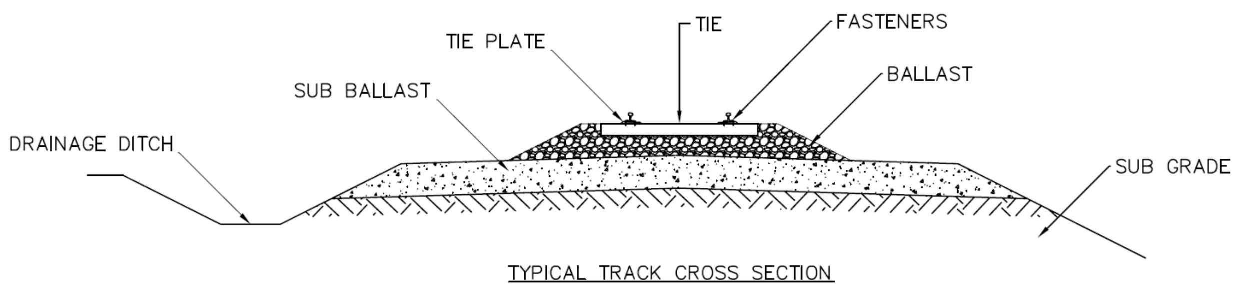



**Figure 4: Typical Railway Track Cross Section**

Figure 4: Typical Railway Track Cross Section shows a typical cross section of a single line railway, similar to what is found on the Island Rail Corridor. The track sits on top of the 'Road Bed', or the ballast, sub ballast and sub grade. If the ballast or road bed is fouled by vegetation or mud, possibly through irregular maintenance, impacts to the quality of the track and its performance can occur. Maintenance of the track drainage and vegetation clearing is integral to the safety of the railway.

### *5.1.1 DRAINAGE & CULVERTS*

The drainage was observed during a week-long site investigation in which it rained most days. This provided an opportunity to observe the drainage performance. During this investigation, there was no significant water ponding noted. As stated in the 2009, HMM report, the drainage was deemed to be in a Fair condition. The 2019 site inspections showed little change to this assessment. Vegetation within the ballast section which prevents free flowing drainage was noted as being the most common observation.

Culverts were observed to be functioning; allowing the passage of water from either side of the track and preventing ponding. Overall, the system was observed to have a fair draining condition and function for its intended purpose. Vegetation and sediment typically accumulate in culverts which can sometimes fully block them. No fully blocked culverts were observed but they could still exist. Rail corridors can still have positive drainage with plugged culverts due to redundancy in their drainage design and porous road bed structure. Although the culverts are in fair condition, vegetation was noted to be partially blocking culvert inlets and outlets. It does not appear that an extensive culvert cleaning program has been performed along the rail corridor. The HMM report notes that there is a speed restriction of the culvert at mile 114.95. No repairs were observed at this location. This section of track is not currently in service.

Figure 5: Typical Drainage Ditch Observed at Langford. shows a typical example of the drainage along the Island Rail Corridor. Vegetation within ballast and drainage ditch but still deemed to be in fair condition allowing the water to flow away from the track maintaining it's integrity.

**Figure 5: Typical Drainage Ditch Observed at Langford.**

### *5.1.2 WASHOUTS*

During the site investigation two repaired washouts were observed. The first was a washout of the track at approximately mile 37 of the Victoria Subdivision. SVI had repaired the washout by placing armouring material at the base of the road bed and re-establishing the track. Washout repairs typically require the dumping of armouring material into the waterway to re-establish and protect the track bed. On operating railways this is done as quick as possible (and mandated by federal regulators in some cases) to re-open the track for the movement of goods and passengers and to generate revenue. Without being present during the placement of the armouring material WSP cannot confirm the slope's integrity. However, from visual inspection it appeared to be suitable for rail loading and to mitigate washouts. Given the proximity, angle of approach and history of the waterway, this site should be monitored to confirm the repair is performing. SVI indicated they have not observed issues at this site since the repair was made. Refer to Figure 6: Washout at mile 37 – Victoria Subdivision.

**Figure 6: Washout at mile 37 – Victoria Subdivision**

The second repaired washout was observed at approximately mile 84.4 of the Victoria Subdivision which was created by the washout of Rumming road located directly above the rail corridor. The slope from the rail up to the road was repaired. A new 900mm culvert was installed under the rail track to convey drainage from the above road safely under and away from the track. Refer to Figure 7: Washout at mile 84.4 - Victoria Subdivision.

**Figure 7: Washout at mile 84.4 - Victoria Subdivision**

## 5.1.3 SLOPE FAILURE

A slope failure was observed at approximately mile 22 of the Victoria Subdivision just south of Shawnigan Lake. SVI indicated that the downside slope failure was not caused naturally but by a third-party excavation of the toe of the slope approximately 100 feet below the rail line. Due to this slope failure the track was impassable at this location. WSP did not confirm the cause of the slope failure as repair of the slope failure is in the process of being addressed with the parties involved. Refer to Figure 8: Slope Failure at mile 22.

**Figure 8: Slope Failure at mile 22**

## 5.1.4 VEGETATION

The Track Safety Rules state that vegetation on railway property which is on or immediately adjacent to the road bed must be controlled so it does not:

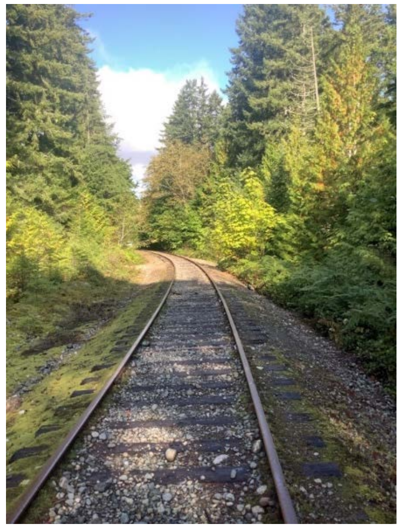
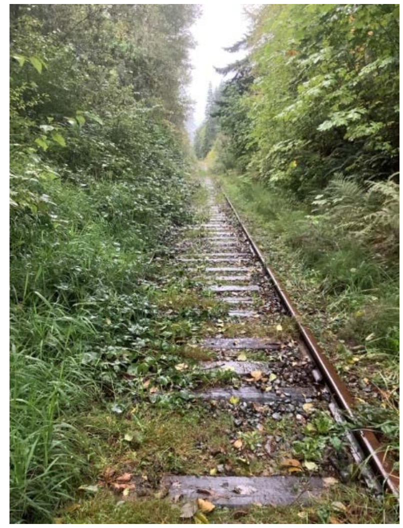
- Become a fire hazard to track carrying structures;
- Obstruct visibility of railway signs and signals;
- Interfere with railway employees preforming duties;
- Prevent proper functioning of signals and communications; or
- Prevent railway employees from visually inspecting moving trains.

Therefore, regular maintenance and removal of vegetation is key to maintaining a safe railway.

The HMM report stated since 2006, SVI has a Pest Management Plan (PMP) in place and is using chemical herbicides (Vantage) and brush cutting to maintain the corridor. The report mentioned that the herbicide does not kill the roots of the vegetation, so its effectiveness is determined by the timing and frequency of the program.

During WSP's site investigations during the summer of 2019, SVI confirmed they have a brush cutting program, and clarified that they use glyphosate, an active chemical in Vantage to control vegetation. SVI added that it does kill the roots of much of the vegetation, however is not very effective at controlling cedar and fir that grows along the corridor.

**Table 2: Vegetation Condition Example Photos**

| Vegetation Condition Example Photos | | |
|---|---|---|
|  |  |  |
| Typical "Good" Vegetation Condition | Typical "Fair" Vegetation Condition | Typical "Poor" Vegetation Condition |

The current condition, of vegetation observed from the site investigation, is similar to the conditions noted in the 2009 HMM report. There is still vegetation within the ballast and trees obstructing the sightlines along both subdivisions. Victoria subdivision is in better condition than the Port Alberni subdivision, as the PMP is not in place on the Port Alberni subdivision. Above, Table 2: Vegetation Condition Example Photos shows a typical example of Good, Fair and Poor vegetation conditions along the corridor. The overall condition of the vegetation along the railway corridor ranges between Fair and Poor.

Below, Table 3: Vegetation Condition by Segment shows the average condition of the vegetation broken down by segment. For further detail on the condition of the vegetation and inspection reports, see Appendix A: Track Condition Assessment Report.

**Table 3: Vegetation Condition by Segment**

| Segment | Vegetation Condition |
|---|---|
| Segment 1: Victoria to Langford | Fair |
| Segment 2: Langford to Duncan | Fair - Poor |
| Segment 3: Duncan to Nanaimo | Fair |
| Segment 4: Nanaimo to Parksville | Fair |
| Segment 5: Parksville to Courtenay | Fair - Poor |
| Segment 6: Parksville to Port Alberni | Poor |
| Wellcox Yard | Good |

## 5.2 TRACK GEOMETRY

The track geometry encompasses track alignment of the railway, comprising of tangents (straight sections), spirals, super elevation, curves, track surface (track smoothness), level and cross-level, track grade and vertical curves. To maintain the track geometry, regular monitoring conducted by a track testing vehicle is used. The track testing vehicles measure the horizontal and vertical alignment, super elevation (track angle through curves), track surface, track gauge (distance between rails) and notes any potential issues.

The 2009, HMM report states that SVI employ Holland TrackStars run track testing vehicles to measure the track geometry and tie conditions annually. While conducting site investigations in August 2019, it was observed that SVI continue to employ Holland TrackStars to measure the track geometry and track surface. SVI indicated that they test track within the 10 mile radius of Nanaimo more frequently than once per year since it is currently in service. The remainder of the Victoria subdivision is tested annually using the Holland TrackStar. SVI does not run the track geometry vehicle on the Port Alberni Subdivision. Please refer to Figure 9: Holland TrackStar Vehicle observed in Nanaimo.


**Figure 9: Holland TrackStar Vehicle observed in Nanaimo**

During the site inspections, it was noted that the general track surface was observed to be in a fair condition across the Island Rail Corridor. No appreciable twisting or warping of the track was detected. The track geometry was observed to be in fair condition. While class of track is restricted in some sections, for instance through the Malahat summit, or through the Capital Regional District (CRD), the condition of the Victoria subdivision is found to be in acceptable Fair condition. Track geometry has more restrictive design guidelines than road geometry; it takes longer for a train to 'turn' than an automobile. Where tighter geometry is required to navigate around natural features, speeds will typically have to be reduced and the track will be super-elevated in curves to compensate for such conditions. For further detail on the condition of the track geometry and inspection reports, see Appendix A: Track Condition Assessment Report.

## 5.3 TRACK STRUCTURE

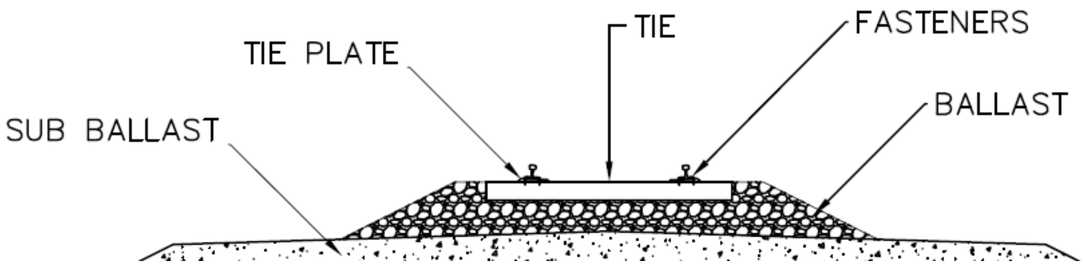



**Figure 10: Typical Track Structure**

The track structure consists of the rails, fasteners, railroad ties and ballast, plus the underlying subgrade. It enables trains to move by providing a dependable surface for their wheels to roll upon. As shown in Figure 10, is a section of a typical single-track railway similar to what can be found on the Island Rail Corridor. Track is a combination of elements consisting of two rails fastened to timber ties by a rail spike/tie plate fastening system, all supported in a course granular encasement placed, on a free draining graded granular surface overlaying a structural soil. The rail, tie and fastening system is similar to that shown below in Figure 11: Rail Spike Fastening System. The Fastening system is made up of a rail spike, tie plates and anchors.

**Figure 11: Rail Spike Fastening System**

### 5.3.1 TIES

The purpose of rail ties is to maintain the gauge between the rails and to distribute the loads from the trains down through the ballast and into the underlaying structural soils. For the most part, the Island Rail Corridor use timber ties sourced in British Columbia.

Over time timber ties deteriorate and may loose gauge. This leads to the need to replace the track ties or to lower track speeds in order to maintain a safe railway operation. Transport Canada Safety Regulations (2012) state:

- Trackage specifications employing a track tie spacing of 22 inches can expect to have 21 track ties per 39-foot length of track
- For Class 2 Track, each 39 foot segment of rail requires 8 non-defective ties (approximately 40% of segment), with one non-defective tie located within 24 inches of a rail joint.

- For Class 3 Track, each 39 foot segment of rail requires 10 non-defective ties (approximately 50% of segment), with one non-defective tie located within 18 inches of a rail joint.

A defective tie is defined as:

- broken through;
- split or otherwise impaired to the extent the crossties will allow the ballast or even vegetation to work through, or will not hold spikes or rail fasteners;
- so deteriorated that the tie plate or base of rail can move laterally more than 1/2 inch relative to the crossties; or
- cut by the tie plate through more than 40 percent of a tie's thickness.

**Table 4: Tie Condition Photos**

| Tie Condition Example Photos | | |
|---|---|---|
|  |  |  |
| **Typical "Good" Tie Condition** | **Typical "Fair" Tie Condition** | **Typical "Poor" Tie Condition** |

As stated in the 2009, HMM report, groups of decayed ties and decayed ties under rail joints were deemed to be non-compliant with rail safety regulations and that an estimated 260,000 ties will reach their service life within the next 15-20 years (now 5-10 years away).

During the 2019 inspection, an estimated 180,000 ties (45% of all ties) across both subdivisions are currently considered defective. The overall conditions of the ties were deemed to be in Poor condition. However, it was noted in the Nanaimo rail service area that ties have been replaced and the track is operational.

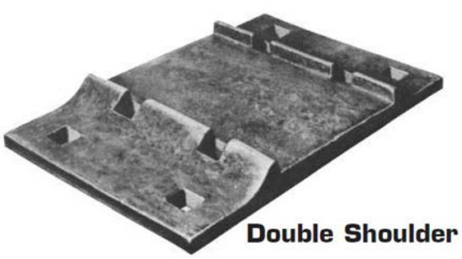
Below, Table 5: Tie Percent by Segment, shows the average percent defective ties per segment. For further detail on the condition of the ties and associated inspection reports, see Appendix A: Track Condition Assessment Report

**Table 5: Tie Percent by Segment**

| Segment | Average percent of defective ties |
|---|---|
| Segment 1: Victoria to Langford | 50% |
| Segment 2: Langford to Duncan | 47% |
| Segment 3: Duncan to Nanaimo | 51% |
| Segment4: Nanaimo to Parksville | 53% |
| Segment 4: Parksville to Courtenay | 58% |
| Segment 5: Parksville to Port Alberni | 34% |
| Wellcox Yard | 25% |

### 5.3.2 TIE PLATES

As shown above in Figure 11: Rail Spike Fastening System, tie plates are part of the rail spike fastening system and separate the rail from the ties. Tie plates serve as a bearing plate between the base of the rail and surface of the track tie. They serve as a mechanism to spread the train loads through the rail onto the tie. Tie plates are generally held in place using rail spikes. The plates are typically either single shoulder plates or double shoulder, as shown in Figure 12: Types of Tie Plates. Shoulders help hold the rail in place and increase the life of the rail spikes by reducing the shear load against the spike and reduces the rotational torque applied to the spike from the rail, thus increasing the life of the track tie. Larger dimensioned plates, while more costly, can improve load distribution to the tie and tie longevity.



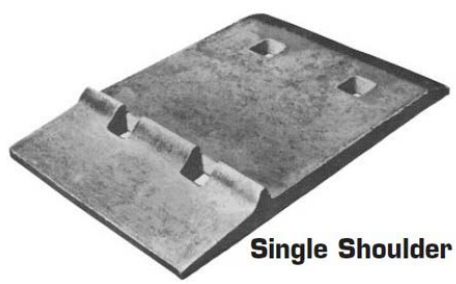




**Figure 12: Types of Tie Plates**

The 2009, HMM report states, that approximately 60% of the Island Rail Corridor has single shoulder plates. During the site 2019 inspection it was observed that the majority of the tie plates were single shoulder and it is agreed that double shoulder plates would be preferred to provide increased performance and tie longevity. This assessment defined that a single shoulder plate was considered to be in Poor condition and double shoulder plates were considered to be in Fair condition.

## 5.3.3 RAIL

Rail is the main structural part of the track structure that interfaces with the train wheels. Rails comes in different sizes that vary in weight, height, width and section which allows for different train loads. The majority of rail on the Island Rail Corridor is 85lb rail, with some sections containing 100lb and some newly upgraded 115lb rail mainly the at upgraded rail grade crossings. From a load carrying capacity, 85lb rail is not preferred for heavy axel loading (286,000 lbs railcar loading). Refer to Figure 13: Typical Rail Section.

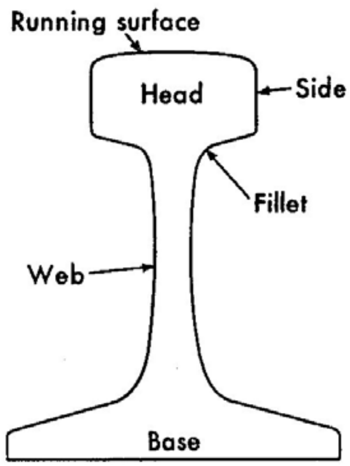



Figure 13: Typical Rail Section

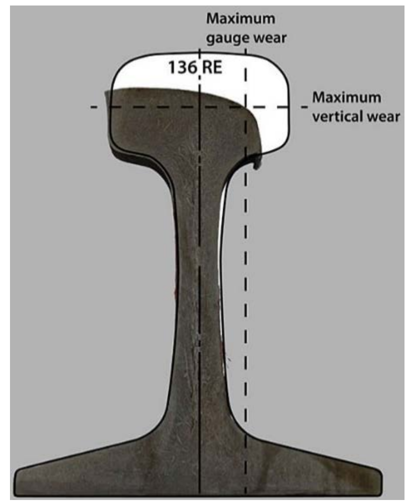



Figure 14: Head Loss (136lb rail)

The 2009, HMM report, describes that the existing rail along the corridor is in fair (adequate) condition. 2019 site investigations also found that the rail is also in fair condition. The 2019 investigation also found that the rails have an average of 7.7mm of rail head loss, with a maximum measured value of 10mm. Head Loss is where the combination of the train load and wheel dynamics have worn down running edge of the rail.

Refer to Figure 14: Head Loss (136lb rail). Shows an example of 10mm head loss which is deemed condemnable on CN and CP mainline Class 1 track. However, the level of operation is important to consider when assessing the appropriateness of the rail's condition; and therefore, the rail is found to be in fair condition.

Table 6: Rail Condition by Segment, shows the average condition and amount of head loss observed, separated into segments. For further detail on the condition of the ties and associated inspection reports, see Appendix A: Track Condition Assessment Report

Table 6: Rail Condition by Segment

| Segment | Average Rail Condition | Average Head Loss (mm) |
|---|---|---|
| Segment 1: Victoria to Langford | Fair | 7.6 |
| Segment 2: Langford to Duncan | Fair | 8.3 |
| Segment 3: Duncan to Nanaimo | Fair | 9.0 |
| Segment4: Nanaimo to Parksville | Fair | 5.5 |
| Segment 4: Parksville to Courtenay | Fair | 8.0 |
| Segment 5: Parksville to Port Alberni | Fair | 7.4 |
| Wellcox Yard | Fair | 10.0 |

## 5.3.4 RAIL JOINTS

Rail joints connect rail sections together to create a continuous running surface for the wheels of the trains to operate on. The condition of rail joints has an impact on the railway operating speed, train performance and in the case of a commuter service, the passenger comfort experience. The joint bar assembly provides for a minor amount of longitudinal movement of the rails to accommodate for rail expansion and contraction resulting form changes in temperature. Where there are gaps between the rail ends, or a difference in rail heights at joints, both passengers and trains are affected. Defects like these also have an impact on train journey times as the trains speeds are slowed through theses sections. Left unaddressed, these defects can accelerate damage to the rail and track structure.


**Figure 15: Joint Bar Types**

As mentioned in the 2009, HMM report, there are three types of joint bars used on the Island Rail Corridor. Splice bars, toeless joint bars (standard joint bars) and angled joint bars known as "toe bars" (as shown above in Figure 15). Angled joint bars are older technology and cause wear issues under the head of the rail as well as accelerate tie and tie plate wear. The 2009 Report noted there were many joints that were "frozen" due to bolts of the joint bars being rusted together, leaving the track susceptible to buckling.

**Figure 16: Standard Joint Bar**

**Figure 17: Angle Joint Bar**

The 2019 site inspections noted similar issues with "frozen" rail joints. The inspections identified standard (refer to Figure 16: Standard Joint Bar) and angled (refer to Figure 17: Angle Joint Bar) joint bars. For the purposes of this assessment, it was deemed that angled joint bars are considered to be in Poor condition while standard joint bars are in Fair condition.

## 5.3.5 BALLAST

Ballast is the aggregate on which the tie sits and is made up of selected uniform sized angular aggregate possessing one or more fracture faces, and capable of free draining. Ballast is used to distribute the static and dynamic train loads throughout the track grade. The ballast also is used to drain the track and allow water to flow through and into the drainage ditches typically located on either side of the track. The shoulder of the ballast (ballast on the outside of the tie) is designed to restrain the lateral forces of the track and prevent the track from moving.

**Figure 18: Typical Ballast Along the Corridor**

The 2009, HMM report, noted that the ballast on the Island Rail Corridor has been fouled with fine granular (typically sediment and organics). Recent inspections noted similar issues along the corridor. The inspection identified certain areas to be in Poor condition. Figure 18: Typical Ballast Along the Corridor, shows a typical example of ballast fouled with mud and vegetation. Fouled ballast, poorly distributes loads from the track, reduces drainage, increases maintenance requirements and other track issues.

Below, Table 7: Ballast Condition by Segment shows the average condition of ballast and shoulders broken down into segment. For further detail on the condition of the ballast, ballast cribs (space between each tie), shoulder and site inspection reports, see Appendix A: Track Condition Assessment Report.

**Table 7: Ballast Condition by Segment**

| Segment | Average Ballast Condition | Average Shoulder Condition |
|---|---|---|
| Segment 1: Victoria to Langford | Poor | Fair - Poor |
| Segment 2: Langford to Duncan | Fair - Poor | Poor |
| Segment 3: Duncan to Nanaimo | Fair - Poor | Poor |
| Segment4: Nanaimo to Parksville | Fair - Poor | Fair - Poor |
| Segment 4: Parksville to Courtenay | Poor | Poor |
| Segment 5: Parksville to Port Alberni | Poor | Fair - Poor |
| Wellcox Yard | Poor | Fair |

## 5.4 TURNOUTS

Turnouts are a specific track fixture that allows the train to move from one track to another. Turnouts are used at railway junctions to switch between track, allow for passing of trains and connect two different lines or branches together (two different subdivisions or spurs). Figure 19: Typical Turnout within Corridor, shows a typical turnout on the Island Rail Corridor.

**Figure 19: Typical Turnout within Corridor**

The 2009, HMM report states that there is a mixture of 85lb and 115lb rail turnouts on the Island Rail Corridor. It also states the turnouts are in a good to fair condition noting that most turnouts are in need of varying levels tie replacement. In the recent 2019 site inspections, similar observations were noted. The condition of the ties within the turnout were considered to be fair to poor. There rail was also noted to have been worn, with 11mm of head loss as seen on some components of the turnout.

The Victoria subdivision (including Wellcox yard) and the Port Alberni subdivision have 78 and 20 turnouts respectively. Overall the turnouts are considered to be in fair condition across the corridor, requiring some tie replacements and re-gauging. For further detail on the condition of the turnouts and inspection reports, see Appendix A Track Condition Assessment Report.

## 5.5 STRUCTURES

### *5.5.1 BRIDGES*

Bridges located along the Island Rail Corridor are an assortment of structures which have a wide variation in type, age and condition. Previous detailed inspection of the bridges along the Victoria Subdivision and Wellcox Spur were completed in 2011. Of the 48 bridges located on the Victoria Subdivision, 31 bridges were inspected in 2019 to confirm the overall condition and to determine if any major deterioration had occurred since the 2011 inspections. No previous inspection data was available for the 19 bridges located on the Port Alberni Subdivision. Overall 13 out of the 19 bridges on the Port Alberni Subdivision were inspected in 2019 to ascertain an overall representative condition assessment of the structures.

The 2019 Victoria Subdivision bridge inspections found the condition of the structures to be in general conformance with the 2011 inspections, demonstrating an overall condition of the bridges varying from good to poor. Based on the inspections, most bridges will require minimal levels of rehabilitation to re-establish rail traffic. Several of the steel bridges were repurposed by CPR, being relocated from other locations in the country when CPR undertook upgrading programs. Much of this activity took place in the first decades of the 1900's. Many of the timber bridges were constructed through the 1940's and 1950's with maintenance and upgrades during the 1980's. Bridges located on the Port Alberni Subdivision are primarily timber trestles, which will require major rehabilitation or replacement within the next 50 years. The other structures on the subdivision are in Good to Fair condition.

The table below summarizes the general condition of the bridges based on each segment. Overall condition ratings are based on the expected level of effort and cost to maintain and or replace the steel structures on each segment for the next 50 years:

- Good: Only minor rehabilitation and maintenance is expected.
- Fair: Low to moderate risk of replacement or major rehabilitation for several structures.
- Poor: Major rehabilitation or replacement is expected for either several small or one or more large structures.

**Table 8: Bridge Segment Summary Table**

| Segment | Overall Condition[1] | General Comments | Initial Cost | Cost (50 yr maintenance/ rehabilitation/ replacement) |
|---|---|---|---|---|
| **Victoria to Langford** | Good | • Mostly newer structures, built after 1997 | $211,500 | $569,500 |
| **Langford to Duncan** | Poor | • 2 timber structures will should be considered for replacement within the next 50 years<br>• Niagara Canyon and Cowichan River bridge have a high risk of replacement within the next 50 years | $10,952,500 | $28,543,500 |
| **Duncan to Nanaimo** | Fair | • 3 timber structures will require replacement within the next 50 years | $12,311,500 | $5,714,000 |
| **Nanaimo to Parksville** | Fair | • 2 timber structures will require replacement within the next 50 yeas | $5,474,000 | $4,386,500 |
| **Parksville to Courtenay** | Fair-Poor | • 2 timber structures will require replacement or major rehabilitation within the next 50 years<br>• Tsable River bridge deck truss has a moderate risk of requiring replacement | $9,471,000 | $34,333,500 |
| **Port Alberni** | Fair | • 13 timber structures will require replacement within the next 50 years | $34,704,500 | $19,178,000 |

[1] Overall condition does not encompass timber bridges as it is expected that all timber bridges will require major rehabilitation or replacement within the next 50 years, therefore not affecting the level of effort required over that time period

Previous load ratings of the bridges located on the Victoria Subdivision were completed in 2012. Based on the 2019 inspection results the 2012 load ratings are still representative of the current bridge conditions. The load ratings identified all bridges are capable of supporting passenger vehicles (RDC-1). However, historical speed restrictions of 10, 15, and 20 MPH do exist on several bridges. All 48 bridges were load rated for heavier 286 kip (286,000lb) freight cars. This identified several bridges that require rehabilitation or further analysis prior to supporting heavier loading conditions.

Several inspected bridges which pass over top of roadways had lower vertical clearance to the roadway than permitted by the MoTI standard of 5m, as required for new bridges. The Shawnigan Lake Road Bridge (mile 26.80) and Koksilah Road Bridge (mile 35.60) have excessively low vertical clearances of 3.40m and 2.90m respectively. The minimal clearances effect the availability for use as routes for certain types of vehicles and trailers. The restricted clearance increases the chance of vehicle impact on the bridge superstructures. The Shawnigan Lake Road Bridge superstructure was replaced in approximately 2005 presumably due to a vehicle impact.

Listed below are several of the bridges located on the Victoria Subdivision which are in poor condition and/or have a high risk of replacement within the next 50 years.

## Niagara Canyon Bridge

Niagara Canyon Bridge, located at mile 14.0, is a 160.2m long double cantilevered deck truss supported on masonry block abutments and piers. The bridge was originally fabricated in 1883 located on CPR in Quebec and was moved to its current site in 1912. Strengthening of the cantilever deck truss occurred in 1928 as well as 1940.

Considering the age of the structure and results of the inspection which identified several minor deficiencies the risk of replacement over the next 50 years was estimated at 70%. The estimated cost to replace the structure is $22,000,000.

**Figure 20: Niagara Canyon Bridge - mile 14.0**

## Cowichan River Bridge

Cowichan River Bridge, located at mile 39.30, is an open deck single span double through truss supported on masonry block abutments. Truss elements are wrought and cast iron with floor beams and stringers made of steel plate beams. The truss was fabricated in 1876 and the abutments were constructed in 1892.

Initial rehabilitation costs to support recommencement of passenger vehicle rail traffic has been estimated at $748,000. The cost is largely due to several deficiencies identified during the inspections. However, even with the required bridge rehabilitation the bridge still has a high risk of replacement within the next 50 years. Therefore, bridge replacement prior to the recommencement of rail traffic may be the most cost effective. Bridge replacement is estimated to cost $4,950,000.

**Figure 21: Cowichan River Bridge – mile 39.30**

## French Creek Bridge

French Creek Bridge, located at mile 98.60, consists of a combination of timber frame trestle approach spans, and steel plate girder main spans that are supported on steel lattice towers. The steel girder spans were constructed in 1913 and the timber frame trestle spans were constructed in 1977. Some maintenance replacement of timbers on the trestle spans has occurred since 1977.

The timber trestle spans were assessed to be in good condition however it is not expected that the timber elements will last another 50 years. Due to the combined length of the timber spans (275m) the cost to replace or rehabilitate the spans is appreciable. The cost to replace the timber spans with a concrete and steel structures is estimated to cost $17,000,000 while rehabilitating the timber spans over the next 50 years is estimated to cost $14,000,000.

**Figure 22: French Creek - mile 98.60**

## 5.5.2 CLEARANCES

The clearance requirements for trains as measured to other objects such as buildings, bridges, fixtures and other trains is identified in regulatory requirements for the safe operation of trains. Clearances from vehicles to structures and overhead obstructions is captured by the Ministry of Transportation and Infrastructure design requirements. Where there are restricted clearance issues between vehicles to bridges, therein lies a risk to the safety of the railway and the public. Bridges impacted by vehicles cause damage to the bridges, pose a risk to the public using the roadway, can potentially pose a risk to train movements and render the bridge unserviceable for railway operations. Attention to substandard clearance issues with railway structures is a safety risk to the railway and to the public.

The 2009, HMM report, reported that there were low clearances on bridges across highways. Damage caused by low clearance issues were noted during the bridge inspections. Figure 23: Shawnigan Lake Road Bridge Impact. shows Shawnigan Lake Road Bridge, on the Victoria Subdivision, having been impacted by vehicle collisions. Road signs were observed on roadways with at-risk bridge locations.

For further details of the bridge clearances and the bridge inspection reports, see Appendix C: Bridge Condition Assessment Report.


**Figure 23: Shawnigan Lake Road Bridge Impact.**

The clearance issues between adjacent tracks has a low risk of potential issue as the Island Rail Corridor is predominantly a single line railway with intermittent sidings along the corridor. The Holland TrackStar track vehicle has the ability to measure clearances and does so as part of the annual inspection. This was observed during their annual survey of the track in August 2019.

## 5.5.3 ROCKFALL

Rockfall needs to be managed for both railways and roadways running through mountainous areas. Rocks falling onto the track cause risk to the safety of the train and occupants. Due to the terrain the railway passes through, visibility of rocks on the tracks is a concern. Rockfall mitigation measures (rockfall meshes and rockfall detectors) are typically in place along high risk areas of rockfall activities.

The 2009, HMM report identified potential rock fall sites at Mile 15.6, 15.7, 16.2 and 16.3 Victoria Subdivision noted "active rock faces with freshly fallen material in the ditches and significant cracking between the blocks".

The 2019 site inspection conducted a similar assessment along the Victoria Subdivision, identifying areas between Langford and Shawnigan Lake as having potential rockfall risks. Areas of risk were noted between Mile 13.1 and 21.3. The Port Alberni Subdivision was also inspected and noted potential risks east of Cameron Lake to Summit Lake.

**Figure 24: Rockfall Located on Port Alberni Subdivision**

Figure 24: Rockfall Located on Port Alberni Subdivision above, shows an example of existing rockfalls located on the Port Alberni Subdivision. For further details about rockfall risks and mitigation options, see Appendix D: Rockfall Assessment Memo.

## 5.6 FENCING

Fencing along the rail corridor is intended to deter people, vehicles and livestock from access to the track. Railway fencing as defined by Regulatory Authorities is typically four-by-four wire mesh fencing fabric on wooden fence posts. It is at the discretion of the land owner or Civic Authority to provide an upgrade to chain link, wooden or livestock proof fencing.

As stated in the 2009, HMM report, the fencing is on fair to good condition. However, also stated is there are reports of a number of trespasser issues as noted during the 2006 and 2009 site inspections. Fencing and other measures were noted to be possible mitigations for trespasser issues.

Similar issues were noted during the 2019 inspections. Fencing is commonly employed to mitigate trespass and associated liability. The existing fencing where installed was noted to be in Fair to Good condition within the residential or urban areas such as Victoria and Nanaimo.

# 5.7 CROSSINGS

## 5.7.1 GRADE & PEDESTRIAN CROSSINGS

A level grade or pedestrian crossings exist where a road or foot path cross a railway line. Below in Figure 25: Typical Grade Crossing, is a diagram of a typical break down of a level crossing, as per Transport Grade Crossing Canada Standards.

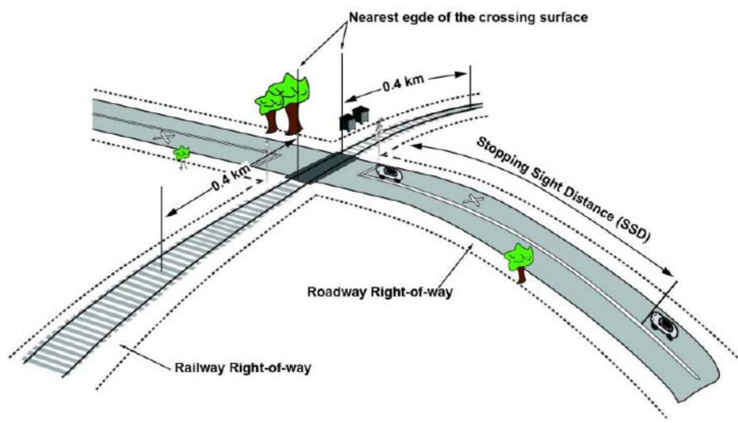
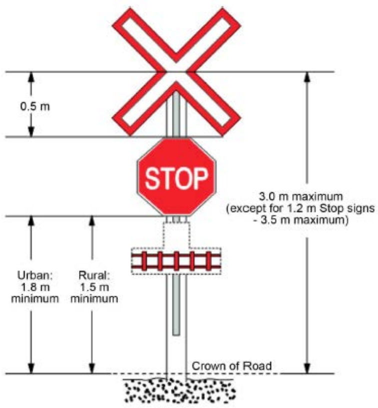
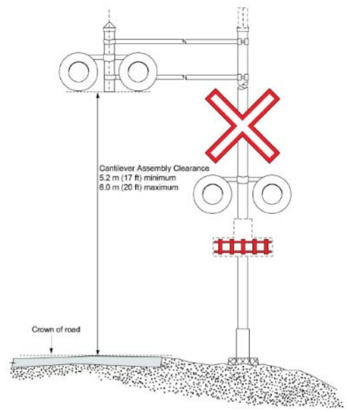
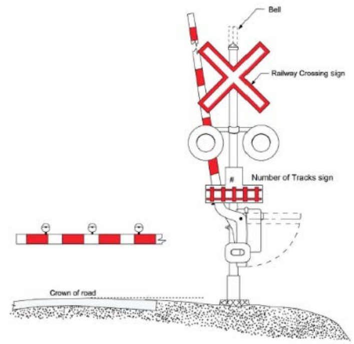



**Figure 25: Typical Grade Crossing**

The Island Rail Corridor has 236 at-grade crossings (including pedestrian crossings) across both the Victoria and Port Alberni Subdivisions. Grade crossing protection systems are divided into passive crossings (non signalized), and active level crossings (signalized crossings). Active crossings are further broken down into two types, the maximum level of crossing protection is offered by Flashing Lights, Bell and Gates (FLB&G) and the slightly lesser level of protection is offered by Flashing Lights and Bell (FL&B). Gates are warranted where train and vehicle traffic levels exceed target levels. Gates are typically installed with FL&B (becoming FLB&G) where sight lines of a train movement from the at-grade are obscured or restricted sufficiently or warranted by the Transport Canada Grade Crossing Regulations and Standards (2015), or where safety protocols warrant the additional protection. Example diagrams of the various levels of crossing protection from Transport Canadas Grade Crossing Standard (2015) can be seen in Table 9Table 9: Grade Crossing Types.

The type of grade crossing protection system is determined by, among other things, the number of trains/vehicles using the crossing, crossing/road surface, the road approach, the proximity to adjacent roadways and the sightlines (fields of vision) between the train and vehicles and vehicles and obstructions.

**Table 9: Grade Crossing Types**

<table>
<tr><th colspan="3">Crossing Types and Protection</th></tr>
<tr>
<td>
</td>
<td>
</td>
<td>
</td>
</tr>
<tr>
<td>Passive Crossing – cross bucks only-<br>Addition of Stop Signs may be applicable as warranted</td>
<td>Active Crossing – FLB<br>Flash Lights and Bell.</td>
<td>Active Crossing – FLBG<br>Flash lights, Bell and Gates</td>
</tr>
</table>

The 2009, HMM report stated that some of the crossing equipment on the Victoria Subdivision may have reached their service life. Where replacement parts are no longer supported by the manufacturer, upgrades should be considered. For the 2019 crossing condition assessments, a rating system of poor, marginal, adequate, good and excellent was used. For better definition of this rating system please refer to Appendix B: Crossing Condition Assessment Report. These assessments determined that the crossings were overall in adequate condition. For the purposes of this summary report and consistent rating terminology, the overall condition of the crossings are considered to be in Fair condition.

Assessing the individual components of the grade crossing determined that sightlines range from Poor to Fair, with an average of Fair. Sightline improvements, like vegetation clearance, will improve the condition. The automatic crossing protection warning systems were also determined to be out of date and in need of upgrade or replacement in some cases.

The below Table 10: Crossing Condition by Segment show the number of crossings per segment and the average condition of the crossing. The crossings were assessed against Transport Canada's Grade Crossing Regulations and Standards (2015). For further details of the crossing conditions, refer to Appendix B: Crossing Condition Assessment Report.

**Table 10: Crossing Condition by Segment**

| Segment | No of Grade Crossings per Segment | Average condition of Grossing |
|---|---|---|
| Segment 1: Victoria to Langford | 20 | Fair |
| Segment 2: Langford to Duncan | 28 | Fair |
| Segment 3: Duncan to Nanaimo | 61 | Fair |
| Segment4: Nanaimo to Parksville | 35 | Fair |
| Segment 4: Parksville to Courtenay | 56 | Fair - Poor |
| Segment 5: Parksville to Port Alberni | 33 | Fair - Poor |
| Wellcox Yard | 3 | Fair |

### 5.7.2 WIRE & PIPE CROSSINGS

Overhead or underground wires, pipes, poles and fibreoptic cable crossings exist along the Island Rail Corridor. Utility crossings require railway approval to cross the corridor and must comply with provincial and in some cases federal guidelines. In each instance a separate agreement is required to be produced for each utility covering responsibilities and obligations between the railway and the utility owner. Where utilities cross above the track, the utility owner is obligated to ensure that utility remains sufficiently above the limits of the clearance envelope (provided by the Transportation Regulator). When disrepair, acts of environment, or neglect by the utility owner occurs, the railway becomes concerned with encroachment into the railway envelope (airspace occupied by the train as it moves). When utilities cross under the track, the railway is warry about the contact with wrongfully installed utilities during maintenance activities involving signaling, drainage, and rail loading impact on said utility. No clearance issues were noted in the 2009, HMM report. Similarly, during the 2019 site investigations, no clearance issues were observed with overhead wires furthermore buried utilities presented no observable issue.

## 5.8 COMMUNICATION

The 2009, HMM report indicates that “Communication is by radio and cell phone. There are two repeater towers used for radio. The south repeater covers Victoria to Nanaimo and the north repeater covers Nanaimo to Parksville. Personnel can communicate through either repeater to the Rail Traffic Controller (RTC) but cannot call to each other when on different repeaters. The equipment is relatively modern; 8 years old and is properly maintained.”

Through discussions with SVI during the workshop and the site investigations, SVI confirmed the communication system is in good working condition and suitable for the required function. They also clarified that the north repeater, located on Mount Cokely, covers from Nanaimo to Courtenay plus the Port Alberni subdivision, and that the south repeater tower is located on Salt Spring Island. These towers were not observed during the site investigations due to accessibility.

## 5.9 BUILDINGS & FACILITIES

During the workshop with SVI, ICF and MoTI on the 15th of July 2019, it was indicated that of the existing railway stations some are leased out, some to be handed over to municipalities and others were in poor condition or not appropriate for future station use. This discussion determined that in all cases the existing stations would not be used for a future rail service and that assessing their condition was not required.

Existing offices are co-shared by ICF and SVI, and the workshop facilities support SVI's daily operations. The Wellcox Yard barge ramp that supports transport of railcars between Vancouver Island and the lower mainland via rail-barge is owned and maintained by Seaspan. As part of the same workshop it was determined that the offices, workshops and barge ramp would not have their condition's assessed.

## 5.10 ROLLING STOCK (RAIL CARS)

During the July 15th workshop, it was also noted that the ICF do not own rolling stock that run on the Island Rail Corridor. All rollingstock is supplied and maintained by SVI or others. In addition, rollingstock does not always stay on the island as it is exchanged with different rollingstock related to new railcar shipments through Wellcox Yard barge ramp. Accordingly, it was determined that assessing the condition of rolling stock running on the Island Rail Corridor would not be required as part of this assessment.

# 6 IMPROVEMENTS

## 6.1 PHASED IMPROVEMENT APPROACH

A phased improvement approach was developed based on meetings held with ICF, SVI, MoTI, Technical Safety BC, site visits, findings, previous reports reviewed, and different potential use cases being considered for the Island Rail Corridor. With these inputs, WSP has outlined a rehabilitation program that entails three improvement phases: Initial, Intermediate, and Ultimate; each will be elaborated on in Phased Improvements below.

Phasing the improvements allocates the appropriate amount of funding for the appropriate levels of demand. For example: When rail volumes increase beyond the Initial phase, capital would be required to implement the Intermediate phase. Similarly, as rail traffic volumes increase beyond the Intermediate phase, capital would be required to implement the Ultimate phase. If rail traffic volumes did not increase, then additional capital funding would not be required (excluding maintenance and operations). Furthermore, dividing the corridor into six different segments allows flexibility for phased improvements to be implemented where and when there is demand.

The phased rationale is based on carrying out improvement works to meet Technical Safety BC and Transport Canada's maximum allowable operating speeds as identified in Figure 26: Classes of Track: Operating speed limits in mph (Rules Respecting Track Safety, 2012, Part II, Section A). These improvement works discussed will include structure upgrades (to allow trains to move faster over the structure) and upgrading at-grade rail crossings to allow for rail traffic to move through intersections unimpeded. Several sections of the corridor cannot attain the intended track class speed due to geometric limitations such as summitting the Malahat Pass and navigating through the winding track geometry in the CRD. Table 11: Geometric Constraint Location between Victoria and Duncan - Ultimate Phase, identifies locations where the operating speed is limited due to track geometry between Victoria and Duncan. However, the overall average anticipated track speeds will support the studied scenarios. Therefore, changes to track geometry are not considered at this time.

**Maximum allowable operating speeds**

| Over track that meets all of the requirements prescribed in this part for- | The maximum allowable operating speed for freight trains is - | The maximum allowable operating speed for passenger trains is - |
|---|---|---|
| Class 1 track | 10 | 15 |
| Class 2 track | 25 | 30 |
| Class 3 track | 40 | 60 |
| Class 4 track | 60 | 80 |
| Class 5 track | 80 | 95* |

* For LRC Trains, 100

**Figure 26: Classes of Track: Operating speed limits in mph (Rules Respecting Track Safety, 2012, Part II, Section A)**

**Table 11: Geometric Constraint Location between Victoria and Duncan - Ultimate Phase**

| Geometric Constraint Location between Victoria and Duncan – Ultimate Phase | | |
|---|---|---|
| **Mile Range** | **Approximate Operating Speed (MPH)** | **Constraint** |
| 0.0 – 1.6 | 10 to 15 | Very tight horizontal curvature |
| 1.6 – 4.1 | 25 to 30 | Tight horizontal curvature |
| 4.1 – 4.2 | 10 | Very tight horizontal curvature |
| 11.8 – 11.9 | 10 | Very tight horizontal curvature & steep vertical grade |
| 11.9 – 28.3 | 25 to 30 | Tight horizontal curvature |
| 28.3 – 28.4 | 10 | Langford to Duncan |

## 6.2 PHASED IMPROVEMENTS

The approach to track restoration has been divided into three phases. In each phase, a rail traffic volume Use Case is assigned and provides a corresponding track class and load characteristics. Additional detail on the specific track infrastructure upgrades can be referenced in Appendix H: Phased Improvements – Track Restoration. Increase of Use Case is dependant on the steady increase in operation/demand of both freight and passenger services and are not dependent on time. The approach below is designed to be in sequential order, i.e. if the Ultimate Phase is selected, the Initial and Intermediate Phase upgrades would have to be completed prior to proceeding with the Ultimate Phase upgrades.

### 6.2.1 INITIAL PHASE

Initial Phase Improvement: includes costs to upgrade infrastructure to re-establish a minimum rail freight and passenger service along the rail corridor.

| **Initial Phase: Class 2 Track Standard Restoration** | |
|---|---|
| **Use Case:** | • 2-4 passenger trains per day<br>• 2-4 freight trains (10-20 car trains) per day |
| **Track Characteristics:** | Class 2 Track Standard (25 mph Freight, 30 mph passenger). * |
| **Load Case:** | Not suitable for sustained 286k lb car loading |
| **Remediation Includes** | • Track upgrades<br>— Vegetation removal<br>— Defective tie replacement<br>— Shoulder plate and anchor replacements<br>— Additional ballast<br>• Turnout upgrades<br>• Bridge replacement and rehabilitation<br>• Grade crossing upgrades<br>• Rockfall remediation. |

*Speeds refer to maximum safe allowable operating speed as per Figure 26: Classes of Track: Operating speed limits in mph (Rules Respecting Track Safety, 2012, Part II, Section A).

### 6.2.2 INTERMEDIATE PHASE

Intermediate Phase Improvement: includes costs to upgrade infrastructure beyond the Initial Phase. This phase will support higher freight loading (286k lb rail car loading) which will accommodate increased freight and passenger volumes and increased speeds.

| **Intermediate Phase: Class 3 Track Standard Restoration and 286lb Upgrade** | |
|---|---|
| **Use Case:** | • 4 passenger trains/d up to 8 trains/d<br>• 4 freight trains (10-20 car trains)/d up to 4 million tonnes per annum (MTPA) or 133 cars/d total.<br>• Once passenger/freight train volumes increase above Initial Phase 1 Use Case or,<br>• Higher operating speeds are desired, further upgrade will be necessary.<br>• Assumes improvements for Initial Phase have already been completed. |
| **Track Characteristics:** | Class 3 Track Standard (40 mph Freight, 60 mph passenger). * |
| **Load Case:** | Suitable for sustained 286k lb car loading |
| **Remediation Includes** | • New track – supporting higher loading<br>— Vegetation maintenance<br>— Rail upgrade<br>— Tie replacement<br>— New rail joints<br>— Additional ballast<br>• New turnouts – supporting higher loading |

*Speeds refer to maximum safe allowable operating speed as per Figure 26: Classes of Track: Operating speed limits in mph (Rules Respecting Track Safety, 2012, Part II, Section A).

### 6.2.3 ULTIMATE PHASE

Ultimate Phase Improvement: includes costs to upgrade infrastructure beyond the Intermediate Phase. This phase will support higher freight and passenger volumes than the Intermediate Phase. This phase is recommended for the implementation of a Commuter Rail Service evaluated in Section 7 Inter-city and South Island Commuter Operations.

| **Ultimate Phase: Ballast Program** | |
|---|---|
| **Use Case:** | • To be implemented during higher passenger volumes at or above 8 trains/d and<br>• Higher freight volumes. If current volumes increase above 4MTPA or 133 cars/d. (Current freight volumes assumed to be 110,000t/yr or 4 cars/d).<br>• Assumes improvements for Intermediate Phase have already been completed. |
| **Track Characteristics:** | Class 3 Track Standard (40 mph Freight, 60 mph passenger). * |
| **Load Case:** | Suitable for sustained 286k lb car loading |
| **Remediation Includes** | • New ballast to support higher freight and passenger numbers<br>— Additional ballast and rail lift |

## 6.3 COMMON CORRIDOR FEATURES

### COMMUNICATION

The existing communication system is relatively new and in good working condition. The technology is appropriate for SVI's current operations. No upgrade improvements are recommended at this point in time.

### FENCING

It is recommended that as part of the Initial Phase Improvements that new fencing be installed to enclose exposed or higher risk areas along the right of way. Based on site inspections, new fencing would be required along 50% of the Victoria to Langford segment of the Victoria subdivision; 5% of the remaining corridor length along the Victoria and Port Alberni subdivisions would require new fencing. No fencing is proposed in any further phases.

### SIGNALLING

If a segment is upgraded to the Ultimate Phase and more specifically if a Commuter Service is implemented with requisite rail traffic volumes, a simple signalling system to control movement of trains such as fixed block, relay based or computerized system is recommended. It is a cost effective and appropriate system for this headway. The principle of fixed block signalling system is to divide track into sections called blocks, the occupancy of each block is monitored by axle counter. The switches can be controlled remotely, and the switch position changed based on the requested route. The switch machine changes the switch remotely and reads the status and position. If set correctly, the proceed aspect is presented to the driver via signal. By setting the route, interlocking protects the safe movement of the train from start to the end of the route and protects for over running. When the train reaches its destination, the previous section of track is released and allows another train to enter the track block. For segments where the Ultimate Phase has not been implemented, maintaining the current Occupancy Control System (OCCS) signalling is appropriate.

### ELECTRIFICATION

The Island Rail Corridor as currently constructed and considering different operating scenarios, is not considered a good candidate for electrification. Please refer to Appendix I: Electrification Memo, for further discussion on electrification. As conditions change, electrification should be re-evaluated to determine appropriateness.

## BRIDGES

It is recommended that as part of the Initial Phase Improvement works, all bridges are to be rehabilitated to support the 286,000 lb car loading. Costing to support the rehabilitation is based on visual inspections and the review of previous reports conducted in 2011. Costs have been reviewed from previous reports and considered when determining 2019 associated rehabilitation costs. Overall the cost of bridge replacements and rehabilitation have increased between inspections, due to deterioration of the structures. For a detailed breakdown of the costs associated with individual bridge rehabilitation, refer to Appendix C: Bridge Condition Assessment Report.

# 7 INTER-CITY AND SOUTH ISLAND COMMUTER OPERATIONS

This section of the report assesses the feasibility (and informs the cost established in Section 9: Cost Estimates) of re-establishing an Inter-City rail service and implementing a new Commuter Rail Service in the South Island area. This section explores several scenarios under which both of these services could operate. However, it has not explored every scenario or possible combination of operating elements. Should either the Inter-City or Commuter Rail Services be advanced, both should undergo further scenario and ridership analysis to determine the appropriate level of service at that time.

## 7.1 OPERATING SCENARIOS

WSP evaluated several operating scenarios as part of this preliminary assessment. A complete discussion of that evaluation process is available in Appendix F: Commuter Rail Assessment. As a result of that evaluation process, there are three operating scenarios advanced for the purposes of this report. These scenarios provide a high-level concept of what Inter-City and Commuter Rail services could look like. However, further analysis of the demands, data collection methods and scenario analysis would be required to move forward with either of these services.

The three operating scenarios are:

1. **Initial Phase**: Inter-City service between Victoria and Courtenay requires the least amount of track infrastructure upgrades and runs at the previously posted 2011 track speeds (average 30 mph).
2. **Intermediate Phase**: Inter-City service between Victoria and Courtenay requires additional upgrades to the track infrastructure beyond the Initial Phase and runs at average track speeds of 50 mph.
3. **Ultimate Phase**: The third scenario combines the Inter-City between Victoria and Courtenay and a Commuter Rail Service between Victoria and Langford. It will require additional upgrades between Victoria and Langford to the track infrastructure beyond the Intermediate Scenario.

   The Ultimate Phase Scenario includes a ballast program which does not increase track speeds above the 50 mph (achieved in the Intermediate Phase) but will accommodate the higher rail volume loading described by the introduction of the Commuter Rail Service in South Vancouver Island.

For more detailed information on the Phased Improvement approach, and the coinciding Track Class Speeds, please refer to Section 6.1 Phased Improvement approach. As identified in Section 6.1, several sections of the corridor cannot attain the intended track class speed due to geometric limitations such as summitting the Malahat Pass and navigating through the winding track geometry in the Capital Regional District (CRD).

However, the overall average anticipated track speeds will support the Three Operating Scenarios. Therefore, changes to track geometry are not considered at this time.

A breakdown of the different service types and assumptions is shown in Table 12: Three Operating Scenarios for the IRC. below.

Table 12: Three Operating Scenarios for the IRC.

| | Inter-City Only Initial Service | Inter-City Only Intermediate Service | Inter-City with Local Commuter Service |
|---|---|---|---|
| Track Speed Avg. mph | 30 | 50 | 50<br>33 (Langford-Victoria) |
| Trains / day | 1 | 1 | 4 |
| Stations | 8 | 8 | 13 |
| Single-direction run duration | 5 hours 11 mins | 3 hours 8 mins | 3 hours 8 mins<br>28 mins (Langford-Victoria) |
| Off-peak storage requirements | 1 train daily at Victoria, overnight at Courtenay | 1 train daily at Victoria, overnight at Courtenay | 4 trains daily at Victoria, 1 overnight at Courtenay, 3 overnight at Westhills |

The current analysis includes assessment of Monday-Friday service only.

For all scenarios, feasible operating profiles and time tables were developed that conform to the Initial Scenario and aspirational track conditions outlined elsewhere in this report. In all instances, travel times between stations have been calculated based on average speeds, known chainage distances, an assumed 15 seconds – 30 seconds dwell time at each station, and some contingency for normal delays and track switching.

Operating times are based on reasonable peak commuter running and origin/destination times; not based on any comparison with existing commuter transit services.

Given the length of track and estimated volume of rail traffic, the proposed Commuter Line is not a good candidate for electrification. Further discussion on electrification considerations can be seen in Appendix F: Commuter Rail Assessment. The Commuter Service scenario therefore assumes a stock capable of both Inter-City service from Courtenay to Langford and local service to stations from Langford to Victoria. No vehicle transfer for passengers is required at Langford.

### 7.1.1 ROLLING STOCK (RAIL CARS)

This assessment of rolling stock options assumes the following (see Section 9: Cost Estimates for estimates):

- All the track related deficiencies will be addressed to accommodate the safe operation of the selected type of rolling stock up to the maximum track design speed.
- The existing infrastructures such as bridges and rail crossings will be accommodating a rolling stock with a similar or smaller dynamic envelope (space occupied by rail car while in motion) as Via Budd Rail Diesel cars.
- Existing tunnels may need to be modified to accommodate a larger rollingstock envelope, such for bilevel coaches.
- Acceleration and deceleration efforts would be affected by a series of factors including technology selection, number of cars in one trainset, brake system type, and axle load which are not being considered at this stage of the report.

- Selection of any fleet will require a provision of spare vehicles to ensure that service levels can be maintained throughout the project life, regardless of possible vehicle failures or planned maintenance intervals. The number of spares will depend on the reliability of the type of vehicle selected, the size of the fleet, and the concept of Operations and Maintenance for the system.

**Table 13: Rolling stock types and applications**

| Vehicle Type and Standard Application | | | | |
|---|---|---|---|---|
| **Criteria** | **100% LFLRV (Elec)** | **Diesel Multiple Unit (DMU) Commuter Class** | **Diesel Locomotive, Bilevel Coach** | **Budd Rail Diesel Car (legacy fleet)** |
| **Seated+ standing Capacity** | 200 (2 car) | 135+150 (3 car) | 162 per car, 12 car set | 70 to 90 |
| **Commute Distance (km)** | 5 to 40 | 5 to 150 | 20 to 200 | 20 to 400 |
| **Max Op. Speed (km/hr)** | 50 to 80 | 140 | 160 | 137 |
| **Reference Vehicle** | Bombardier Flexity | Alstom LINT | Bombardier Bi-Level | Budd Company |
| **Reference Project** | Waterloo LRT | Ottawa Trillium Line | West Coast Express | Vancouver Island Rail Corridor |

Canadian reference projects that employ the use of these rolling stock options are listed below:

- The Waterloo Light Rail Transit (LRT) is an integrated urban LRT which provides 5-minute headways and a rapid service using electrified 100% low floor Light Rail Vehicles (LRVs).
- The Ottawa Trillium Line features a modern DMU (diesel multiple unit) and provides a high level of service and reliability. It runs a diesel LRT service on an existing mainline freight corridor which features numerous sections of single track, 15-minute headways, and stations spaced at intervals of typically one to two kilometers apart.
- Bilevel cars have been providing commuter service in Canada's largest cities for several decades using conventional diesel locomotive technology. These systems are characterized as having very high capacity ridership, stations further apart, with a higher operating speed and longer trip durations. GO Transit in Greater Toronto and Hamilton Area in Ontario and West Coast Express in the Lower Mainland both employ the use of bilevel rolling stock.

For further discussions on these options please refer to Appendix F: Commuter Rail Assessment.

**Table 14: Rolling Stock References**

| Rolling Stock References Options | |
|---|---|
|  |  |
| **Waterloo LRT** (https://www.bombardier.com) | **Ottawa Trillium Line** (https://obj.ca) |

| | |
|---|---|
|  |  |
| **West Coast Express (https://www.bombardier.com)** | **VIA RDC – Vancouver Island Rail Corridor (https://www.CBC.com)** |

## 7.1.2 DOUBLE-TRACKING

Although double tracking is not considered necessary to reopen the line and has not been included in cost estimates, some discussion on opportunities and constraints to double track have been explored. The corridor is constrained with regards to right of way and capacity to widen or double track the rail service for additional capacity and redundancy (see current track diagram below). However, some opportunities do exist for double tracking and shared rail platforms between Victoria to Langford and Shawnigan Lake to Courtenay. The Malahat area poses significant challenges to double tracking given the elevation change and geometry. Significant blasting and tunnelling would be required to accommodate.

Double-tracking portions of the line permits greater flexibility for maintenance and fewer track-switching delays to Inter-City and Commuter Services. A peak-direction service with only four trains will not likely require double-tracking upgrades. However, should additional trains (or 2-way service) be added over and above what is shown in the Ultimate service scenario, more double-track capacity will need to be added to minimize train conflicts and delays. These levels of service are not considered in this study and costs for double tracking have not been included in this assessment.

Figure 27: Current Track Diagram – Double Tracking below, illustrates potential locations for double tracking.

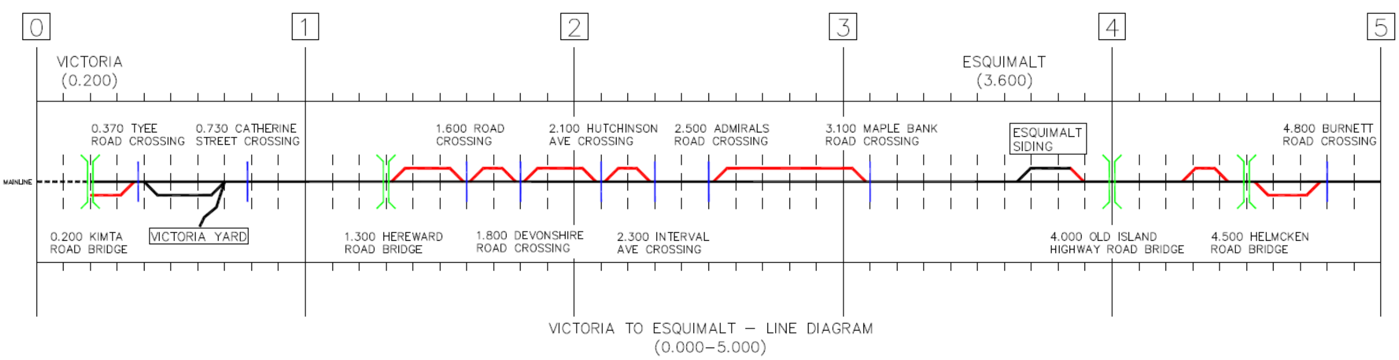



**Figure 27: Current Track Diagram – Double Tracking**

### 7.1.3 INITIAL SCENARIO – INTER-CITY SERVICE AT 2011 TRACK SPEEDS

In this scenario, one inter-city train makes a single return trip per day between Victoria and Courtenay; also travelling to six other stations:

- Station 1 – Victoria (same for Inter-City and Commuter service scenarios)
- Station 2 – Shawnigan Lake Station
- Station 3 – Duncan
- Station 4 – Ladysmith
- Station 5 – Nanaimo
- Station 6 – Parksville
- Station 7 – Qualicum Beach
- Station 8 – Courtenay

The Inter-City train runs inbound to Victoria in the AM peak period and outbound to Courtenay in the PM peak period at track speeds commensurate to what were achieved prior to the line's decommissioning in 2011.

The daily Inter-City inbound train is scheduled to arrive in Victoria at 08:32 and depart it at 17:00. The required departure time from Courtenay (03:00) is not ideal but not uncommon for other inter-city services in Canada. The schedule was established to provide some commuter functionality for riders from Duncan and Nanaimo. See Appendix F: Commuter Rail Assessment, for alternative time table options and ridership profiles.

Trains would travel at the average speeds listed below for a journey time of just over **five hours**:

- 23 mph between Victoria Station (Station 1) and Shawnigan Lake Station (Station 2)
- 30 mph between Shawnigan Lake Station (Station 2) and Courtenay Station (Station 8)

The operating schedule assumes a 15-minute hold in Duncan for schedule adjustment, operator break, and/or contingency.

Presently all bridges and level crossing infrastructure between Victoria and Shawnigan Lake is single track. This is not proposed to change with the Initial operating scenario. Increased travel speeds will still need to share single track bridges and level crossings for later (Intermediate and Commuter) scenarios.

### 7.1.4 INTERMEDIATE SCENARIO – INTER-CITY SERVICE AT ULTIMATE TRACK SPEEDS

In this scenario, one Inter-City train makes a single return trip per day between Victoria and Courtenay; also travelling to the same six other stations listed above. The train runs inbound to Victoria in the AM peak period and outbound to Courtenay in the PM peak period at Ultimate track speeds.

The daily Inter-City inbound train is scheduled to arrive in Victoria at 08:28 and depart it at 17:00. Trains would travel at the average speeds listed below for a journey time of just over **three hours**:

- 33 mph between Victoria Station (Station 1) and Shawnigan Lake Station (Station 2)
- 55 mph between Shawnigan Lake Station (Station 2) and Courtenay Station (Station 8)

The operating schedule also assumes a 15-minute hold in Duncan for schedule adjustment, operator break, and/or contingency. Track and bridges would remain single-track as outlined in the Initial service.

### 7.1.5 COMMUTER SERVICE SCENARIO – ADDITION OF COMMUTER SERVICE BETWEEN LANGFORD AND VICTORIA

The Commuter Service scenario assumes a 4-train, peak-direction service based on Ultimate operating speeds. In addition to the one daily train to and from Courtenay, local commuter service is provided between Langford and Victoria at five additional stations (station location analysis discussed in greater detail in Section 0:

Locations), bringing the total number of Inter-City and Commuting Service stations to 13:

- Station 1 – Victoria (same for Inter-City and Commuter service scenarios)
- Station 2 – Admirals Station
- Station 3 – Six Mile Station
- Station 4 – Atkins Station
- Station 5 – Langford Station
- Station 6 – Westhills Station
- Station 7 – Shawnigan Lake → Station 13 – Courtenay (7 stations total)

The operating schedule also assumes a 15-minute hold in Duncan for schedule adjustment, operator break, and/or contingency. The travel times between Duncan and Victoria as well as Nanaimo and Victoria are unchanged from the Intermediate Scenario.

At Ultimate operating speeds, the train from Westhills Station in Langford takes **twenty-eight minutes**. The fourth AM inbound train will arrive at Westhills Station from Courtenay at 08:00 and continue to Victoria for a scheduled 08:28 terminus.

The first PM train will depart Victoria 17:00 and continue through to Courtenay. The following three trains will terminate at Westhills.

## 7.2 FORECAST RIDERSHIP

A forecast analysis conducted as part of this report shows that rail trips increase with corresponding increases in track speed. The Intermediate and Commuter Service scenarios demonstrate a greater number of peak period rail passengers than the Initial service scenarios.

Additional information on the analysis' methodology – in addition to other operating scenarios evaluated – are included in Appendix F: Commuter Rail Assessment.

### 7.2.1 RESULTS TABLES

The following result tables reflect peak period (AM & PM) ridership estimates. Station boarding totals inter-station travel boardings (i.e. riders boarding with destinations different from Victoria). They show the ridership forecast profiles of the most efficient of six scenarios reviewed, based on average riders per train. The scenario corresponds to Case 2B from the appendix report noted above – 3 Commuter-only trains per peak per day + 1 combined Inter-City + Commuter train per peak per day.

#### 7.2.1.1 PEAK-DIRECTION TRAIN SERVICE

As shown in The elasticity analysis employed to forecast these figures used regional Origin-Destination information from two sources. The figures therefore include trips shifted from both transit and private vehicle commuter travel modes at ratios roughly equal to those existing, regional commuting mode shares:

- Between Victoria and Langford, the Capital Regional District (CRD)'s Household Travel Survey data (2017)
- Between the CRD region and Courtenay, a 3rd party smartphone application

They also do not reflect trips between individual stations within the CRD Commuter service catchment area and those north of Westhills. For Inter-City to Commuter-service area trips, the CRD area was considered a single catchment area whose trips were assigned to Victoria Station. Therefore, no destination trips are identified in the AM between individual Commuter service-area stations and stations north of the CRD. For the purposes of tracking OD trips between areas within and north of the CRD, the CRD was treated as a single catchment area with all CRD passengers assigned to Victoria Station.

Table 15 shows forecast ridership increasing in the AM peak period with the higher service speeds between the Initial and Intermediate track conditions. The table shows boardings for the single combined Inter-City + Commuter-service train and three Commuter-only train services whose schedules are noted above. Overall boardings increase approximately 300% over the Intermediate Service scenario with the introduction of Commuter Service between Victoria and Langford. The largest, single station boardings are at the Admirals and Six Mile stations.

The elasticity analysis employed to forecast these figures used regional Origin-Destination information from two sources. The figures therefore include trips shifted from both transit and private vehicle commuter travel modes at ratios roughly equal to those existing, regional commuting mode shares:

- Between Victoria and Langford, the Capital Regional District (CRD)'s Household Travel Survey data (2017)
- Between the CRD region and Courtenay, a 3rd party smartphone application

They also do not reflect trips between individual stations within the CRD Commuter service catchment area and those north of Westhills. For Inter-City to Commuter-service area trips, the CRD area was considered a single catchment area whose trips were assigned to Victoria Station. Therefore, no destination trips are identified in the AM between individual Commuter service-area stations and stations north of the CRD. For the purposes of tracking OD trips between areas within and north of the CRD, the CRD was treated as a single catchment area with all CRD passengers assigned to Victoria Station.

**Table 15: AM Peak Period Trip Boarding for peak-direction service options**

| Stations | Boardings per station with 4-train service (Case 2B) | | |
|---|---|---|---|
| | Initial Service | Intermediate Service | Commuter Service |
| Victoria | | | 0 |
| Admirals | | | 120 |
| Six Mile | n/a | n/a | 114 |
| Atkins | | | 48 |
| Langford | | | 110 |
| Westhills | | | 83 |
| Sub-total | n/a | n/a | 475 |
| Avg. per train | | | 119 |
| Shawnigan Lake | 72 | 70 | 70 |
| Duncan | 105 | 131 | 131 |
| Ladysmith | 31 | 35 | 35 |
| Nanaimo | 62 | 71 | 71 |
| Parksville | 66 | 75 | 75 |
| Qualicum Beach | 151 | 179 | 179 |
| Courtenay | 10 | 13 | 13 |
| Total | 497 – 1 train | 574 – 1 train | 1,049 – 3 Commuter + 1 dual Commuter / Inter-City train |
| Avg. per train | 497 – 1 train | 574 – 1 train | 262 |

The majority of these trips are shifted from private vehicles, not existing transit. For ridership forecasts between Westhills and Victoria stations, the percentage of Commuter Service customers likely shifting from existing bus service is only equal to the percentage of transit commuter mode share near the stations for buses running at or near the same time as the proposed Commuter train service. The rest comes from car commuters.

For ridership between Westhills and Victoria stations, at the Commuter service scenario proposed here, there would only be four peak-direction trains per day. If train journey times are faster for passengers who currently take bus routes that run near these six train stations, they will likely switch to the Commuter service. If those travel times do not overlap, or if the Commuter service does not offer a faster trip relative to an existing car or bus journey, customers will retain their current travel modes.

For ridership between Courtenay and Victoria (or the CRD region), these potential transit mode shift figures were checked against existing ridership on two express commuter bus routes from the Cowichan Valley – the 66 from Duncan to Victoria and the 99 from Shawnigan Lake to Victoria. The 66 operates four peak-direction runs per day at approximately 80 minutes per trip. The 99 operates two per weekday and takes approximately 90 minutes.

Although ridership data supplied by BC Transit shows average maximum passenger counts of 26 passengers for each AM run of Route 66 from Duncan and 25 passengers on Route 99 from Shawnigan Lake, the methodology of this report's elasticity analysis and train ridership forecasts would not capture any of these figures, as all proposed train service from these locations is an hour after commuter bus service ends. Running additional train service scenarios that overlap with commuter bus schedules would likely show some mode shift transfer above its current proportion of overall travel mode share, but this would still be proportional to the time savings offered by the rail service.

PM service shows the same pattern, but with a greater number of boardings for all scenarios and results are shown in Appendix F: Commuter Rail Assessment and below in Table 16: PM Peak Period Trip Boarding for peak-direction service options The PM peak is typically longer than the AM, resulting in a prolonged period of mode share elasticity for transit use relative to car use. This typically results in higher PM transit boardings, as is shown below.

**Table 16: PM Peak Period Trip Boarding for peak-direction service options**

| Stations | Boardings per station with 4-train service (Case 2B) | | |
|---|---|---|---|
| | Initial Service | Intermediate Service | Commuter Service |
| Victoria | n/a | n/a | 387 |
| Admirals | | | 170 |
| Six Mile | | | 53 |
| Atkins | | | 0 |
| Langford | | | 46 |
| Westhills | | | 0 |
| Sub-total | n/a | n/a | 656 |
| Avg. per train | | | 164 |
| Shawnigan Lake | 182 | 208 | 208 |
| Duncan | 47 | 55 | 55 |
| Ladysmith | 76 | 86 | 86 |
| Nanaimo | 181 | 213 | 213 |
| Parksville | 242 | 284 | 284 |
| Qualicum Beach | 2 | 3 | 3 |
| Courtenay | 0 | 0 | 0 |
| Total | 730 – 1 train | 849 – 1 train | 1,505 – 3 Commuter + 1 dual Commuter / Inter-City train |
| Avg. per train | 730 – 1 train | 849 – 1 train | 376 |

# 8 COMMUTER RAIL STATIONS & MAINTENANCE FACILITY

## 8.1 FOOTPRINT AND AMENITIES

The following assumptions were made to develop the footprint for stations servicing the proposed commuter rail. Costs are noted in Section 9: Cost Estimates.

- Capacity for three 25m passenger cars + one additional locomotive and/or rail car = 100m length
- Single platform for single-direction peak service + contingency = 5m width (500m$^2$ area total)
- Basic concrete platform approximately 100m X 5m
- Single covered shelter approximately 5m X 2.5m
- Single ticket machine
- Dual platform (median or dual-sided) for dual-track sections and stations (where applicable)

The general opportunities and constraints for each station location are provided in the section below; focusing on the requirements to achieve reasonable, multi-modal access and the basic station template described above.

The Trillium Line in Ottawa (Bayview Station pictured below) demonstrates how trains can service a single-side platform from either direction. The platform is equipped with basic shelters and amenities for passengers.


**Figure 28: Comparator Station – Bayview, Trillium Line, Ottawa (www.cbc.ca)**

## 8.2 LOCATIONS

The revised commuter rail service includes 13 upgraded stations whose locations are described in the Table 17: List and Mileages of Inter-City and Commuter Rail Stations. Stations 1 – 6 (Victoria to Westhills, for the Commuter Service scenario) were explicitly identified in the 2011 IBI report as potential future stations. This assessment has revisited those same locations and presents updated descriptions of current conditions and challenges in providing a basic, template station platform and minimal amenities (described further below).

The provision of a basic park and ride amenity is discussed in the descriptions of stations 3 (Six Mile), 5 (Langford), and 6 (Westhills). Supplemental transit connectivity is also discussed in the description of Station 1 (Victoria).

This assessment places the southern terminus of both the Inter-City and Commuter rail services at Victoria Station – located at the western approach of the Johnson Street Bridge (west shore of the Upper Harbour). Consideration for a commuter rail link directly into downtown Victoria was not considered as there is no current connection in place.

Without a fixed link, commuters will alight just west of downtown. Some enhanced multi-modal connectivity features are discussed below to mitigate potential transfer times for commuters. However, this additional time has been worked into the total travel time factors built into the demand model discussed in the previous section.

**Table 17: List and Mileages of Inter-City and Commuter Rail Stations**

| Station Number | Station Name | Inter-City or Commuter | Mileage | General Location Description |
|---|---|---|---|---|
| 1 | Victoria | Inter-City / Commuter | 0.00 | West end of the Johnson Street Bridge |
| 2 | Admirals | Commuter | 2.63 | Lockley Road/Admirals Road intersection, Esquimalt |
| 3 | Six Mile | Commuter | 5.50 | Island Highway/Atkins Avenue intersection, Langford |
| 4 | Atkins | Commuter | 6.77 | Opposite 380 Atkins Road, Langford |
| 5 | Langford | Commuter | 7.90 | Opposite 827 Station Avenue, Langford (Transit Exchange) |
| 6 | Westhills | Commuter | 10.06 | West Shore Parkway/Landing Lane intersection, Langford |
| 7 | Shawnigan Lake | Inter-City | 27.80 | Shawnigan Lake Community Centre, Shawnigan Lake |
| 8 | Duncan | Inter-City | 39.70 | 120 Canada Avenue, Duncan |
| 9 | Ladysmith | Inter-City | 58.40 | Transfer Beach Boulevard, Ladysmith |
| 10 | Nanaimo | Inter-City | 72.50 | 321 Selby Street, Nanaimo |
| 11 | Parksville | Inter-City | 95.20 | Nicnebec Way and Alberni Highway |
| 12 | Qualicum Beach | Inter-City | 101.80 | 198 Sunningdale Road West, Qualicum Beach |
| 13 | Courtenay | Inter-City | 139.70 | 899 Cumberland Road, Courtenay |

The locations of stations 7 – 13 (Shawnigan Lake to Courtenay) were identified as the nearest to the locations of the former stations that could accommodate a basic, template station platform, minimal amenities, and some provision of park and ride.

These locations north of Westhills were reviewed at high-level in the 2011 IBI report and have been examined to a similar level of detail in this report.

Additional information on station conditions and future station viability is found in Appendix F: Commuter Rail Assessment.

### 8.2.1 COMMUTER STATIONS

As shown in Figure 29: South Island Commuter Map the proposed Commuter service would make local stops between Langford and Victoria. Each of the proposed stations is outlined below and discussed in more detail in Appendix F: Commuter Rail Assessment. This section precedes discussion of Inter-City service within this report because these station sites are closest to Victoria and were reviewed in IBI's 2011 Commuter Rail report.

Upon reflecting on the findings and analysis of this report, it has been determined that Atkins Station in Langford does not present a viable option for a station location. This option was originally explored to build on previous studies which evaluated this location and to validate it. Due to ridership, catchment, safety, and limited benefits per costs associated with its construction it has been identified as a non-viable station location. It is discussed in this report only to demonstrate the assessment of these factors.


**Figure 29: South Island Commuter Map**

### 8.2.1.1 *STATION 1 – VICTORIA (INTER-CITY & COMMUTER SERVICE) – MILEAGE 0.00*

## EXISTING CONDITIONS

Victoria Station is the southern terminus of both the Inter-City and Commuter service lines. The rail terminus location, shown in the figure below, ends to the south of and roughly parallel to Esquimalt Avenue at its intersection with Harbour Road – approximately 120m west of the Johnson Street Bridge span.

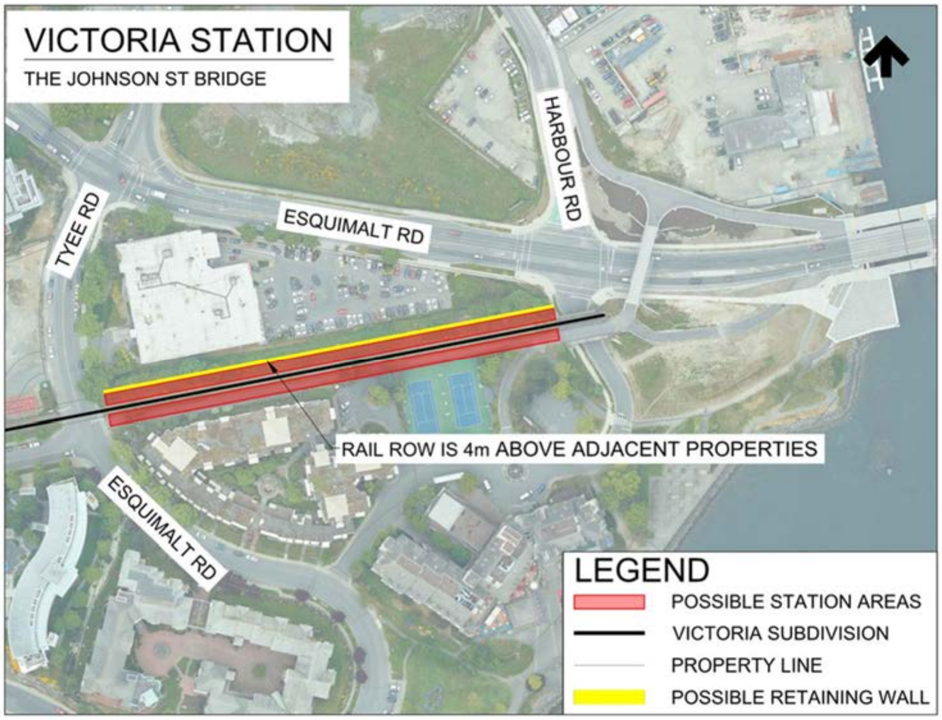



**Figure 30: Victoria Station layout, context, options**

The rail line is elevated approximately 4m above Esquimalt Road, Harbour Drive, and adjoining properties to the north. The linear rail property itself is bounded by a residential development immediately to the south, Harbour Drive to the east, a car dealership on the north, and Tyee Road to the west – a length of 220m. A 4m-wide multi-use path runs adjacent and parallel to the line on its south side, which connects to the pedestrian and cycling networks across the Johnson Street Bridge for access into downtown and to a smaller bridge over Esquimalt Road.

## CHANGES SINCE 2011

The priority of the road and rail alignments to the bridge have been reversed since the 2011 IBI report. The previous alignment of Esquimalt Road followed the original rail alignment to the bridge. The connection to Esquimalt Road was indirect and ran around and under the original bridge alignment. As part of the Johnson Street Bridge reconstruction in 2017, the priority of alignment was reversed. Esquimalt Road is now the more direct connection to the bridge and the rail line’s previous bridge alignment has been severed. The former station house on the east side of the bridge (not in aerial but referenced in the 2011 report) was also removed to accommodate a new westbound alignment for Pandora Avenue vehicle traffic.

The new alignment provides more options for both pedestrians and cyclists. The former rail bridge on the north side of the vehicle bridge has been replaced with a multi-path bridge for cyclists and pedestrians. However, on-road cycle lanes also exist on both sides of the bridge for both eastbound and westbound cyclists. Pedestrians also can cross on either side of the bridge, foregoing the need for additional crossings on both approaches to access a single side of the bridge.

For Inter-City and Commuter rail service, the primary outcome of this change has been a severing of simpler connectivity into downtown. Without significant investment in new bridge realignment or tunnel infrastructure, the fixed location of the rail line will restrict the service's southern terminus to this location at the west end of the bridge.

## TEMPORARY TRAIN STORAGE

All rail operating scenarios (Initial, Intermediate, and Commuter) require storage capacity for off-peak trains at or near Victoria Station. This ranges from one train for the Initial? and Intermediate service scenarios to four trains for the Commuter service scenario. This is temporary, daily off-peak storage only but requires between 150m and 800m total linear metres of train storage space (assuming 100m per train + 25m for gaps and contingency).

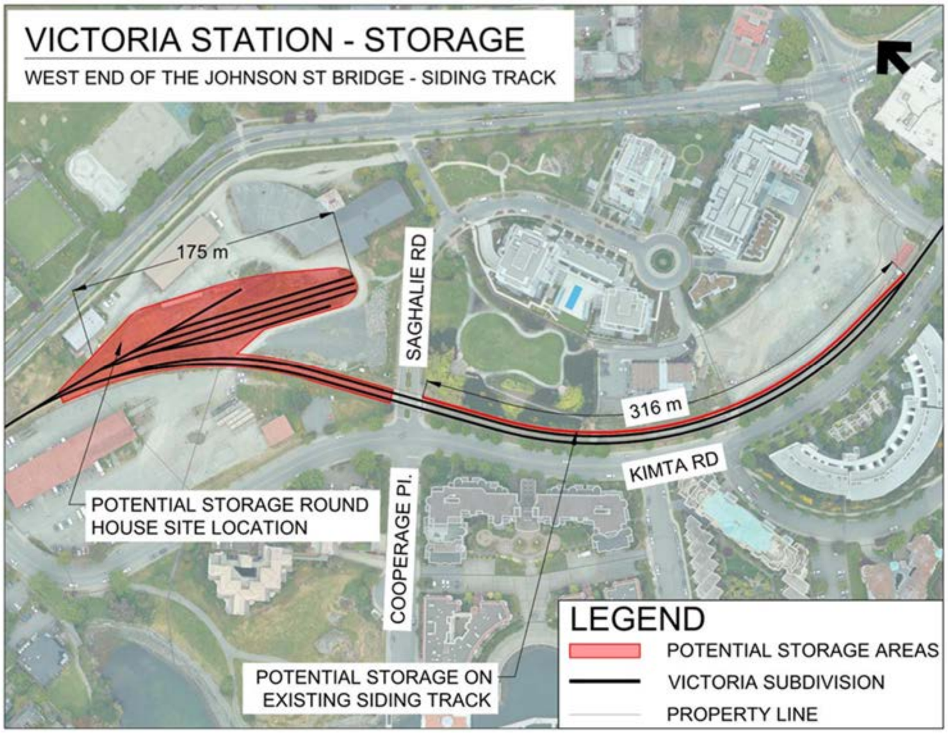



**Figure 31: temporary train storage options at Victoria Station**

Temporary storage space for up to four trains of this assumed length is potentially available in the vicinity of Victoria Station, but this is contingent upon local development, track management capacity, and any additional car-servicing needs during off-peak storage times.

This includes the potential use of the IRC Roundhouse location, which is still zoned for transportation use. However, this is challenged by its position within the Bayview place development proposal; a multi-use development that proposes to use the current Roundhouse site as its centre market. While a large-scale, urban development would undoubtedly benefit from its proximity to a commuter rail line, the potential for utilization of this area as an active, train operations or storage facility will need to be carefully negotiated and managed with the property owners and Bayview place development team.

### 8.2.1.2 *STATION 2 – ADMIRALS ROAD – MILEAGE 2.63*

## EXISTING CONDITIONS

Admirals Station is located adjacent to the intersection of Admirals Road and Colville Road in Esquimalt. The station itself would be located on the north side of the westbound Admirals Road approach and to the south of the Galloping Goose trail, which runs parallel to and just north of the IRC alignment.

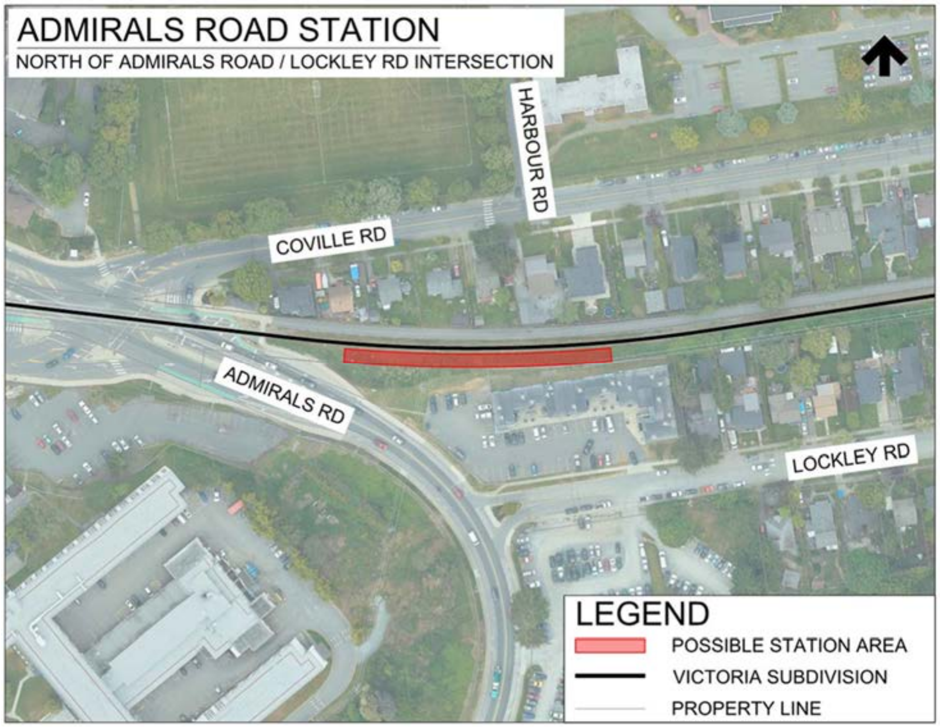



**Figure 32: Esquimalt Station layout and context**

The station site is opposite the Esquimalt Navy Base, and many nearby land uses reflect housing, commercial, and recreational needs of naval and military personnel. Indicative of this, the 2011 IBI report placed a potential, future station at 1250 Lockley Road, a lot which has since been developed and is now occupied by a Seaspan facility.

## CHANGES SINCE 2011

Aside from the introduction of the Seaspan facility and some cycling infrastructure improvements through the intersection, there have been relatively few, significant changes to the station area since 2011.

### 8.2.1.3 *STATION 3 – SIX MILE – MILEAGE 5.50*

## EXISTING CONDITIONS

Six Mile Station would be located near the intersection of Atkins Road and Brydon Road in Langford; approximately halfway between Island Parkway (150m to the south) and the Trans Canada Highway (150m to the north). As shown in Figure 33: Six Mile Station layout, context, and options, this is a relatively remote area with few adjoining land uses in the immediate vicinity. Thee are some residences to the south and west of the station area and a mix of commercial and retail to the south on Island Highway near Six Mile Road.

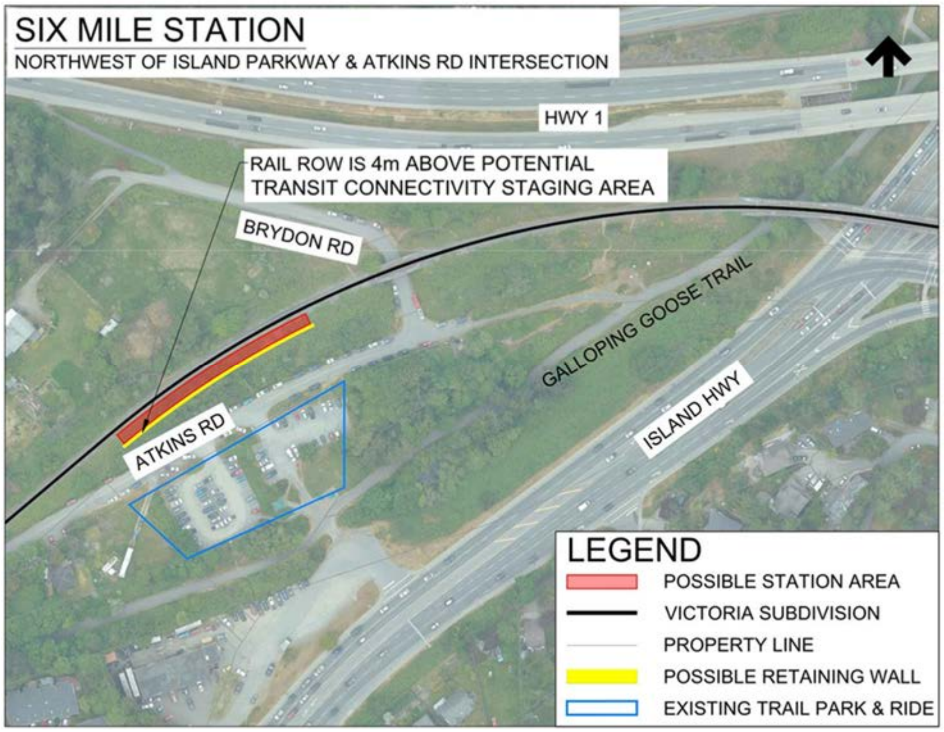



**Figure 33: Six Mile Station layout, context, and options**

The station is situated close to the highway on/off ramps and off a major arterial; including pedestrian access to express commuter bus service directly to downtown. However, the local pedestrian infrastructure is limited to 1.5m wide sidewalks directly on the 5-7 lane arterial. It is a 360m walk along Island Highway to cross to the north at Burnside Road and 390m to cross it to the south at Six Mile Road. It is two kilometres north of Colwood Transit Exchange.

Vehicle access to the station is currently blocked from Island Highway by bollards separating a small access road to a commercial business from the Galloping Goose Trail and a park and ride for trail riders. Motorists access the park and ride from Atkins Road via Six Mile Road, 500m to the west.

## CHANGES SINCE 2011

There have been relatively few, significant changes to the immediate station area since the 2011 IBI report.

### 8.2.1.4 *STATION 4 – ATKINS STATION – MILEAGE 6.77*

## EXISTING CONDITIONS

The Atkins Station site is in a low-density, residential area approximately 2 kilometres southwest of the Six Mile Station site. The proposed station area is just west of the single track's crossing of Atkins Avenue, opposite the residences at 364-380 Atkins Avenue.

Access to and around the station area is predominantly by car. There are no sidewalks in the immediate vicinity of the station and although there is a connecting link to the Galloping Goose Trail 280m to the east, there is otherwise no cycle infrastructure on Atkins Avenue; a relatively narrow, 2-lane road with a 30 km/hr posted speed.

There is currently no direct pedestrian or vehicle access to Goldstream Avenue, a major arterial and potential catchment area 300m to the south. The station site is served by BC Transit's 53 bus route, providing local service between the Langford and Colwood transit exchanges. The only road illumination is from vehicle headlamps and lighting from the homes on the north side of the road.

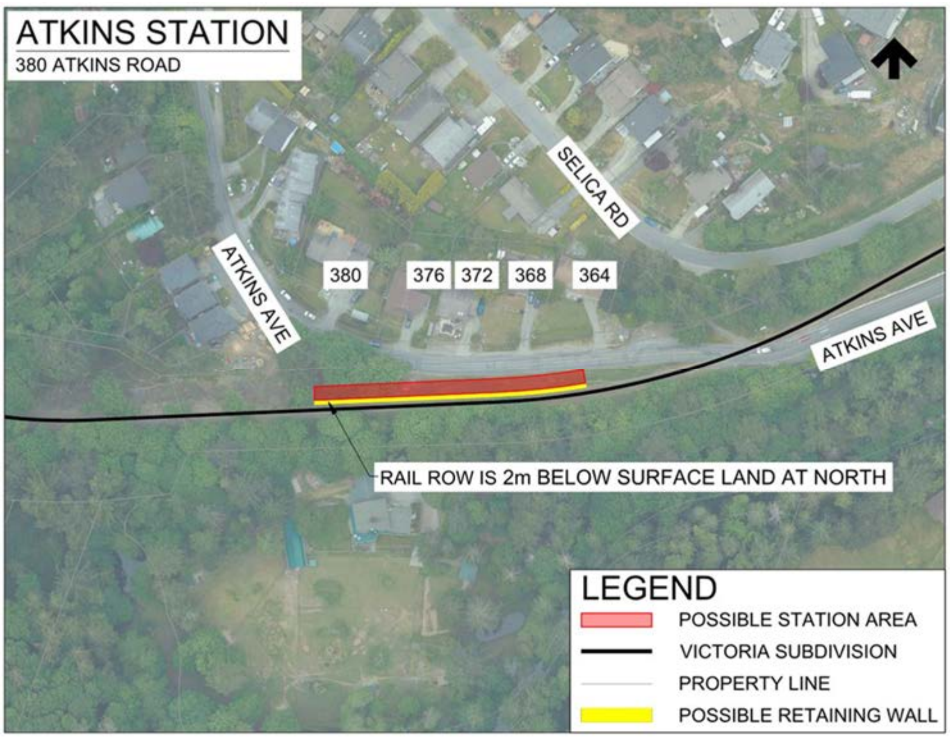



**Figure 34: Atkins Station layout and context**

As with stations 1 and 3, the rail line at Atkins Station runs atop a steep wooded ridge sloping down to the south. The crossing and station area traverses a utility corridor, further limiting any dual-track or expanded station platform capacity. Visibility from the site of a potential platform is limited to less than 50m to the west due to a 90-degree bend in the road and less than 80m to the east due to vegetation and changes to the road's horizontal and vertical profile.

Upon reflecting on the findings and analysis, it has been determined that Atkins Station does not present a viable option for a station location. This is due to ridership, catchment, safety, and limited benefits per costs associated with its construction.

## CHANGES SINCE 2011

Local land uses and road network characteristics do not demonstrate many changes since the 2011 report.

### 8.2.1.5 *STATION 5 – LANGFORD STATION – MILE 7.90*

## EXISTING CONDITIONS

The Langford Station site is located adjacent to the existing BC Transit Langford Transit Exchange on Station Avenue between Jacklin Road and Peatt Road in central Langford. The line runs north of the existing transit exchange's eight sawtooth bay curbs (see Figure 35: Langford Station layout and context). The transit exchange serves 14 bus routes, including the 50, which runs express from Langford to downtown Victoria via Island Parkway and Highway 1.

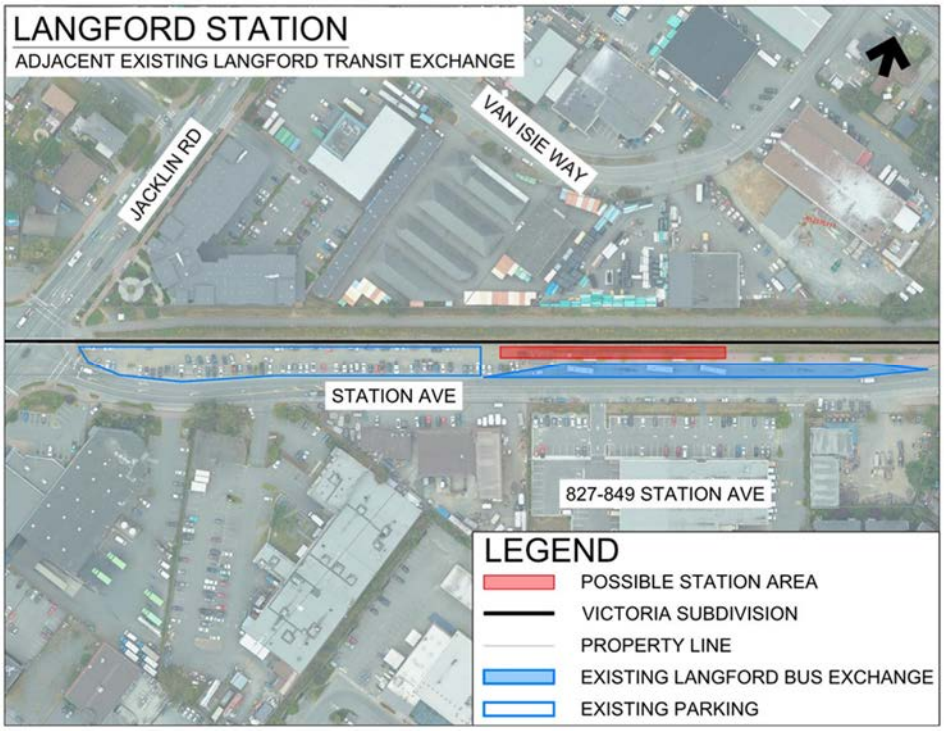



**Figure 35: Langford Station layout and context**

The location is surrounded by commercial and light industrial uses, with residences 200m beyond. The Langford Official Community Plan (2008, updated 2019) identifies this location as the site of a "Major Transit Exchange" and stop on a commuter rail alignment.

## CHANGES SINCE 2011

There have been relatively few, significant changes to the immediate station area since the 2011 IBI report.

### 8.2.1.6 *STATION 6 – WESTHILLS STATION – MILEAGE 10.06*

## EXISTING CONDITIONS

The Westhills Station site is located in the Goldstream neighbourhood of Langford, just west of Langford Lake and three kilometres south of Highway 1. The 2011 reported tentatively placed a future station just north of the IRC track and to the west of the then-unbuilt portion of West Shore Parkway. This portion of West Shore Parkway is newly-constructed, as is most of the adjacent land development. The road is an arterial that connects Langford Centre and Westhills Stadium in the east to Highway 1 to the north.


**Figure 36: Westhills Station layout, context, and options**

The Goldstream neighbourhood is a developing area and consists of a mix of newly-built homes and businesses, cleared development sites, and wooded hills. It is Langford's – and the Capital District Region's – westernmost developing area.

Bus stops at the site currently serve the limited express 47 bus route, running twice inbound and twice outbound per weekday to downtown Victoria via Highway 1; and the local 58 route, running to Langford Transit Exchange once per hour every day.

The Langford Official Community Plan (2008, updated 2019) identifies this area off West Shore Parkway as the site of a "Major Transit Exchange" and stop on a commuter rail alignment. However, lots to the northeast, northwest, and southeast of the general site have either been developed or are currently under development. The southwest portion of the site is a heavily-forested rise that terminates at a BC Hydro right of way corridor just south of the track.

Similar to Station 4 (Atkins), the rail intersects the road between two bends, limiting visibility to the south and north from the points of the crossing and a future station. The curvature of the roadway limits visibility to approximately 80m to the south and 100m to the north.

## CHANGES SINCE 2011

Since the 2011 IBI report, the adjacent lots north of the track have since been developed or are currently under development. The lots to the north of the track and west of West Shore Parkway are now home to 150 residences at Kettle Point and a new commercial-area development in the West Shore Business Park. The 3.5 ha site to the north of the track and east of West Shore Parkway is the site of Aqua Langford Lake, a planned residential community of 950 residences situated on Langford Lake.

### TEMPORARY TRAIN STORAGE

The operating service scenarios noted in this report require between three and six trains to be stored overnight and on weekends/non-service days at or near Westhills Station. This requires a storage facility be constructed in close proximity of the station with facilities for temporary maintenance, heating, and personnel access road. Given the local constraints noted in this section, and the alignment and topography constraints north of Westhills noted elsewhere in this report, the only viable location for is on the south side of the rail west of West Shore Parkway. This could be accommodated in the linear corridor adjacent to the existing track, but again, would likely require relocation and/or burial of the overhead utility lines.

## 8.2.2 INTER-CITY STATIONS

As shown in Figure 37: Inter-City Map the proposed Inter-City service would travel up the southeast coast of Vancouver Island. Each of the proposed stations is outlined below and discussed in more detail in Appendix F: Commuter Rail Assessment.


Figure 37: Inter-City Map

#### 8.2.2.1 STATION 7 – SHAWNIGAN LAKE – MILEAGE 27.80

The Shawnigan Lake Station would be located adjacent to the former station site at the northeast shore of the lake – behind the Shawnigan Lake Commuter Centre, west of the intersection of Shawnigan Lake Road and Mill Bay. The area is a mix of local retail land uses and nearby residences. There are no sidewalks or formal cycle facilities on Shawnigan Lake Road, but it is a two-lane, narrow road through the village centre with clear sight lines to pedestrians on a 2.0m – 3.0m hard shoulder.

The Community Centre area is served by BC Transit's Cowichan Valley Regional Service, with 7 trips per day between Shawnigan Lake and downtown Duncan; a 1 hour, 10-minute one-way trip. The Shawnigan Lake commuter ervice (Route 99) makes two trips to/from the Government Centre transit exchange in Victoria at 90 minutes per trip.

With a limited pedestrian and cycling catchment within 800m, the majority of station demand would be vehicle trips and park and ride. There is some space within the Community Centre and adjacent Shawnigan Lake Museum lots for additional parking, pending environmental and arboreal assessments.

#### 8.2.2.2 STATION 8 – DUNCAN – MILEAGE 39.70

The station house is still located at 120 Canada Avenue, in downtown Duncan, where it was prior to the suspension of the Dayliner service in 2011. The original station house is now part of the Cowichan Valley Museum facility.

The station easily accessible to the city's multi-modal transportation network and three-hour, public parking; some of which would have to be removed if the line were to be double-tracked. The area is well-served by Cowichan Valley Regional Transit. The Canada at Station stop, located in front of the original station/museum, is a major downtown stop, served by the 2, 3, 4, 5, 6, 7, 8, 9, 36 and 44 routes.

Station catchment would be served by pedestrian, cycling, driving, and transit connections.

#### 8.2.2.3 STATION 9 – LADYSMITH – MILEAGE 58.40

The former Via Rail station was located near the intersection of Trans-Canada Highway with Gatacre Street in Ladysmith. The station and track are to the northeast of the highway, but at a grade approximately 3m below the highway. The station sits on the rise of a slope overlooking the harbour and is obscured by overgrowth.

The only access to the site is currently by vehicle from an access road off of Transfer Beach Boulevard. There is no transit on Trans-Canada Highway and the only pedestrian access is via the crossing at Transfer Beach Boulevard en-route down to Transfer Beach Park.

#### 8.2.2.4 STATION 10 – NANAIMO – MILEAGE 72.50

The original station building is located at 321 Selby Street in Nanaimo, approximately 500m west of central Nanaimo. The historic building is now occupied by a pub and is accessible from Selby Street via a marked pedestrian crossing over the tracks from Prideaux Street. The station is in a densely-populated neighbourhood with a mature, multi-modal network of sidewalks, cycle facilities, parking, and transit.

The 9m ROW provides sufficient width double-tracking and a centre platform; should passenger demand warrant. The urban transportation network provides easy access, but rail speeds would necessarily be slow through most of Nanaimo to reduce conflicts. There are ten level crossings in the two kilometres between Seventh Street and Comox Road in central Nanaimo. Rail speeds and road operation impacts would need to be reviewed prior to determining appropriate mitigation measures.

#### 8.2.2.5 STATION 11 – PARKSVILLE – MILEAGE 95.20

The original Parksville Station is located near the intersection of Nicnebec Way and Alberni Highway, 1.6 kilometres southwest of central Parksville. The station building still sits on Nicnebec Way on the south side of the tracks, east of

Alberni Highway. The station is near two major highways and the entry point to the City of Parksville, but it is remotely located from transit, cycling, and pedestrian infrastructure. Access is primarily by car and without significant enhancements to multi-modal connections, the demand catchment would be limited to vehicles and park and ride customers.

However, should the catchment be contained primarily to park and ride, there is sufficient space adjacent to the station and ROW for double-track and platform alignments.

#### 8.2.2.6 STATION 12 – QUALICUM BEACH – MILEAGE 101.80

The historic Qualicum Beach Station is located at 198 Sunningdale Rd W, Qualicum Beach, near the centre of the village. It can be accessed from all three adjacent roads: Harlech Road, Beach Road and Sunningdale Road and is a 15-minute walk from the beach. For a village the size of Qualicum Beach, the demand catchment is well-served by vehicle and pedestrian proximity. Parking is also available for expanded park and ride.

#### 8.2.2.7 STATION 13 – COURTENAY – MILEAGE 139.70

Courtenay Station is located at 899 Cumberland Road, at the southwest end of central Courtenay and about 900m southwest of the Courtenay River. The area around the station is a mix of light industrial land uses.

There is some multi-modal access to the station area, via the #8 bus route, adjacent Rotary Connector trail, and a cycling and sidewalk network to adjacent businesses and neighbourhoods. The station building includes a parking lot on the south side, with access directly from Cumberland Avenue.

## 8.3 MAINTENANCE FACILITY

The preliminary assumption was that maintenance of new commuter rail rollingstock would be done at the Wellcox Yard Maintenance Facility located in Nanaimo. However, if a dedicated facility is desired, assumptions about the facility requirements and costs have been made and carried for the purposes of this report. To develop a high level estimate the following inputs were considered:

- Site preparation
- Utilities
- Trackwork
- Buildings
- Shop Equipment

# 9 COST ESTIMATES

Cost estimates have been developed with input from MoTI and in accordance with MoTI's best practices for cost estimation. WSP has developed the **Construction Cost** estimates based on Phased Improvement options discussed in Section 6.2: Phased Improvements. The rates used represent costs associated with MoTI best practices for cost estimation for improvements of this scale and complexity. Please refer to Table 19: MoTI Contingencies.

The cost estimate splits the rail corridor into six segments to show where costs are geographically located. In addition, the cost estimates have been broken down into three phases: Initial, Intermediate and Ultimate. For basis of each estimate, refer to Appendix G: Cost Estimate.

Furthermore, this condition assessment is an update to previous condition assessments. In order to appreciate the changes in conditions over time, the cost estimates for the 2009 HMM report and ICF/SVI Budget Estimate – 2018/2019 are shown below in Table 18: Previous Cost Estimates. WSP's 2019 Cost Estimates are subsequently included in Table 18 – Table 24 and are in 2020 dollars except where escalations are accounted for in Table 25: Cost Escalation.

For reference, the 2009 HMM report outlines an upgrade program that is consistent with WSP's Initial Phase Improvements. However, HMM's detailed estimate was not available for review so this comparison is based on their report and summary cost estimates only. The ICF/SVI Budget Estimate outlines an upgrade program that is consistent with WSP's Intermediate Phase Improvements. Therefore, compare these previous cost estimates to WSP's Initial and Intermediate **Construction Cost** estimates only. Therefore, exclude MoTI contingency and rates.

A detailed risk registry was not conducted as part of this assessment. However, some high-level risks have been identified in Table 26: High Level Risk Identification.

**Table 18: Previous Cost Estimates**

<table>
<tr><th></th><th>Segment 1 (Victoria to Langford)</th><th>Segment 2 (Langford to Duncan)</th><th>Segment 3 (Duncan to Nanaimo)</th><th>Segment 4 (Nanaimo to Parksville)</th><th>Segment 5 (Parksville to Courtenay)</th><th>Sub Total (Victoria Subdivision)</th><th>Sub Total (Port Alberni Subdivision, Segment 6)</th><th>Island Rail Corridor Total</th></tr>
<tr><td>ICF/SVI Budget Estimate 2018 /2019 (comparable to Initial Phase: Class 2 Track)</td><td colspan="3">$42,690,936</td><td colspan="2">$52,339,991</td><td>$95,030,927</td><td>$53,061,852</td><td>$148,092,779</td></tr>
<tr><td>Hatch Mott MacDonald 2009 Reference Report (comparable to Intermediate Phase: Class 3 Track & 286lb Upgrade)</td><td>$88,240,000</td><td>$20,640,000</td><td colspan="3">$61,720,000</td><td>$170,600,000</td><td>$25,700,000</td><td>$196,300,000</td></tr>
</table>

Table 19: MoTI Contingencies

| Contingencies | Percentage |
|---|---|
| **Project Management & Administration** | 10% |
| **Engineering** | 12% |
| **Construction supervision** | 10% |
| **Contingency** | 50% |
| **First Nations Consultation** | 15% |
| TOTAL = | 97% |

Table 20: Initial Phase Cost

| Initial Phase: Class 2 Track | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item # | Description of work | Segment 1 (Victoria to Langford) | Segment 2 (Langford to Duncan) | Segment 3 (Duncan to Nanaimo) | Segment 4 (Nanaimo to Parksville) | Segment 5 (Parksville to Courtenay) | Sub Total (Victoria Subdivision) | Sub Total (Port Alberni Subdivision, Segment 6) | Island Rail Corridor Total |
| 1 | **Construction** | $7,367,385 | $24,237,778 | $32,507,005 | $16,553,861 | $34,719,448 | $115,385,478 | $50,324,366 | $165,709,843 |
| 2 | **Construction Supervision (10%)** | $736,739 | $2,423,778 | $3,250,700 | $1,655,386 | $3,471,945 | $11,538,548 | $5,032,437 | $16,570,984 |
| | **Construction Sub-Total** | **$8,104,124** | **$26,661,556** | **$35,757,705** | **$18,209,247** | **$38,191,393** | **$126,924,025** | **$55,356,802** | **$182,280,828** |
| 3 | **Engineering (12%)** | $884,086 | $2,908,533 | $3,900,841 | $1,986,463 | $4,166,334 | $13,846,257 | $6,038,924 | $19,885,181 |
| 4 | **Project Management & Administration (10%)** | $736,739 | $2,423,778 | $3,250,700 | $1,655,386 | $3,471,945 | $11,538,548 | $5,032,437 | $16,570,984 |
| 5 | **First Nation Consultation & Accommodation** | $1,105,108 | $3,635,667 | $4,876,051 | $2,483,079 | $5,207,917 | $17,307,822 | $7,548,655 | $24,856,477 |
| 6 | **Contingency (50%)** | $3,683,693 | $12,118,889 | $16,253,502 | $8,276,931 | $17,359,724 | $57,692,739 | $25,162,183 | $82,854,922 |
| | **Other Cost Sub-Total** | **$6,409,625** | **$21,086,867** | **$28,281,094** | **$14,401,859** | **$30,205,920** | **$100,385,365** | **$43,782,198** | **$144,167,564** |
| | **Total Project Costs** | **$14,513,749** | **$47,748,423** | **$64,038,799** | **$32,611,106** | **$68,397,313** | **$227,309,391** | **$99,139,001** | **$326,448,391** |

Table 21: Intermediate Phase Cost

| Intermediate Phase: Class 3 Track & 286lb Upgrade | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item # | Description of work | Segment 1 (Victoria to Langford) | Segment 2 (Langford to Duncan) | Segment 3 (Duncan to Nanaimo) | Segment 4 (Nanaimo to Parksville) | Segment 5 (Parksville to Courtenay) | Sub Total (Victoria Subdivision) | Sub Total (Port Alberni Subdivision, Segment 6) | Island Rail Corridor Total |
| 1 | **Construction** | $6,988,850 | $16,897,101 | $25,824,054 | $14,094,345 | $26,717,794 | $90,522,143 | $23,983,207 | $114,505,351 |
| 2 | **Construction Supervision (10%)** | $698,885 | $1,689,710 | $2,582,405 | $1,409,434 | $2,671,779 | $9,052,214 | $2,398,321 | $11,450,535 |
| | **Construction Sub-Total** | **$7,687,734** | **$18,586,811** | **$28,406,459** | **$15,503,779** | **$29,389,574** | **$99,574,358** | **$26,381,528** | **$125,955,886** |
| 3 | **Engineering (12%)** | $838,662 | $2,027,652 | $3,098,886 | $1,691,321 | $3,206,135 | $10,862,657 | $2,877,985 | $13,740,642 |
| 4 | **Project Management & Administration (10%)** | $698,885 | $1,689,710 | $2,582,405 | $1,409,434 | $2,671,779 | $9,052,214 | $2,398,321 | $11,450,535 |
| 5 | **First Nation Consultation & Accommodation** | $1,048,327 | $2,534,565 | $3,873,608 | $2,114,152 | $4,007,669 | $13,578,322 | $3,597,481 | $17,175,803 |
| 6 | **Contingency (50%)** | $3,494,425 | $8,448,551 | $12,912,027 | $7,047,172 | $13,358,897 | $45,261,072 | $11,991,604 | $57,252,675 |
| | **Other Cost Sub-Total** | **$6,080,299** | **$14,700,478** | **$22,466,927** | **$12,262,080** | **$23,244,481** | **$78,754,265** | **$20,865,390** | **$99,619,655** |
| | **Total Project Costs** | **$13,768,034** | **$33,287,290** | **$50,873,385** | **$27,765,860** | **$52,634,054** | **$178,328,623** | **$47,246,918** | **$225,575,541** |

Table 22: Ultimate Phase Cost

| Ultimate Phase: Ballast Program | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item # | Description of work | Segment 1 (Victoria to Langford) | Segment 2 (Langford to Duncan) | Segment 3 (Duncan to Nanaimo) | Segment 4 (Nanaimo to Parksville) | Segment 5 (Parksville to Courtenay) | Sub Total (Victoria Subdivision) | Sub Total (Port Alberni Subdivision, Segment 6) | Island Rail Corridor Total |
| 1 | **Construction** | $3,648,816 | $17,022,148 | $18,146,356 | $11,473,194 | $22,163,796 | $72,454,310 | $17,268,721 | $89,723,031 |
| 2 | **Construction Supervision (10%)** | $364,882 | $1,702,215 | $1,814,636 | $1,147,319 | $2,216,380 | $7,245,431 | $1,726,872 | $8,972,303 |
| | **Construction Sub-Total** | **$4,013,698** | **$18,724,363** | **$19,960,992** | **$12,620,513** | **$24,380,176** | **$79,699,741** | **$18,995,594** | **$98,695,335** |
| 3 | **Engineering (12%)** | $437,858 | $2,042,658 | $2,177,563 | $1,376,783 | $2,659,656 | $8,694,517 | $2,072,247 | $10,766,764 |
| 4 | **Project Management & Administration (10%)** | $364,882 | $1,702,215 | $1,814,636 | $1,147,319 | $2,216,380 | $7,245,431 | $1,726,872 | $8,972,303 |
| 5 | **First Nation Consultation & Accommodation** | $547,322 | $2,553,322 | $2,721,953 | $1,720,979 | $3,324,569 | $10,868,147 | $2,590,308 | $13,458,455 |
| 6 | **Contingency (50%)** | $1,824,408 | $8,511,074 | $9,073,178 | $5,736,597 | $11,081,898 | $36,227,155 | $8,634,361 | $44,861,516 |
| | **Other Cost Sub-Total** | **$3,174,470** | **$14,809,269** | **$15,787,330** | **$9,981,679** | **$19,282,503** | **$63,035,250** | **$15,023,788** | **$78,059,037** |
| | **Total Project Costs** | **$7,188,168** | **$33,533,632** | **$35,748,321** | **$22,602,192** | **$43,662,678** | **$142,734,991** | **$34,019,381** | **$176,754,372** |

Table 23: Commuter Rail Service Cost

| Commuter Rail Service | | |
|---|---|---|
| **Item #** | **Description of work** | **Segment 1 (Victoria to Langford)** |
| **1** | **Signalling Upgrades** | $26,000,000 |
| **2** | **Rollingstock x 7** | $38,430,000 |
| **3** | **New Stations x 6** | $27,192,850 |
| **4** | **Property Acquisition** | $44,237,000 |
| **5** | **New Commuter Storage Tracks** | $1,637,950 |
| **6** | **Maintenance Facility** | $60,000,000 |
| **7** | **Phased Improvements** | |
| 7.1 | **Victoria to Langford: Initial Phase** | $7,367,385 |
| 7.2 | **Victoria to Langford: Intermediate Phase** | $6,988,850 |
| 7.3 | **Victoria to Langford: Ultimate Phase** | $3,648,816 |
| | **Total Construction** | **$230,979,628** |
| **8** | **Construction Supervision (10%)** | $23,097,963 |
| | **Construction Sub-Total** | **$254,077,591** |
| **9** | **Engineering (12%)** | $27,717,555 |
| **10** | **Ministry Overheads (10%)** | $23,097,963 |
| **11** | **First Nation Consultation & Accommodation** | $34,646,944 |
| **12** | **Contingency** | $255,489,814 |
| | **Other Cost Sub-Total** | **$340,952,276** |
| | **Total Project Costs** | **$595,029,867** |

Table 24: Costs for Combining Sequential Phases

| Costs for Combining Sequential Phases (includes MoTI contingencies) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Segment 1 (Victoria to Langford) | Segment 2 (Langford to Duncan) | Segment 3 (Duncan to Nanaimo) | Segment 4 (Nanaimo to Parksville) | Segment 5 (Parksville to Courtenay) | Sub Total (Victoria Subdivision) | Sub Total (Port Alberni Subdivision, Segment 6) | Island Rail Corridor Total |
| **Initial Phase** | $14,513,749 | $47,748,423 | $64,038,799 | $32,611,106 | $68,397,313 | **$227,309,391** | $99,139,001 | **$326,448,391** |
| **Intermediate = Initial + Intermediate** | $28,281,783 | $81,035,713 | $114,912,185 | $60,376,966 | $121,031,367 | **$405,638,013** | $146,385,919 | **$552,023,932** |
| **Ultimate = Initial + Intermediate + Ultimate** | $35,469,950 | $114,569,344 | $150,660,506 | $82,979,158 | $164,694,045 | **$548,373,004** | $180,405,300 | **$728,778,304** |
| **Commuter Rail Service** | $595,029,867 | N/A | | | | | | **$595,029,867** |

The MoTI has requested a scenario to illustrate how cost escalation would impact the price of future phased works up to 2031. To illustrate this scenario, it is assumed the Initial Phase Improvements are completed in 2021, Intermediate Phase Improvements in 2026, followed by Ultimate Phase Improvements with the Commuter Rail Service in 2031. Please refer to Table 25: Cost Escalation

**Table 25: Cost Escalation**

| Costs for Combining Sequential Phases: With 3% Annual Escalation (includes MoTI contingencies) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Segment 1 (Victoria to Langford) | Segment 2 (Langford to Duncan) | Segment 3 (Duncan to Nanaimo) | Segment 4 (Nanaimo to Parksville) | Segment 5 (Parksville to Courtenay) | Sub Total (Victoria Subdivision) | Sub Total (Port Alberni Subdivision, Segment 6) | Island Rail Corridor Total |
| **Initial Phase (2021)** | $14,949,162 | $49,180,876 | $65,959,963 | $33,589,439 | $70,449,232 | **$234,128,673** | **$102,113,171** | **$336,241,843** |
| **Intermediate Phase (2026)** | $16,439,752 | $39,746,764 | $60,745,483 | $33,153,888 | $62,847,814 | **$212,933,701** | **$56,415,291** | **$269,348,993** |
| **Ultimate Phase (2031)** | $9,950,105 | $46,418,389 | $49,484,037 | $31,286,720 | $60,439,358 | **$197,578,609** | **$47,090,780** | **$244,669,388** |
| **Commuter Rail Service (2031)** | $823,660,496 | N/A | | | | | | **$823,660,496** |

A detailed risk registry was not conducted as part of this assessment. However, some high-level risks have been identified and listed below in Table 26: High Level Risk Identification

**Table 26: High Level Risk Identification**

| Risk Category | Risk Item | Risk Description |
|---|---|---|
| **Engineering** | Unidentified bridge defects | The 2019 bridge inspections were limited to basic visual inspections of most bridge components and the previous detailed bridge inspections are 9 years old. Detailed bridge inspections occurring prior to the reestablishment of rail traffic may observe undocumented defects which would affect the load carrying capacity of a bridge and may require some level of rehabilitation. |
| **Engineering** | Accelerated rate of bridge deterioration | As the existing rail structures continue to age the rate of bridge deterioration may accelerate due to increased exposure to debris, coating failure and stress caused by the reestablishment of rail traffic. The accelerated rate of deterioration may increase the number of structures that require rehabilitation or replacement within the next 50 years. |
| **Engineering** | Seismic Retrofit Costs | The costs developed for the seismic retrofit implementation (construction) program were developed under the assumption that the structures would require seismic upgrades. Since no analysis was performed, the actual extent of rehabilitation necessary is unverifiable. |
| **Engineering** | Bridge Replacement Costs | Bridge replacement costs were based on assumed unit rates for similar structures and actual replacement costs may vary. |
| **Geotechnical** | Underground Mineworkings | Underground mineworking in Nanaimo and Cumberland Areas. Possible surface subsidence associated with collapse either due to time or possible seismic shaking. |
| **Geotechnical** | Liquefiable Soils | Areas where soils may be susceptible to liquefaction during a seismic shaking event. Could cause localised loss of support and/or lateral spread. See seismic memo. |
| **Geotechnical** | Upslope Rockfall Hazard | Relating to large slope above Cameron Lake - rockfall source zone may be present significant distance outside the railway corridor. |
| **First Nations Consultation** | First Nations Support | Partnering/Involvement of First Nation with project. |
| **Planning** | Change in Future Demand | Viability of business case (freight/commuter/tourist) to sustain railway operation long term. |
| **Environment** | Climate Change | Influence of weather pattern changes on engineering/construction costs of infrastructure. |
| **Engineering** | Pit Source | Development of source of locally supplied ballast, grade material. |
| **Engineering** | Disposal of retired track material | Finding accepting destinations for defunct creosote ties, rail steel, contaminated ballast. |
| **Environment** | Archeological Investigation | First Nation artifacts discovered during revitalization of rail line. |
| **Engineering** | Road Authority Funding | At some if not all of the 93 rail crossings where the Ministry is not the Road Authority, a municipality may not have access to the necessary funding needed to pay for the improvements required to improve the at-grade crossing. |
| **Engineering** | Standards Change | The conditions of the provincially regulated grade crossings were measured against the standards prescribed in the federal Grade Crossing Regulations (2014) and Grade Crossing Standards (2014) which Technical Safety BC is anticipated to adopt. If Technical Safety BC does not adopt these standards, then fewer improvements may be required for the railway crossings to be deemed compliant. |
| **Engineering** | Change in Future Traffic Conditions | Traffic volumes may increase beyond those anticipated in the assessment at any or all 124 passive crossings or any or all 96 active crossings equipped with Flashing Lights & Bells that would require a higher level of protection. |
| **Engineering** | Change in Future Rail Operations | Train volumes may increase beyond those anticipated in the assessment at any or all 124 passive crossings or any or all 96 active crossings equipped with Flashing Lights & Bells that would require a higher level of protection. |
| **Engineering** | Change in Track Elevation | If the elevation of the rail is raised/lowered by the Railway Company to such an extent that the Road Approaches would need to be reconstructed to meet the maximum |

| | | |
|---|---|---|
| | | permissible grades than the Railway Company may be responsible for funding that improvement (subject to the terms of the Grade Crossing Agreement). |
| **Engineering** | Encroachment of Developments | Future developments adjacent to the rail corridor may result in obstructions (buildings, landscaping, etc.) that block sight lines resulting in a higher level of protection at a crossing, e.g. flashing lights, bells and gates. |
| **Planning** | Future developments | Future developments may cause locations of proposed stations and ridership to be re-evaluated. |
| **Planning** | Commuter Rail & Inter-City Service change | Changes to the proposed level of service could impact all elements of the project and should be re-evaluated as necessary. |
| **Planning** | Station foot print and amenities change | A change in station requirement may impact the station function and foot print. |
| **Planning** | Public infrastructure adjacent to track | An introduction of public infrastructure such as bikeways and footpaths may limit the viability of future double tracking along the corridor. |
| **Properties** | Track storage property | Additional land may need to be acquired for new rail car maintenance facility and storage tracks due to increase in level of service. |
| **Properties** | Station property | Additional property may be required for stations if station requirements change |
| **Engineering** | Signalling - Yards and Maintenance Facility | There is a risk that a signalling system will be required in the non-mainline track, including yards and maintenance facility to provide safe train separation and protection for train movements within the yard. This may increase the cost of the signalling system. |
| **Engineering** | Signalling - Brownfield | There is a risk that the existing Brownfield track conditions may require the Signalling designs to change due to unanticipated track layout and intersection conditions. |
| **Engineering** | Signalling - Technology | There is a risk that the interoperability challenges with Freight rail may force a change to the Signalling system technology design selection (e.g. Fixed Block conventional signalling to Positive Train Control PTC). |
| **Procurement** | Vehicle - Late Delivery | Late delivery of the first vehicles for testing and commissioning will delay the opening of the network for revenue service. |
| **Procurement** | Vehicle - Testing Certification | Vehicle fails testing requiring redesign of sub-system or component, delaying the opening of the network for revenue service. |
| **Procurement** | Vehicle - Interoperability with freight trains | Interoperability of Light Rail vehicles with Freight impacts with system certification. |
| **Procurement** | Vehicle - Station Platform Gaps | Vehicle to station platform gap is not managed which causes non-compliance to prevailing standards for Accessibility and Safety. |
| **Engineering** | Electrification | As part of this current project, the Island Rail Corridor is not considered a good candidate for Electrification at this point. Should future requirements change, additional risks below should be considered. |
| **Engineering** | Electrification- EMI | There is a risk that Electromagnetic Interference (EMI) of Electrification of the existing track impacts on third party system. For instance, public communication network. |
| **Engineering** | Electrification- EMI | There is a risk that Electrification of the existing track impacts on existing communication system. |
| **Engineering** | Electrification- EMI | There is a risk that Electrification of the existing track impacts on existing signalling system. |
| **Engineering** | Electrification- Power Quality Index | There is a risk that Electrification impacts on power quality index of utility network due to unbalanced feeding of electrified line and generated harmonics from traction system. |
| **Engineering** | Electrification- Design changes | As no specific standards, codes and concept design are identified for the electrification, there is a risk of design changes due to these uncertainties. |
| **Engineering** | Electrification-Track modification | There is risk that existing track shall be modified to guarantee compatibility of existing track with electrification requirements. For instance, track to ground electrical resistance. |
| **Engineering** | Electrification- Power Requirement | There is a risk that required electrical power for this electrification may not be available to provide from a near utility feeding point, if any. |

# 10 ASSUMPTIONS & DISCLAIMERES

The below project assumptions have been made:

- Due to unforeseen market conditions creating excessive demand, availability could be limited and/or impact pricing.
- Uniform existing conditions between zones inspected and those uninspected.
- Previous phase infrastructure will be maintained when next phase is implemented (no maintenance will result in additional cost to subsequent phases).
- All unit rates in 2020 dollars.
- 50% of Victoria – Langford requires new fencing. 5% of remainder of corridor requires new fencing (crossings and high traffic areas). Based on observations while in field and desktop study.
- To determine the type and volume of replacement ties, the following was assumed. 60% of track is tangent (straight) with No. 2 ties and 40% is on curve with No. 1 ties. Based off aerial imagery (in the absence of existing track schematics).
- Ballast sourced from Lower Mainland and shipped via truck and tandem trailers. Locally sourced (Vancouver Island) would save on shipping. In discussions with SVI they have indicated that there are suitable pits located on the Island.
- Relay components (85# rail, joint bars, plates, etc.) are available in sufficient quantities at time when work is completed.
- Uninspected bridges on Port Alberni Sub assumed to be in similar condition to inspected bridges based on known similar structure types, similar climate, locations and historical loadings and maintenance.
- All segments will remain OCS (Occupancy Control System – radio clearance for rail movements), no allowance for incorporation of CTC (Centralized Traffic Control – system of signals to convey instructions to train crews) have been made for track. For higher frequency commuter rail between Victoria – Langford, allowance for CTC is included in costs.
- All commuter and inter-city maintenance assumed to be completed at Wellcox yard, using existing facilities.
- Operational and maintenance costs have not been included in the cost estimate.
- Environmental Impact assessment of the Island Rail Corridor was not assessed as part of this project.

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# APPENDIX

# A TRACK CONDITION ASSESSMENT REPORT

# APPENDIX

# B CROSSING CONDITION ASSESSMENT REPORT

# APPENDIX

# C BRIDGE CONDITION ASSESSMENT REPORT

# APPENDIX

# D ROCKFALL ASSESSMENT MEMO

# APPENDIX

# E

## SEISMIC CONSIDERATION MEMO

# APPENDIX

# F

# COMMUTER RAIL ASSESSMENT

# APPENDIX

# G COST ESTIMATE

# APPENDIX

# H

## PHASED IMPROVEMENTS – TRACK RESTORATION

| Initial Phase: Class 2 Track Standard Restoration | |
|---|---|
| **Use Case:** | • 2-4 passenger trains per day<br>• 2-4 freight trains (10-20 car trains) per day |
| **Track Characteristics:** | Class 2 Track Standard (25 mph Freight, 30 mph passenger). * |
| **Load Case:** | Not suitable for sustained 286 lb loading |
| **Proposed Restoration Approach:** | Track Restoration<br>1. Vegetation and weed control:<br>- Clear canopy by brush cutting.<br>- Spray to kill weeds, then remove.<br>2. Replace 55% to 70% of defective ties (approx. 800 to 1000 new ties) with No. 2 ties.<br>3. Replace single shoulder plates with second double shoulder plates on those ties that are replaced.<br>4. Add anchors. Box (4 anchors per tie) ever 4th tie on tangent, Box every 2nd tie on curve.<br>5. Replace old style angle joint bars with standard joint bars and with new bolts.<br>6. Resurface track and add limited additional ballast (approx. 325 cu yards/mile or 5-7 car loads per mile = 1.5" lift for resurfacing). Assuming each car = 55 cu yards<br>7. No rail replacement. This rail displays head loss (7-10mm) but can support light traffic.<br>8. Test track geometry and rail condition with TrackStar before commissioning.<br>9. Allow ballast to consolidate for 100,000 tonnes of rail traffic prior to operating at Class 2 Track Standard speeds.<br><br>Turnout Restoration<br>1. Replace 30% turnout ties.<br>2. Re-gauge.<br>3. Replace rigid braces with adjustable rail braces. (8/switch)<br>4. Repair frog wing rail by welding and grinding.<br>5. Replace bad switch points, frogs and stands.<br>6. Re-surface turnout and half car of ballast. |

*Speeds refer to maximum safe allowable operating speed as per Figure 26 in body of report.

| Intermediate Phase: Class 3 Track Standard Restoration and 286lb Upgrade | |
|---|---|
| **Use Case:** | • 4 passenger trains/d up to 8 trains/d<br>• 4 freight trains (10-20 car trains)/d up to 4 million tonnes per annum (MTPA) or 133 cars/d total.<br>• Once passenger/freight train volumes increase above Initial Phase Use Case or,<br>• Higher operating speeds are desired, further upgrade will be necessary.<br>• Assumes improvements for Initial Phase have already been completed. |
| **Track Characteristics:** | Class 3 Track Standard (40 mph Freight, 60 mph passenger). * |
| **Load Case:** | Suitable for sustained 286 lb loading |
| **Proposed Restoration Approach:** | The following approach has been adopted for the Class 3 Track Standard Restorations and is assumed to occur within 5 years of the end of Initial Phase restoration. It is believed the approach will support the above criteria.<br><br>Track Restoration<br>1. Vegetation has been maintained.<br>2. Replace all 80, 85, 100 lb rail with 115 lb rail.<br>3. Replace all remaining defective ties (assumed 20-30% of total tie count) with No. 1 ties.<br>4. Install new #115 tie plates.<br>5. Install new anchors. Boxed every 4th tie on tangent and every 2nd on curve.<br>6. Install new joint bars with new bolts.<br>7. Resurface track and add limited additional ballast (approx 325 cu yards/mile or 5-7 car loads per mile = 1.5" lift for surfacing). Assuming each car = 55 cu yards<br>8. Turnouts will need to be upgraded to 115 lb Turnouts for this phase.<br><br>Turnout Restoration<br>1. Completely install 115 lb Turnouts. Can be good condition used materials.<br>2. All new switch ties.<br>3. New ballast. |

*Speeds refer to maximum safe allowable operating speed as per Figure 26 in body of report.

| Ultimate Phase: Ballast Program | |
|---|---|
| **Use Case:** | • To be implemented during higher passenger volumes at or above 8 trains/d and<br>• Higher freight volumes. If current volumes increase above 4MTPA or 133 cars/d. (Current freight volumes assumed to be 110,000t/yr or 4 cars/d).<br>• Assumes improvements for Intermediate Phase have already been completed. |
| **Track Characteristics:** | Class 3 Track Standard (40 mph Freight, 60 mph passenger). * |
| **Load Case:** | Suitable for sustained 286 lb loading |
| **Proposed Restoration Approach:** | The following approach has been adopted for the Ballast Program and is assumed to occur within 5 years of the end of Intermediate Phase restoration. It is believed the approach will support the above criteria.<br>1. Undercut track by 6".<br>2. Renew ballast up to 6" under the tie. |

*Speeds refer to maximum safe allowable operating speed as per Figure 26 in body of report.

| Summary of Quantities<br>Initial Phase: Class 2 Track Standard Restoration | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Component | | Unit | Segment 1 (Victoria to Langford) | Segment 2 (Langford to Duncan) | Segment 3 (Duncan to Nanaimo) | Segment 4 (Nanaimo to Parksville) | Segment 5 (Parksville to Courtenay) | Segment 6 (Parksville to Port Alberni) | Total |
| | | | Quantity | | | | | | |
| Ties | Number 2 Softwood ties | No. | 10583 | 16114 | 21658 | 13611 | 30208 | 15754 | 137541 |
| | Number 1 Hardwood ties | No. | 6881 | 10742 | 14439 | 9074 | 20138 | 10502 | 91519 |
| Rail | 85lb Relay Rail | Lf | 5892 | 15829 | 21596 | 12508 | 23871 | 22429 | 125341 |
| | 115lb Rail | Lf | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Joint Bars | 85lb Standard Joint Bars | Pairs | 6804 | 1688 | 2303 | 1334 | 2546 | 2392 | 25719 |
| | 115lb Standard Joint Bars | Pairs | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tie-Plates | 85lb Single Shoulder Tie-Plates | No. | 8732 | 13428 | 18049 | 11343 | 25173 | 13128 | 114530 |
| | 115lb Double Shoulder Tie-Plates | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Anchors | 85lb Anchors | No. | 35354 | 94975 | 129569 | 75048 | 143222 | 134574 | 752036 |
| | 115lb Anchors | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ballast | Crushed Gravel – 40mm | Cu Yd | 4102 | 10793 | 16000 | 8528 | 16276 | 15906 | 87435 |
| Turnouts | Repair 85lb Turnout | No. | 12 | 3 | 41 | 9 | 7 | 21 | 105 |
| | 115lb No. 9 Turnout | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb No. 7 Turnout | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Summary of Quantities<br>Intermediate Phase: Class 3 Track Standard Restoration and 286lb Upgrade | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Component | | Unit | Segment 1 (Victoria to Langford) | Segment 2 (Langford to Duncan) | Segment 3 (Duncan to Nanaimo) | Segment 4 (Nanaimo to Parksville) | Segment 5 (Parksville to Courtenay) | Segment 6 (Parksville to Port Alberni) | Total |
| | | | Quantity | | | | | | |
| Ties | Number 2 Softwood ties | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Number 1 Hardwood ties | No. | 5432 | 17904 | 24065 | 15124 | 33564 | 17504 | 140287 |
| Rail | 85lb Relay Rail | Lf | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb Rail | Lf | 106593 | 284930 | 396728 | 225150 | 429676 | 407584 | 2268552 |
| Joint Bars | 85lb Standard Joint Bars | Pairs | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb Standard Joint Bars | Pairs | 1367 | 3653 | 5087 | 2887 | 5509 | 5225 | 29086 |
| Tie-Plates | 85lb Single Shoulder Tie-Plates | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb Double Shoulder Tie-Plates | No. | 10864 | 35808 | 48130 | 30248 | 67128 | 35008 | 280574 |
| Anchors | 85lb Anchors | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb Anchors | No. | 35354 | 94975 | 129569 | 75048 | 143222 | 134574 | 752036 |
| Ballast | Crushed Gravel – 40mm | Cu Yd | 4018 | 10793 | 14724 | 8528 | 16276 | 15293 | 85462 |
| Turnouts | Repair 85lb Turnout | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb No. 9 Turnout | No. | 5 | 3 | 7 | 9 | 7 | 5 | 48 |
| | 115lb No. 7 Turnout | No. | 7 | 0 | 34 | 0 | 0 | 16 | 57 |

| Summary of Quantities<br>Ultimate Phase: Ballast Program | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Segment 1 (Victoria to Langford) | Segment 2 (Langford to Duncan) | Segment 3 (Duncan to Nanaimo) | Segment 4 (Nanaimo to Parksville) | Segment 5 (Parksville to Courtenay) | Segment 6 (Parksville to Port Alberni) | Total |
| Component | | Unit | Quantity | | | | | | |
| **Ties** | Number 2 Softwood ties | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Number 1 Hardwood ties | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Rail** | 85lb Relay Rail | Lf | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb Rail | Lf | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Joint Bars** | 85lb Standard Joint Bars | Pairs | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb Standard Joint Bars | Pairs | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Tie-Plates** | 85lb Single Shoulder Tie-Plates | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb Double Shoulder Tie-Plates | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Anchors** | 85lb Anchors | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb Anchors | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Ballast** | Crushed Gravel – 40mm | Cu Yd | 21320 | 59960 | 66620 | 47380 | 90420 | 77660 | 363360 |
| **Turnouts** | Repair 85lb Turnout | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb No. 9 Turnout | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 115lb No. 7 Turnout | No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# APPENDIX

# I

## ELECTRIFICATION MEMO