APPENDIX F: EXPANSION SITE ENVIRONMENTAL ASSESSMENT AND ANALYSES

Please note that these reports were commissioned by MHAC prior to the purchase of NHS.

1. Phase I and II Environmental Assessment 3113-011
2. Soil Analysis and Classification Update

Final Report

Environmental Screening (Phase I & 2)
Proposed Fish Hatchery Location
Marine Harvest Atlantic Canada
Stephenville, NL

(FFC File 3113)

Prepared for

Marine Harvest Atlantic Canada Ltd.
#124 - 1334 Island Highway
Campbell River, BC
V9W 8H9

by

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL
A1A 5A1

PROVINCE OF NEWFOUNDLAND
PERMIT HOLDER
CLASS "A"
This Permit Allows
FRACFLOW CONSULTANTS INC.
To practice Professional Engineering
in Newfoundland and Labrador.
Permit No. as issued by APEGN D0169
which is valid for the year 2018.

July 6, 2018

REGISTERED PROFESSIONAL ENGINEER
JOHN B. GALE
SIGNATURE
July 6, 2018
DATE
PROVINCE OF NEWFOUNDLAND

Summary

Fracflow Consultants Inc., under contract to Marine Harvest Atlantic Canada (MHAC), conducted a combined Environmental Screening (Phase I and II) at the site that may be purchased for a potential land-based aquaculture operation in Stephenville, NL. This report provides a description of the scope of work, field methods, findings, and recommendations arising from the work completed between November 2017 and June 2018. The site of the potential aquaculture operation is located in the Town of Stephenville on the north shore of St. George's Bay, NL, which borders on the eastern shore of the Gulf of St. Lawrence. The properties of interest to MHAC are situated within an Industrial General zone of the Town.

The purpose of this work was to identify any actual and/or potential contamination. The records review included historical maps and property ownership documents obtained from Newfoundland and Labrador Housing Corporation (NLHC), aerial photographs, Environmental Site Assessment, Environmental Audit, Demolition reports obtained from Transport Canada regarding the PWGSC properties in the vicinity. Present site conditions were observed and documented by Fracflow staff by various site visits and site activities between November 2017 and June 2018. Additional information was obtained from interviews with knowledgeable former staff from the Port Harmon Authority - now the Port of Stephenville, Town of Stephenville, Transport Canada, and NLHC as part of the Phase I (Fracflow, 2010a) that was completed for Northern Harvest Sea Farms (NHSF) Newfoundland Ltd. This current combined Phase I and Phase II, has been prepared by referencing the 2010 Phase I NHSF Phase II (Fracflow 2010b). Additional site investigation reports that Fracflow has completed for MHAC are also attached to provide a complete record of site conditions.

The information gathered during the Environmental Screening has been evaluated in terms of the presence of actual (observed) versus potential (probable) contamination. Hydrocarbon contamination does exist on property that is adjacent to the property that is being considered for purchase (Fracflow 2018a) but this subsurface (>2.5 m bgs) contamination is a result of historical activities and exists on down-gradient property owned by the Town of Stephenville and the Port of Stephenville. These impacted properties may be leased by MHAC. Actual contamination on the property of interest was neither observed by Fracflow staff nor was it documented in any of the previous reports that were available to Fracflow for review. Several up-gradient potential sources of contamination were identified, using available information, that may affect soil and groundwater quality at the proposed MHAC fish hatchery site. Those potential sources that appear to pose the greatest risk to soil and groundwater quality are:

1. Buried waste materials - automobile parts, scrap metal, steel cables, wood, and plastics were visible on the ground surface during the site walkover. There is a possibility that similar materials have been buried on site;

2. Former fuel transmission and potable water pipelines. Abandoned buried fuel lines run along the upper side of the proposed MHAC fish hatchery site, parallel to the old Abitibi

road. These old fuel lines or the fuel line valve chambers may have leaked petroleum into the subsurface. These pipelines were initially constructed and used by the United States Air Force. A water supply pipeline also runs parallel and adjacent to the abandoned fuel lines and could pose risk of flooding and erosion if this pipeline is not relocated. It is Fracflow's understanding that the old fuel lines will be removed and the water supply line will be re-located. However, the water supply line is approximately 200 to 250 mm in diameter and pressurized and any future pipeline break will pose risks of flooding and erosion;

3. Former Abitibi railway line - chemical residues from the treated railway ties, as well as from possible herbicide applications along the margins of the railway tracks, could be present in the subsurface;

4. Laydown area of the former pulp and paper mill - materials that were handled and stored in the laydown area by the former owners of the pulp and paper mill may have impacted subsurface soil and groundwater quality.

5. The up-gradient areas, owned by or formerly owned by PWGSC and Irving Oil Ltd, that are suspected to have hydrocarbon and/or metal contamination may be a source of future contamination of the groundwater under the proposed MHAC fish hatchery site.

6. A metal recycling operation is lcoated on the southeast boundary of the proposed MHAC property. However, this site is trans-gradient relative to the proposed MHAC property and does not pose a threat of groundwater contamination under the MHAC property unless the groundwater gradients are reversed by activities on the proposed MHAC property.

It is Fracflow's opinion that the new development will pose a significantly lower risk to the environment compared with the risk posed by the potential sources identified in this report. However, if MHAC decides to acquire or lease the property(ies) in question, MHAC should ensure that it is released from any past or future liabilities associated with the existing condition of the property(ies).

To make a reasonable determination if there may be actual contamination of soil and groundwater on the property that MHAC proposes to purchase, a Phase I level walking tour was completed over the property, obvious environmental issues identified, and the old fuel line valve chambers were located. Also, an intrusive program of eight (8) boreholes was completed and both soil and water samples were collected. Monitoring wells were installed in each borehole and several of the boreholes were instrumented with two piezometers, an upper and a lower piezometer. This intrusive program located the old fuel lines, located the existing potable water supply line, and identified one area that is impacted with hydrocarbons. The laboratory analysis of the collected soil and water samples identified trace levels of hydrocarbons that were indicative of industrial activities and indicative of migration of hydrocarbons as a dissolved

phase in groundwater. An area on the western corner of the property was determined to be impacted with hydrocarbons and these impacts were delineated by excavating and sampling 18 test pits to and below the existing water table. The impacted area is not part of the property that MHAC proposes to purchase and is identified as a separate area on the survey plans.

A separate property is located on the northeast side of Connecticut Drive. This property is owned by the Town of Stephenville with an easement for an access road that cuts across the property. A site walkover did not identify any environmental issues and the existing records do not show any historical activity on this property.

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Glossary of Terms

ACM	Asbestos Containing Material
AVGAS	Avgas is a high-octane aviation gasoline that is used by aircraft with piston engines
BTEX	Benzene, toluene, ethylbenzene, xylenes, which are the most volatile and soluble compounds in 'light-end' petroleum products such as gasoline, aviation, and diesel fuels
CCME	Canadian Council of Ministers of the Environment
CEQG	Canadian Environmental Quality Guidelines
CSA	Canadian Standards Association
EPU	Emergency Power Unit
ESA	Environmental Site Assessment
FOF	Fuel Oil Fraction
GF	Gas Fractionation
LEL	Lower Explosive Limit
LNT	Lowest Normal Tide
LOF	Lube Oil Fraction
mg/kg	milligrams per kilogram, which is equivalent to parts per million or ppm
mg/L	milligrams per litre, which is equivalent to parts per million or ppm
MOGAS	Motor gas, or ground fuel, used in automobiles
NLHC	Newfoundland and Labrador Housing Corporation
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated Biphenyl

PWGSC	Public Works and Government Services Canada
RBCA	Risk based corrective action
TC	Transport Canada
TPH	Total Petroleum Hydrocarbons
USAF	United States Air Force
UST	Underground fuel or chemical storage tank

1.0 INTRODUCTION

Fracflow Consultants Inc. (Fracflow) conducted a combined Phase I and Phase II Environmental Screening at the site of a potential land-based aquaculture operation in Stephenville, NL. This report provides a description of the scope of work, field methods, findings, and recommendations of the work completed between November 2017 and June 2018, with the Phase I component of this report consisting primarily of a revised Phase I report that was prepared by Fracflow in 2010 for Northern Harvest Sea Farms (2010a).

1.1 Site Location and Background

The site of the potential aquaculture operation is located in the Town of Stephenville on the north shore of St. George's Bay, NL, which borders on the eastern shore of the Gulf of St. Lawrence (**Figure 1.1**). The topography of the area and key site features are shown in **Figure 1.2.** The properties of interest to Marine Harvest Atlantic Canada (MHAC) are situated within an Industrial General zone of the Town. The site boundaries are illustrated in **Figure 1.3** and is broken down into two individual sites:

- Land Parcel 1 and 2 on the northeast side of Connecticut Drive which is currently owned by the Town of Stephenville with an area of 4.156 hectares (**Figure 1.4a**)
- Main land parcel, the Lower fish hatchery site on the southwest side of Connecticut Drive which is currently owned by the Town of Stephenville (**Figure 1.4b**)

1.2 Objectives and Scope of Work

Fracflow, acting as an objective and independent consultant, free of any conflict of interest, assigned an experienced site assessment team to complete the Phase I and Phase II Environmental Screening on both properties, using due care and diligence, following the systematic procedures that are set out in the Canadian Standards Association document Z768-01 (CSA, 2012), for Phase I Environmental Site Assessments, as a guide. The CSA Standard, first issued in 1994 and revised in 2012 establishes the principles and practices that are applicable to a Phase I ESA. The purpose of the Phase I work was to identify actual and potential site contamination by evaluation of existing information collected through a (i) records review, (ii) site visit, (iii) interviews and evaluation of information, and (iv) reporting.

A Phase II Environmental Screening consists of a limited intrusive program of groundwater, soil and surface water sampling, where appropriate. For the Phase II on this site, eight boreholes were drilled, soil samples were collected at different depths, monitoring wells were installed, water table elevations were measured, and water samples were collected from each piezometer. In addition, 18 test pits were excavated and sampled to delineate hydrocarbon impacts.

1.3 Regulatory Framework

The process for management of contaminated sites in the Province of Newfoundland and Labrador is outlined in the Government's Policy Directive PPD05-01 and in a companion document entitled *Guidance Document for the Management of Impacted Sites* Version 2.0 (DOEC, revised 2014). The policy states that the province has adopted the CCME Canadian Environmental Quality Guidelines (CEQG) as the environmental quality standard in the absence of a specific regulation pertaining to remediation of an impacted site. For those sites with petroleum hydrocarbon impacts only, the Province accepts the use of the Atlantic RBCA model. The guidance document applies to all chemicals of concern present in the natural environment, due to spillage or release, that require management or remediation. The Province recognizes seven groups of common chemicals of concern:

Group 1 - Petroleum Hydrocarbons
Group 2 - Polycyclic Aromatic Hydrocarbons (PAHs)
Group 3 - Heavy Metals
Group 4 - Non-Chlorinated Organic Compounds
Group 5 - Chlorinated Organic Compounds
Group 6 - Pesticides
Group 7 - Microbiological

In this report, the analytical results for petroleum hydrocarbons in soil, sediment and water are compared to the Atlantic RBCA Tier I Look Up Table values for a commercial site with non-potable water and coarse-grained soils, after confirming the soil type by completing a number of grain size determinations. For all other organic and inorganic chemicals that were quantified by laboratory analysis, the following guidelines have been used:

(a) Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Update 6.0.2, November 2006. Interim remediation criteria for soil are used for chemical parameters that have not yet been replaced by Canadian Soil Quality Guidelines (CCME, 1991) and accessed via st-ts.ccme.ca (most current version);

(b) Canadian Water Quality Guidelines for the Protection of Aquatic Life, Update 6.0, July 2006 and accessed via st-ts.ccme.ca (most current version); and

(c) Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Update 2002 and accessed via st-ts.ccme.ca (most current version).

There are no specific CCME guidelines available to assess the significance of dissolved chemicals in non-potable groundwater. The CCME guidelines for potable water are not applicable because the mill site and neighbouring commercial properties are serviced by municipal water.

1.4 Qualifications of the Consultant Team

The Phase I and II ESAs were conducted by a team of site professionals from Fracflow Consultants Inc. The Senior Engineer and Principal-in-Charge of this project was Dr. John Gale, who is a registered engineer and geoscientist with the Professional Engineers and Geoscientists of Newfoundland (PEG-NL). He has over 30 years of experience in the fields of geological engineering, engineering geology, hydrogeology, site assessment and remediation. Dr. Gale was assisted by Dr. Eunjeong Seok, a senior hydrogeologist. Scientific review of this work was provided by Mr. Glenn Bursey, B.Sc., M.Sc., a Certified Environmental Site Assessor. The report QA/QC was provided by Ms. Karen Andrews.

1.5 Limitations

Fracflow has prepared this report for the exclusive use of Marine Harvest Atlantic Canada (MHAC). This report is intended for use by MHAC and its subsidiaries, affiliates, successors, and assignees only. Any third party reliance on this report, except by the Newfoundland and Labrador Department of Municipal Affairs and Environment (DMAE) and the Town of Stephenville will require additional agreement between Fracflow, MHAC and that third party.

Fracflow warrants that the work was conducted in accordance with the scope of work, schedule and budget as approved and controlled by MHAC. The results and interpretation thereof, expressed herein, are based on available background data together with site-specific observations and subsurface information that were collected at the locations sampled between November 2017 and June 2018. Samples of soil and groundwater were collected from areas that Fracflow deemed to be representative of the subsurface conditions on and around the properties of interest. Selected samples were analyzed for those substances that may have been released to the natural environment.

The conclusions expressed in this report reflect Fracflow's best professional judgement of the conditions observed and the information available at the time of sampling. In addition, the fact that potential environmental conditions may not have been identified in one location does not necessarily preclude the presence of a potential environmental condition in other locations for which no data or no information were available for review by Fracflow as part of this ESA.

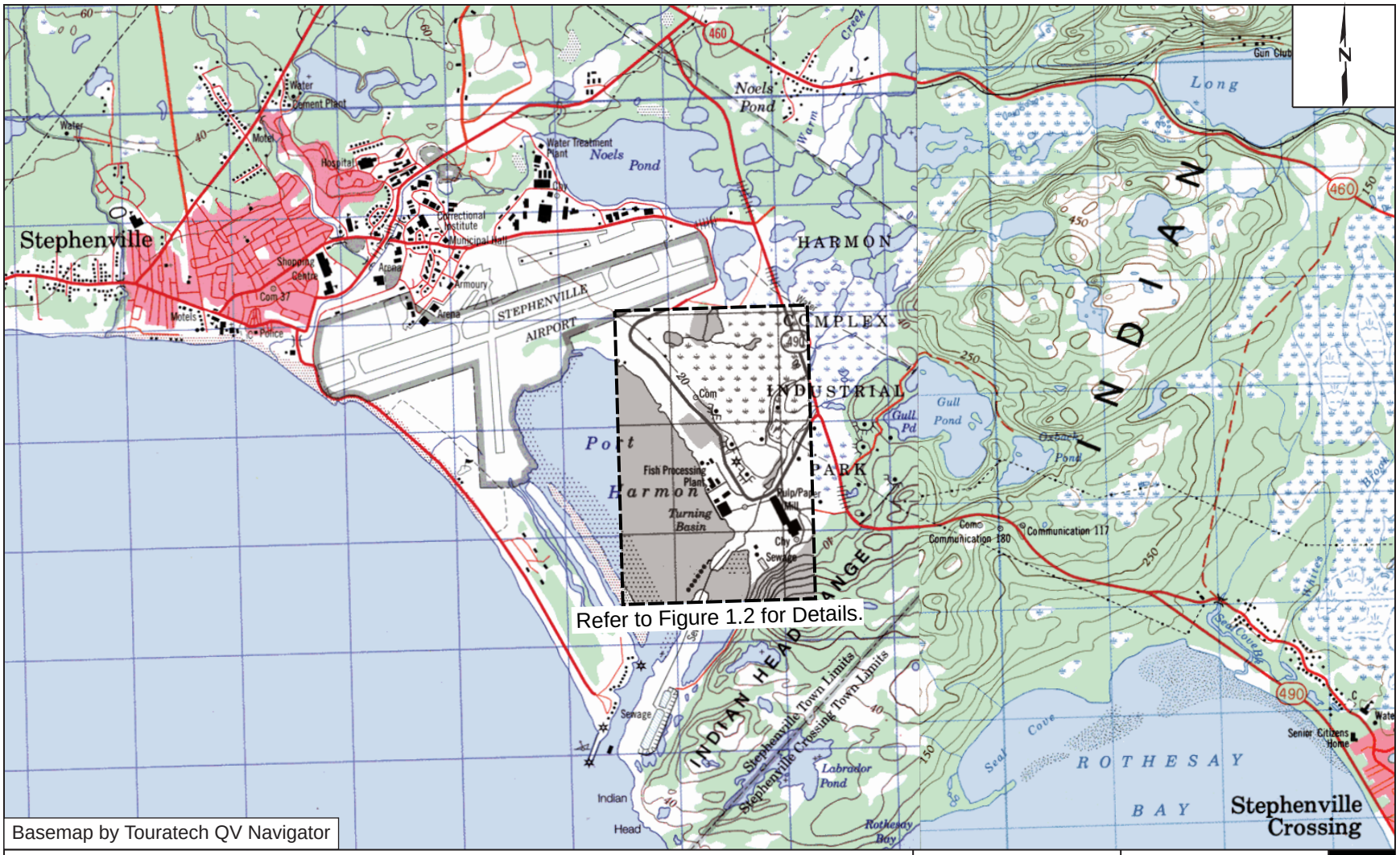
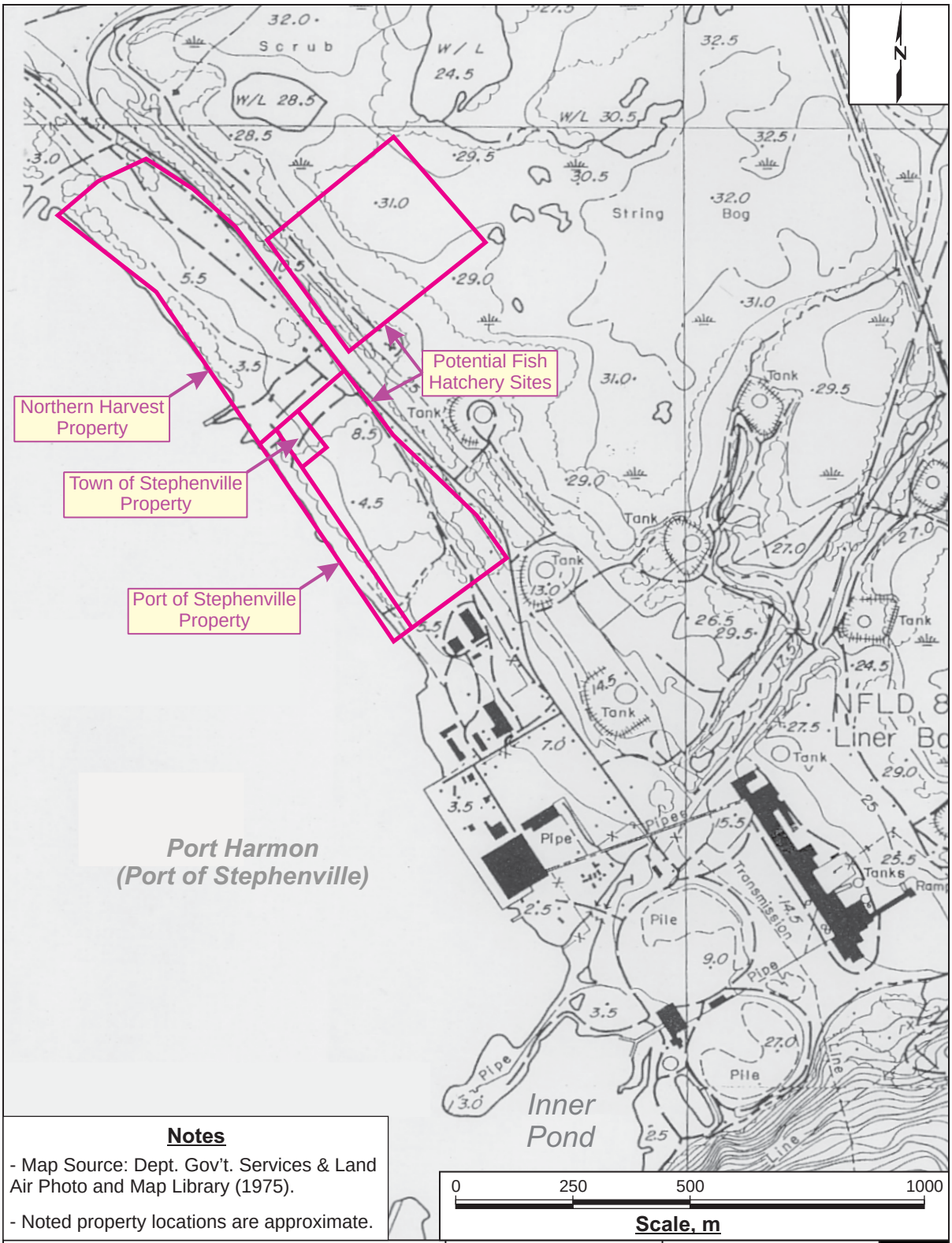


Figure 1.1 General location map of the Northern Harvest Sea Farms site and the potential MHAC site, Stephenville, NL.

Project No.	Scale
3113	1 km Grid
Location	**Date**
Stephenville, NL	July 2018

FFC



Notes

- Map Source: Dept. Gov't. Services & Land Air Photo and Map Library (1975).
- Noted property locations are approximate.

Figure 1.2 Topographic map of potential Northern Harvest Sea Farms site and surrounding area.

Project No.	Scale
520	As Shown
Location	**Date**
Stephenville, NL	July 2009

FFC

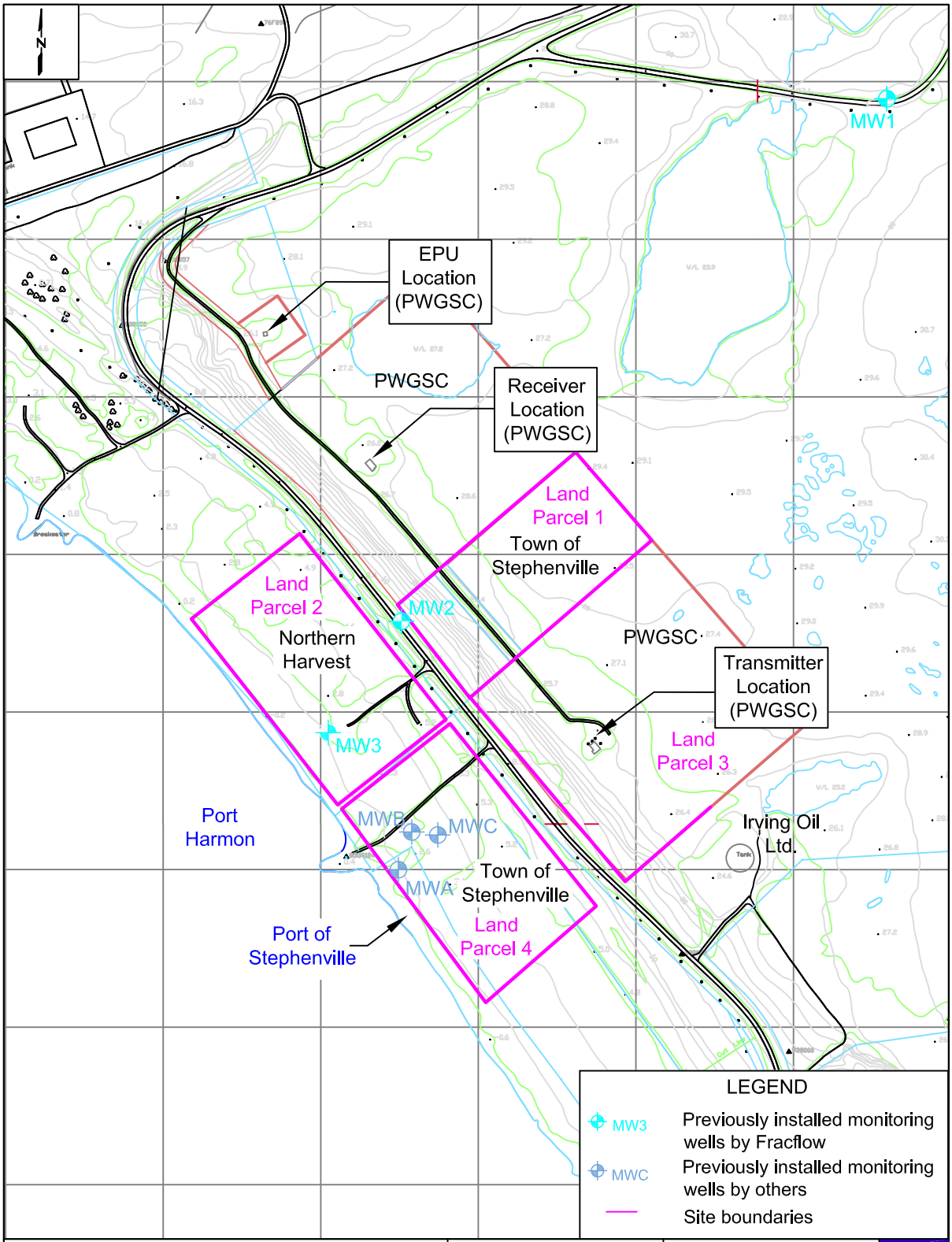
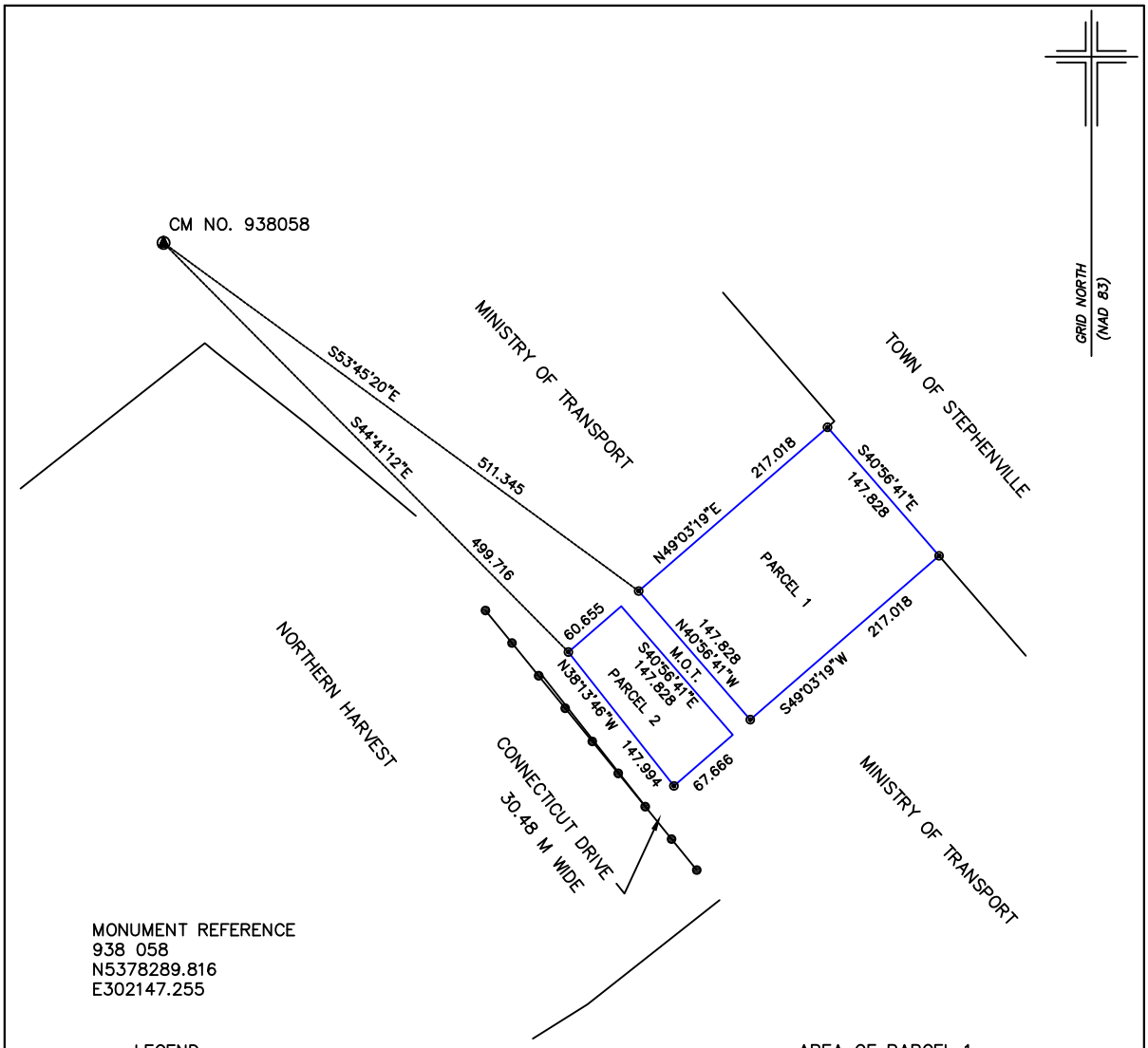


Figure 1.3 Topographic map depicting site boundaries, for land parcels described in Fracflow (2010a).

Project No.	Scale
3113	200 m Grid
Location	Date Revised
Stephenville, NL	July 2018

FFC



LAND SURVEY FOR MARITIME HARVEST ATLANTIC CANADA

CONNECTICUT DRIVE, STEPHENVILLE, NL.

SCALE 1 : 5000

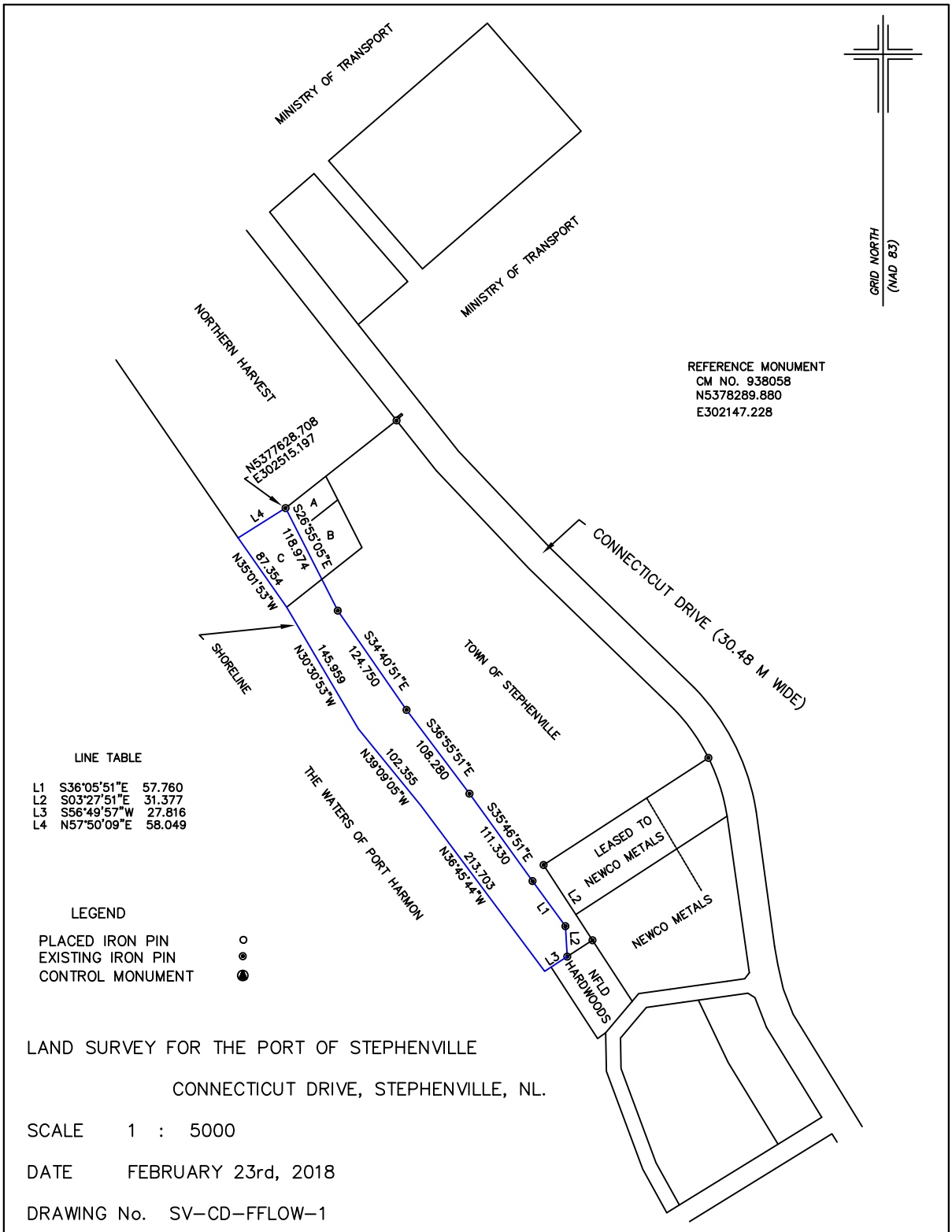
DATE DECEMBER 9th, 2017

DRAWING No. SV–CD–MARINE–1

Figure 1.4a Legal survey by Enos Fudge Surveys for proposed property purchase northeast (above) of Connecticut Drive.

Project No.	Document Reference	Location	Date
3113	FFC-NL-3113-011	Stephenville, NL	July 2018

FFC



LINE TABLE

L1	S36°05'51"E	57.760
L2	S03°27'51"E	31.377
L3	S56°49'57"W	27.816
L4	N57°50'09"E	58.049

LEGEND

PLACED IRON PIN
EXISTING IRON PIN
CONTROL MONUMENT

LAND SURVEY FOR THE PORT OF STEPHENVILLE

CONNECTICUT DRIVE, STEPHENVILLE, NL.

SCALE 1 : 5000

DATE FEBRUARY 23rd, 2018

DRAWING No. SV–CD–FFLOW–1

Figure 1.4b Legal survey by Enos Fudge Surveys for proposed property purchase southwest (below) of Connecticut Drive.

Project No.	Document Reference	Location	Date
3113	FFC-NL-3113-011	Stephenville, NL	July 2018

FFC

2.0 DATA COLLECTION AND SITE VISIT

Various records and documents were collected and reviewed and a group of knowledgeable individuals were interviewed (Fracflow 2010a) during the initial Environmental Screening for this area to infer the environmental conditions, physical environment, ownership and history of the subject properties.

2.1 Document Collection, Review and Interviews

A list of the contacts made and the various sources of documented information for the properties of interest, including the Northern Harvest Smolt Limited (NHSL) property and the properties that MHAC proposes to purchase or lease, during Fracflow's 2009 Phase I work for Northern Harvest Sea Farms are provided below. There are no indications that there have been any changes to the historical impacts on the reference properties since 2009 and the information (Fracflow 2010a) that was obtained from those contacts are considered to be valid for this combined Phase I and Phase II and are presented as a direct copy below.

- Alan Reid - Newfoundland and Labrador Housing Corporation;
- Brian Kinsmen - Town of Stephenville;
- Barry Coates - Town of Stephenville;
- Joe White - Town of Stephenville;
- James Cochrane - Port Harmon Port Authority;
- Margie Whyte - Transport Canada;
- Aerial photographs;
- Property use records;
- Prior Phase 1 ESA and Environmental Audit reports;
- Geological and geotechnical reports; and
- Regulatory information.

The scope of the information available from key sources is described in separate sections below.

2.1.1 Newfoundland and Labrador Housing Corporation

In 2009, the Lead Site Assessor reviewed and obtained copies of several maps from the Newfoundland and Labrador Housing Corporation's office in Stephenville. These maps included:

- Town of Stephenville, Stephenville East, Port Harmon Industrial Development Land Transfers, January 1994, Revised March 1994; , John G. Williams Associates Ltd., telephone: 416-391-3050, fax: 416-391-3051 (photocopied sections);

- Properties Acquired from Harmon Corporation on October 31, 1987 (photocopied sections); and
- Un-named map showing land ownership (on loan).

Note that Port Harmon has been renamed the Port of Stephenville. Also, property ownership and property boundaries for the entire harbour area, including the referenced properties, have been surveyed and/or confirmed by Enos Fudge Surveys and are available from Enos Fudge Surveys (**Figures 1.4a** and **1.4b**).

2.1.2 Transport Canada

Fracflow issued a request to Transport Canada (TC), on June 26, 2009, to supply any environmental reports on the Public Works Government Services properties, within the area of interest, for review by Fracflow. Fracflow was advised by Mrs. Margie Whyte, the Regional Manager for Environmental Affairs with Transport Canada, that reports regarding decommissioning/environmental work at the sites were prepared. The reports made available to Fracflow include:

a) Phase II Environmental Site Assessment of Former Transmitter, Receiver and Emergency Power Unit Sites, Stephenville, NL., Issued to Public Works and Government Services Canada, Issued by MGI (MGI 2003) Limited on November 2003;

b) Lead Abatement at the Former Transmitter and Receiver Sites, Stephenville, NL (Project No. 40287D)., Issued to Public Works and Government Services Canada, Issued by MGI Limited (MGI 2004) on October 2004;

c) Letter Report, Lead and Asbestos Abatement Program at the Former Transmitter and Receiver Sites in Stephenville, NL., Issued to Transport Canada, Issued by Public Works and Government Services Canada on November 8, 2004 (PWGSC 2004); and

d) Demolition of EPU/Transmitter/Receiver and Clean-Up at Stephenville, NL., Issued to Transport Canada, Issued by Whalen Enterprises Limited on August 2007 (Whalen 2007).

Figure 2.1 identifies the key properties in the above reports. Reports (a) through (c) were made available for review by Fracflow on July 8, 2009 and Report (d) was made available on July 9, 2009. A brief summary of the results and full references are contained in this report and copies are presented in **Appendix D**. Additional site work on the referenced properties has been completed by Fracflow and those reports are included as appendices to document the Phase I and Phase II professional activities for this combined Phase I and Phase II summary report (Fracflow 2018a, 2018b, 2018c).

The reports that are provided in the appendices include:

1. Technical Memorandum FFC-NL-3113-005: Geotechnical and Environmental Assessment of the Town of Stephenville Property that is Being Considered for Purchase by Marine Harvest Atlantic Canada for a Fish Hatchery Construction Site (**Appendix A**);

2. Technical Memorandum FFC-NL-3113-004: Assessment of Hydrocarbon Impacts on the Southwest Corner of the Proposed Fish Hatchery Property and Location of Old Fuel Lines (**Appendix B**); and

3. Technical Memorandum FFC-NL-3113-007; Assessment of the Groundwater Supply Potential from the Overburden Aquifer – Field Data and 3-D Model Simulations, Stephenville, NL (**Appendix C**).

2.1.3 Other Reports and Files

Additional information on the physical environment and history of this site was obtained from Fracflow's in-house project library and from various internet sources during the 2009 Phase I ESA. The Newfoundland and Labrador Heritage web site (www.heritage.nf.ca/society/stephenville) and the official website of the Town of Stephenville (www.town.stephenville.nf.ca) provided some historical information on the development of the area.

Soil conditions on and around the potential property were assessed through a review of the Newfoundland Soil Survey Report No. 12 (Agriculture Canada, 1989). That report provided the Fracflow team with a general description of the area, within the context of soil development, and a detailed description of the soil, with supporting chemical and physical analyses, 23 different soil associations. Information on the surficial geology of the area was obtained from the soil survey report referenced above, and supplemented with additional information from maps compiled by the Department of Mines and Energy maps (Batterson, M.J., 2001a; Batterson, M.J., 2001b). The bedrock geology was also assessed using maps from the Department of Mines and Energy maps (Knight, I., 1982; S.P. Colman-Sadd et al., 1990).

In Fracflow (2010a) the hydrogeology of the subject property and surrounding areas was assessed through a review of Water Resources Report 2-8 (Golder Associates, 1986), together with observations made during the site walkover and data contained in pervious site investigation reports. The Fracflow team has completed a preliminary hydrogeological evaluation of the surficial and bedrock strata within the St. George's Bay area using the published and unpublished information that was available at the time of this initial 2009 Phase I ESA work. Fracflow subsequently completed an extensive hydrogeological assessment of the groundwater resources for the area, including the development of a drainage basin scale 3D groundwater flow and transport model, including a reassessment of the water budget for the

immediate drainage basin area in which the potential fish hatchery water supply would be extracted. This report is attached as **Appendix C**.

Other sources of information that were present in Fracflow's in-house library included aerial photographs. These aerial photographs were originally obtained from the Government of Newfoundland and Labrador Map and Air Photo Library. These photographs document site conditions and the history of development for the years 1949, 1966, 1973, 1974, 1982, 1984, 1995, 1997 and 2016 (Google Earth imagery). Copies of these aerials are presented in **Appendix E**. A copy of a 1:12,500 scale topographic map was also obtained from the Map and Air Photo Library (Department of Forestry and Agriculture, 1975). The relevant portion of that map, which was produced using 1973 aerial photographs, was scanned, cropped and labelled to highlight key features of the property and surrounding lands (see **Figure 1.2**).

2.2 Interviews - Fracflow (2010a)

In 2009, the Fracflow team interviewed a cross-section of knowledgeable individuals to gain additional information about the history of the site and issues of environmental concern. Several interviews were completed on site, and two others were conducted by telephone after the site visit had concluded. For each interview, a record of communication is presented in **Appendix F**.

Individuals who were interviewed and/or contacted as part of this Phase I ESA in 2009 to gain information and knowledge about site conditions on, and adjacent to, the sites included Mr. Alan Reid, the Regional Director of NLHC. Mr. James Cochrane of the Port Harmon Authority Ltd. was also interviewed. Mr Cochrane is originally from Port au Port. He worked in some capacity the US military base for over 30 years and was also the last Chairman of the Harmon Corporation (1976-87). Mr. Cochrane was one of the two employees of the Port Harmon Authority.

In 2009, the Fracflow team also spoke with several employees of the Town of Stephenville, including Mr. Brian Kinsmen (Tax Collector), Mr. Barry Coates (Town Manager and resident for over 30 years) and Mr. Joe White (Public Works) who has been in the area for over 60 years. The Fracflow team also spoke with the Regional Manager of Environmental Services for Transport Canada (Mrs. Margie Whyte).

2.3 Site Visit

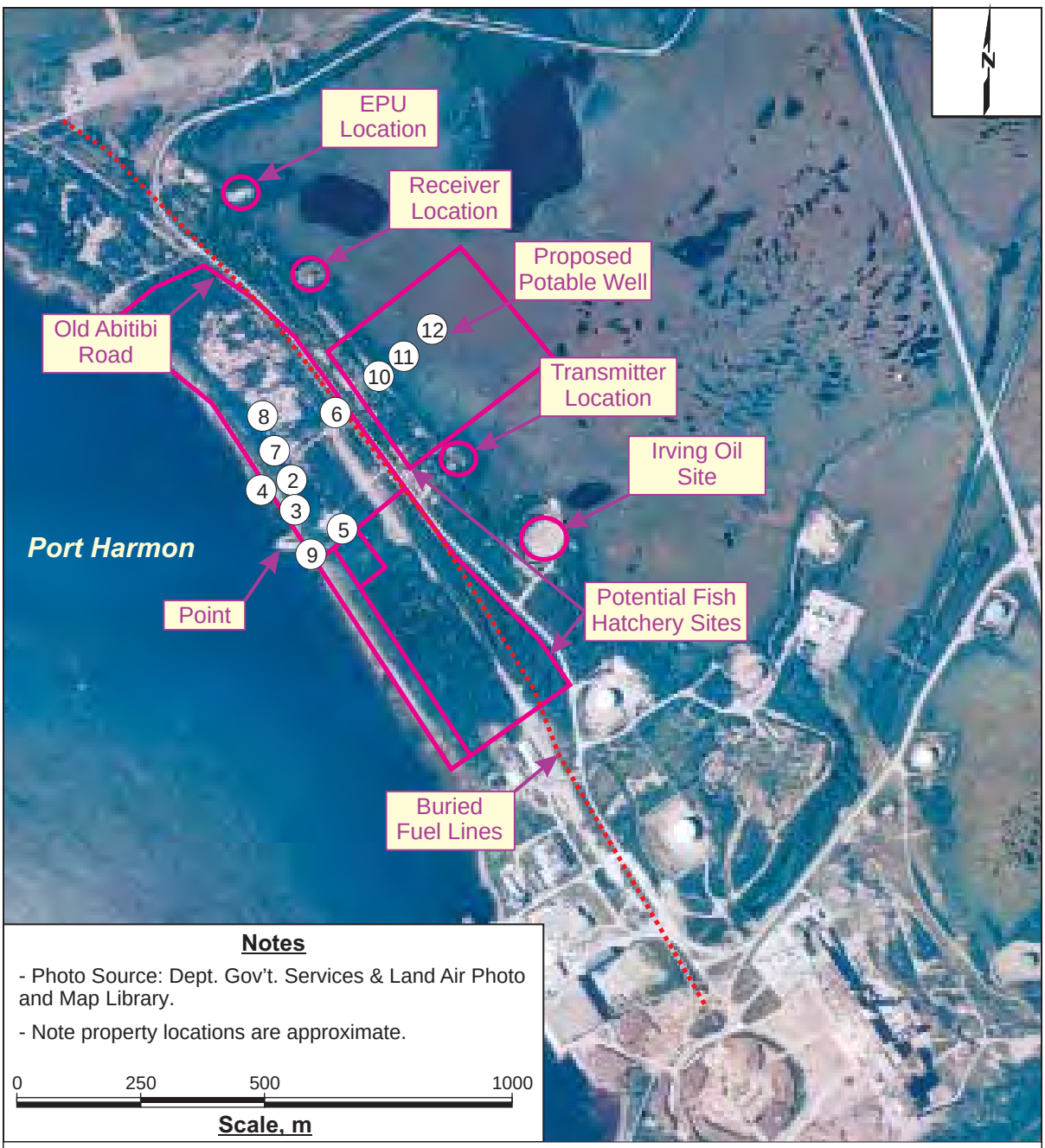
In 2009, the Lead Site Assessor conducted the site inspection of the area on which the NHSLis currently located on May 30 and 31, 2009. A visual assessment of the presence and condition of the following items was made:

- Plant and animal life;

- Site infrastructure;
- Infilling, mounding of soil or other disturbances to the surface;
- Waste materials or industrial materials at the site;
- Activities denoted by trails, roads, tracks, and truck loading/offloading areas;
- Aboveground piping systems including pumps, valves and joints;
- Unidentified pipes projecting from the ground which may indicate the presence of buried facilities;
- Discharge pipes/vents for water, sewage and exhaust;
- Standing water bodies, drainage ditches and runoff patterns;
- Water supply wells, boreholes, and monitoring wells; and
- Adjacent land uses.

A completed field checklist for the Northern Harvest property is presented in Table 2.1 of the Fracflow (2010a) report. Features of interest around the properties are identified in that report. Photographs of the site, taken during that site inspection, are attached in **Appendix C** of Fracflow (2010a) and referenced by the feature numbers shown in **Figure 2.1** (Fracflow 2010a).

On December 7, 2017, the lead investigator conducted a Phase I walk over on the property that MHAC proposes to purchase. **Figure 2.2** shows the GPS recorded track of the path followed during this walkover. **Figures 2.3** and **2.4** show various waste materials that exist on the property below Connecticut Drive such as metal debris, piles of steel cable, fuel tank mounts and miscellaneous pieces of garbage. Part of the proposed fish hatchery site is heavily forested and it is expected that other waste materials and debris are buried or concealed by the forest cover.



Notes

- Photo Source: Dept. Gov't. Services & Land Air Photo and Map Library.
- Note property locations are approximate.

0 250 500 1000

Scale, m

KEY CODE

1 - Not specific, photo is high altitude photo of entire site
2 - Old drum, possibly containing foam insulation
3 - One of many wood timbers with steel bolts along property edge
4 - Stressed vegetation near groundwater seep (GWSEEP-3)
5 - Two sets of above ground concrete cribbing and MWB
6 - Partially buried steel casing/pipe
7 - Illegal dumping (cable shields)
8 - Discarded BBQs
9 - Stressed vegetation near groundwater seep (GWSEEP-1)
10 - Possible communications cable that was encountered during ditching operations
11 - Observation well access
12 - Potable well access

Figure 2.1 Aerial photograph (1997) showing the approximate location of the overall area and issues and points of interest from Fracflow (2009).

Project No.	Scale
3113	As Shown
Location	**Date**
Stephenville, NL	July 2018

FFC

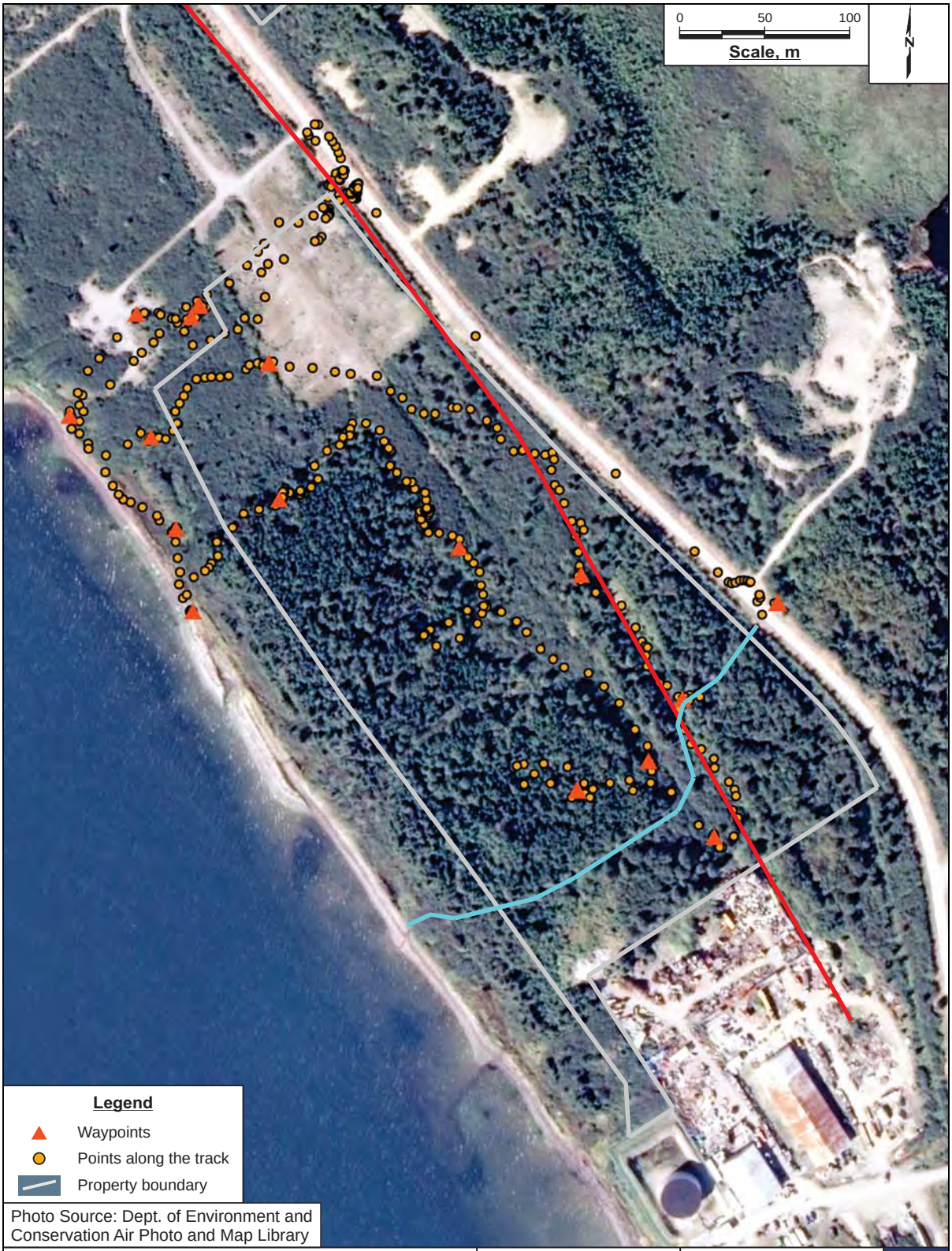


Figure 2.2 Air photo map showing the path followed for the walking Phase I tour.

Project No.	Document Reference
3113	FFC-NL-3113-011
Location	Date
Stephenville, NL	July 2018

FFC

Figure 2.3 Photograph of large piles of old steel cable.

Figure 2.4 Large section of abandoned steel plate or a tank near the shoreline of the port of Stephenville.

3.0 DOCUMENT REVIEW AND FINDINGS

The following sections provide a description of the physical environment, history of site development, a description of the properties of interest, and a discussion of actual and potential sources of contamination that were developed as part of the 2009 Phase I ESA and revised as needed in this combined Phase I and Phase II ESA.

3.1 Physical Environment

The physical environment of the general study area was reviewed in terms of the soils and surficial geology, bedrock geology, hydrology, hydrogeology, plant and animal life, and archaeology.

3.1.1 Soil Conditions

Soils of the St. George's Bay area have been mapped according to soil associations. A soil association refers to soil groups of about the same age that have developed from similar parent materials under the same climatic conditions, but which show local variations in the basic soil characteristics due to different relief and drainage conditions. The potential hatchery site properties lie within the St. George's Bay Pedoclimatic Zone, which is characterized by more than 1,200 degree days[1] above 5°C each year and mean annual precipitation of between 1,200 and 1,400 mm (Agriculture Canada, 1989). That zone consists predominantly of coarse-textured Humo-Ferric Podzols, with some Brunizols and Gleysols existing in areas of relatively poor drainage. Organic soils have developed on raised bogs, slope bogs and sloping fens (Agriculture Canada, 1989).

3.1.2 Surficial Geology

The surficial deposits of the St. George's Bay area are the remnants of three main glacial events that involved: (1) the initial deposition of 1 to 5 m of lodgement till with some pockets of overlying ice-contact gravels; (2) subsequent deposition of a layer of marine sediment, on top of the till, during subsequent deglaciation; and (3) a readvance of ice into the sea, resulting in the deposition of a sheet of coarse till and ice-contact stratified drift on top of the marine sediment

[1] There are various definitions for annual growing degree days (GDD) and the method of calculation was not noted in the Agriculture Canada report (1989). It is assumed that the GDD in this case was calculated by subtracting the base temperature of 5°C from the mean daily air temperature and then calculating the total GDD on an annual basis.

(Agriculture Canada, 1989). The type and distribution of the surficial materials are illustrated in **Figure 3.1.**

Overburden materials were visible in exposed borrow pits at the former mill site. The deposits consist predominantly of medium-to-coarse, reddish-brown to brown, sand with rounded gravel and cobbles. The compacted sand was layered with the gravel, with each layer varying from 1 to 10 cm in thickness. The layering and rounded nature of the gravel and cobbles suggested that these materials were deposited in a glaciofluvial system or marine terrace setting. The sand and gravel was overlain by 30 cm of root mat and organics. Geological maps of the area confirm these observations (Batterson, M.J., 2001a; Batterson, M.J., 2001b).

The surficial geology of the area east of the properties of interest consist predominantly of bog and glaciofluvial deposits in hummocky terrain.

3.1.3 Bedrock Geology

The bedrock geology of the coastal lowlands that surround St. George's Bay consists of deposits of sandstone, siltstone, conglomerates and minor limestone with intercalated marin, evaporitic rocks, and coal beds (Knight, I., 1982; Colman-Sadd et al., 1990). Granitoid orthogneiss and subordinate mafic gneiss and paragneiss occur to the east of the main mill site (Knight, I., 1982; Colman-Sadd et al., 1990). The type and distribution of bedrock units are illustrated in **Figure 3.2**.

There are no areas of exposed bedrock on the properties of interest. Bedrock exposures in rock cuts show a high degree of faulting and fracturing. The igneous rocks show two main orthogonal sets of sub-vertical fractures, while there are three visible fracture sets in the adjacent metasediments, two of which are steeply dipping. The third set dips approximately 45 degrees to the west.

3.1.4 Drainage Patterns and Groundwater Flow

Topography and surface water drainage patterns are illustrated in **Figure 3.3**. The area north-east of Connecticut Drive is bounded by a large area of low-lying string bogs to the north and north-east, which occur at an average elevation of 30 to 35 m above mean sea level. These bogs drain southwest toward Port Harmon - now the Port of Stephenville. The areas to the east and south of the main Abitibi mill site are bounded by a series of hills with rugged slopes, some at slopes of 26 percent or more, that rise to peak elevations of over 114 m, on the east side of Route 490, to more than 190 m to the south of the former Abitibi mill site. The hillslopes to the east and south are tree-covered with forests of balsam fir and black spruce, with some yellow birch, aspen and tamarack.

Several water courses drain from the area east of Route 490 into the Port of Stephenville. There are also several ponds in the area. Gull Pond, known colloquially as Mine Pond, is the largest fresh water body in the area, located about 1,250 m to the northeast of the former Abitibi mill site. Mine Pond was the industrial water supply for the mill operation. The water level in that pond has an elevation of 30.5 m above mean sea level, according to the topographic base map of the area. The potable water supply for the mill site is obtained from the Town of Stephenville's well field, which is located a considerable distance away from the properties of interest, to the northwest of the Port of Stephenville and the Town of Stephenville - in a separate but adjoining drainage basin.

3.1.5 Birds and Animals

A detailed survey of plants and animals was beyond the scope of the Fracflow 2009 assessment, but it is necessary to consider the types of plants and animals that may exist in the study area. The protection of wildlife species at risk is a legislative requirement of the *Species at Risk Act*, which was proclaimed by the federal government in 2003. During the 2009 survey, the Fracflow team observed common birds, silver fox, and evidence of moose activity at the sites. During the 2017 survey, the lead assessor also noted extensive evidence of moose activity and several rabbits. Due to the late fall time of the 2017 Phase I walkover (December 7), the birds were less frequent. However, in the spring of 2018, migratory birds were present along the shoreline of the Port of Stephenville adjacent to the proposed fish hatchery site. In addition, an osprey has an active nest in the middle of the property that is located northeast of Connecticut Drive.

There were no references to rare species of wildlife being present or likely present in the study area in any of the documents that were reviewed as part of this work.

We understand that there is no active commercial fishery within the Port of Stephenville harbour, but we expect that a wide variety of marine life may occupy the harbour waters given the strong tidal action. A resource inventory of the fish community in St. George's Bay was completed a few years ago by another consultant. The project report is privileged, but Fracflow can disclose that the species identified included cod, lobster, Atlantic salmon, herring, capelin, mackerel and crab.

3.1.6 Vegetation

Most of the plant life in and around the sites are common to the St. George's Bay lowlands. As mentioned in an earlier section of this report, the proposed fish hatchery area below Connecticut Drive is tree-covered with forests of balsam fir and black spruce, with some yellow birch, aspen and tamarack. There is a large area of low-lying string bogs to the north and north-east of the site that may support valuable ecological communities. A preliminary wetlands survey was previously carried out on behalf of NLHC (AGRA, 1997), which included the area of the sites.

The report indicated that there were no wetland areas of significance identified that would require an extensive impact assessment prior to any new developments that NLHC may have been contemplating at the time.

3.1.7 Archaeological Resources

A preliminary archaeological survey of the Stephenville (Harmon) industrial area was conducted on behalf of NLHC (AGRA, 1997). The results showed that various Paleo-Eskimo and Indian people had travelled through and camped in the St. George's Bay and Port au Port areas.

On another recent project in the Stephenville area, Fracflow contacted the Newfoundland Museum to determine if the museum had any concerns related to intrusive activities in the area of the MHAC properties. The Museum advised Fracflow (May 31, 2006) that an archaeological assessment would not be required unless archaeological remains were encountered during intrusive work. Remains of possible significance may include bone, charcoal or burned rock, fireplaces, house pits and/or foundations. If any such items or features are discovered, it is a legislative requirement of the *Historic Resources Act* that work must cease immediately and contact should be made with the Provincial Archaeologist in St. John's. No such items or features were observed during the work for this combined Phase I and Phase II.

3.2 Area History

Readily available archival information and aerial photographs were collected and reviewed to develop a general understanding of the history of the property of interest and its surroundings. The findings are discussed below.

3.2.1 Historic Time Line of the Site

The following historic time line is based on interviews:

- Prior to 1940-1941 the land was owned by the Government of Newfoundland and Labrador. The land was primarily used as farmland;
- 1940-1941 - the United States (US) expropriated the land from the Government of Newfoundland and Labrador;
- 1941-1966 - land is used by the US for a military installation. The US Corp of Engineers set up Camp Morris. The tent site housed military personnel, corps of engineers and civilian contractors. Each tent had was reported to have a 45 gallon drum for storing heating oil and several "honey" trucks were present to clean up the empty drums and dispose of the remaining fuel. The Americans did not have any vehicle maintenance sheds at this site at the time of the tent site. The Americans did have some bulk

5,000 gallon tanks at the site, and they were located on the concrete tank cribs that are still present at the site today. After the tent site was removed, the Americans used the site as a laydown area for storage of the 45 gallon drums. The area between the seaport and the airport was used for this storage. The area where the current fire training area is next to the airstrip was used for the bulk fueling station where fuel was stored in 45 gallon drums as well. The Americans did have communication structures up on the hill (now PWGSC/Ministry of Transport properties) that flank the potential fish hatchery site northeast of Connecticut Drive;

- December 31, 1966 - US closes military base, land transferred to the Government of Canada where the following occurs:
  - Government of Canada takes what it needs from the land transfer for use of an airport and sea port;
  - Government of Canada transfers what is left to Newfoundland;
  - Newfoundland creates the Harmon Corporation (provincial crown corporation) which is set up to manage the assets left from the US Military;
- 1969-1972 - the land at the proposed fish hatchery site was used as a laydown yard for the Newfoundland and Labrador Liner Board Company (NLLBC). When the NLLBC was active, they stored pulp wood at the site along with some construction materials and equipment. In the late 60s to early 70s, rail tracks were installed to the site from the main NLLBC property to move the pulp wood. The railway tracks were active for about three years and were eventually removed by the NL government after the NLLBC closed. Regarding the small point that juts off into Port Harmon, the NLLBC constructed it and used it as a tie up for its small work boats that moved pulp around the Port. Some refueling was performed there. That wharf was constructed of cribbing and rocks;
- 1972 - the housing stock is transferred from the Harmon Corporation to the Newfoundland Housing Corporation;
- Mid-1970s - The small point was used as a Yacht Club that berthed three to four long liner class boats and a few bay liners. No buildings were ever present and the Yacht Club did not last due to lack of boats and interest. The second point, which is located near the fire training area was used as a ramp area and some Search and Rescue Training;
- 1977 - NLLBC shuts down. Land was used for storing pulp wood as stacks and stacks of it were present on the land;
- 1977-1979 - land was vacant;
- 1979 - Abitibi takes over the NLLBC property. No known activity at the site;
- 1987 - the Harmon Corporation is phased out and all assets (except utilities) are transferred to the Town of Stephenville;
- 2000 - rest of the lands are diverted to the Town of Stephenville from the Newfoundland and Labrador Housing Corporation (NLHC). The NLHC still (in 2009) holds a mortgage on land that gets transferred from the Town of Stephenville;
- 2003 - The communication buildings on the PWGSC properties undergo a Phase II ESA where lead paint and asbestos containing material are tested for. Underground storage tanks are removed from two of the sites;

- 2004 - The communication buildings on the PWGSC properties undergo additional lead and asbestos abatement; and
- 2007 - The communication buildings on the PWGSC properties undergo demolition and clean-up.

3.2.2 Overview of the Area

Paleo-Eskimo and Indian peoples lived and camped throughout the St. George's Bay lowlands in prehistoric times. A total of six archaeological sites have been documented at Seal Cove, the closest site to the Port of Stephenville, and at Messervey's Point, Port au Port, the Isthumus site, Gravel Pond and Long Point (AGRA, 1997).

The more recent history of the Stephenville area is documented on the official website of the Town of Stephenville (www.town.stephenville.nf.ca). The area was once known as the Acadian Village, which was founded in 1844 with a total population of 103. The area was then referred to as Indian Head, between 1848 and 1870, before becoming known as Stephenville. As with most Newfoundland coastal communities, fishing and farming was the primary way of life. Much of the industrial development in Stephenville was initiated by the Americans during the construction and operation of the Harmon Field air base by the United States Air Force (USAF), beginning in 1941.

The base served as a strategic refuelling point for aircraft travelling between North America and Europe during World War II. As such, a massive fuel storage and distribution system was constructed at the base with a total reported capacity of 176,000,000 litres (AGRA, 1997). A detailed tank and pipeline inventory was completed by NLHC in 1995 (JWEL, 1995). Most of the storage capacity was initially held close to the airfield and included Aviation Turbine Fuel, or Jet, and Aviation Gasoline, or AVGAS (JWEL, 1995). The USAF modernized its storage facilities between 1951 and 1957. The upgrade consisted of four integrated tank farm systems that were connected by underground pipelines. Valve chambers were an integral part of the fuel distribution systems, allowing different aviation fuels (JET, AVGAS) and ground fuels (MOGAS, Diesel) to be routed from different tanks through common fuel lines (JWEL, 1995). The new fuel system included a sizeable tank farm in the general vicinity and surroundings of the present ACCC-Stephenville pulp and paper mill. An abandoned set of valve chambers are located on the northeast corner of the property that is located below Connecticut Drive.

The base remained in operation until 1966. Some of the infrastructure was decommissioned and dismantled, while a large portion of the base was abandoned in place and redeveloped. Past American influences still exist in the form of streets named after American states, large paved airstrips, aircraft hangars, aboveground fuel tanks and distribution systems, abandoned underground and aboveground ammunition depots, and apartment buildings that were once the barracks of military personnel. Some of the remaining aboveground tanks have been used and maintained by different parties over the years.

The closure of the base was a major blow to the economy of the Town, which was the impetus for the Smallwood government to plan and construct the NLLBC mill. Construction activities began in 1970 and were completed in 1973. The main features of the site at that time included the paper mill building; effluent treatment system, including ash ponds, settling ponds, and aeration stabilization basins; paper storage shed; maintenance building; and the Mine Pond waste disposal site to the east of Route 490.

The unbleached-kraft linerboard mill was in operation until 1977, employing more than 800 employees during peak operations. The mill closed due to high costs and an accumulating debt. Abitibi-Price Inc. purchased the site and converted it to a pulp and paper mill. The mill resumed operations in 1979 and remained a cornerstone of the local economy, employing between 275 and 343 people, until final mill closure in December 2005.

3.2.3 Search of PWGSC Records

Fracflow made a request to Transport Canada (TC), on June 26, 2009, to locate and review any environmental reports on the Public Works Government Services properties that contained the three communication buildings in Stephenville. Three reports were made available for review by Fracflow on July 8, 2009 and an additional report was made available on July 9, 2009. These reports are presented in **Appendix D**. A brief summary of the results are described below.

1) Phase II Environmental Site Assessment of Former Transmitter, Receiver and Emergency Power Unit Sites, Stephenville, NL (MGI, 2003)

The above report was issued to Public Works and Government Services Canada in November 2003 by MGI Limited. This report describes the three sites as existing on property formerly occupied by a United States Air Force Base and are currently part of the Stephenville Airport. There are three separate parcels of land, known as the EPU site, the Transmitter site and the Receiver site. The consultant's assessment included a site investigation which included conducting test pit investigations at each of the three sites and collecting paint chip samples and suspected asbestos containing material (ACM) samples.

The test pit program included digging three test pits at the Transmitter site, two test pits at the Receiver site and two test pits at the EPU site. During the test pit investigations, one underground storage tank (UST) was encountered at the Receiver site and one UST was encountered at the Transmitter site. Each of these tanks were reported removed from the Transmitter and Receiver sites. Soil samples were collected from the resulting excavations and soil samples were also collected from around the perimeter of the EPU site. The consultant's soil analytical results reported benzene, toluene, ethylbenzene and xylene (BTEX) concentrations to be within the Atlantic PIRI Tier I Look Up Table values in all of the samples submitted for petroleum hydrocarbon analysis. Modified total petroleum hydrocarbon (TPH) concentrations for the soil samples analyzed ranged from 'not-detected' to 3,457 mg/kg in the fuel oil range (at

the EPU site) which is within the Atlantic PIRI Tier I Look Up Table values for petroleum hydrocarbons in the fuel oil range (4,000 mg/kg). Two soil samples from the Transmitter site were analysed for concentrations of polycyclic aromatic hydrocarbons (PAHs) and none were detected. Two soil samples from the Transmitter site and four soil samples from the EPU site were also analysed for polychlorinated biphenyls (PCBs) and none were detected.

The investigation also included sampling one paint sample from the Receiver site. The results of this paint chip samples included one sample containing 33,000 mg/kg of lead which exceeded the Hazardous Products Regulation for lead in paint. As a result of the high lead concentration a lead leachate test was carried out on the sample. The sample contained 7.59 mg/L of lead which exceeds the Transportation of Dangerous Goods Act. The Canadian Council of Ministers of the Environment (CCME) guideline for mercury was not exceeded in the paint sample. The surface area of lead-based paint is estimated to be 10.5 m^2.

Two samples of suspected ACMs were collected from the Transmitter site and two samples of suspected ACMs were collected at the Receiver site. All four samples were found to contain chrysotile (ranging from 10-70%) and amosite (ranging from 10-40%). The volume of ACM is estimated to be 0.2 m^3 at the Receiver site and 0.5 m^3 at the Transmitter site.

Fracflow recommends that a monitoring well be constructed between each of those two sites, that are know to be impacted, approximately half way between each of those two sites and the established well field that will supply water to the existing and proposed fish hatchery site.

2) Lead Abatement at the Former Transmitter and Receiver Sites, Stephenville, NL (Project No. 40287D)

The above report was issued to Public Works and Government Services Canada in October 2004 by MGI Limited (MGI, 2004). This report describes the methodology and results of additional lead and asbestos abatement work at the Transmitter and Receiver sites on the PWGSC properties.

Additional painted surfaces were identified at the Transmitter and Receiver Sites which required further investigation. Based on the results of ten additional samples being analysed for lead content and leachate analysis, lead containing paint were identified at the Transmitter and Receiver Sites, totalling approximately 75 m^2. As a result, approximately 30 m^2 of paint was removed from the interior walls of the transmitter building and approximately 45 m^2 from the interior walls of the receiver building. Upon completion of this work the consultant stated that there are no further environmental concerns with lead-based paint at the Transmitter and Receiver Sites.

Within the consultant's report, a site plan illustrates a feature, designated 'A/G' that pass through the centre of Land Parcels 2 and 4 (the area below Connecticut Drive), in a direction parallel to

the road extending from the airport to the sea port. It remains unclear whether this indicates that an above ground pipeline was present or a buried pipeline was used for AVGAS transport (AVGAS is a high-octane aviation gasoline that is used by aircraft with piston engines). During the site visit on May 29 and 30, 2009, it was apparent that if they were above ground pipelines, they had been decommissioned and dismantled. Fracflow's 2018 report (**Appendix B**) identified five buried fuel lines that appear to have been decommissioned. It is Fracflow's understanding that these old buried fuel lines, along with the adjacent potable water line, will be removed with appropriate sampling to confirm that these fuel lines have not leak along the pipeline route or at the decommissioned valve chambers.

3) Lead and Asbestos Abatement Program at the Former Transmitter and Receiver Sites in Stephenville, NL

Letter report issued to Transport Canada, in November 8, 2004 by Public Works and Government Services Canada (PWGSC, 2004). This letter contained a summary of the activities undertaken at the site to date.

4) Demolition of EPU/Transmitter/Receiver and Clean-Up at Stephenville, NL, was issued to Transport Canada in August 2007 by Whalen Enterprises Limited (Whalen, 2007).

This report documents the demolition of the buildings and concrete structures at the EPU, Transmitter and Receiver sites. At each site, the buildings were demolished using an excavator. All concrete and rebar were trucked off site with rebar going to a recycling yard and the concrete with any remnants of rebar was trucked to a local landfill. Any concrete that was deemed clean was buried on site. It is Fracflow's understanding that there is no buried concrete at the EPU site.

3.2.4 Review of Aerial Photographs

The history of site development on this property and in the neighbouring areas is well documented in available aerial photographs that date back to 1949. Copies of those photographs are provided in **Appendix E**. Our interpretations are summarized below. The original Fracflow (2010a) land parcel designations (**Figure 1.3**) have been retained in this discussion for completeness. Land Parcel 1 is the area northeast of Connecticut Drive, owned by the Town of Stephenville. Land Parcel 2, below Connecticut Drive, covers part of the land that was bought by NHSL. Land Parcel 3 is on the northeast side of Connecticut Drive and covers part of the land owned by the Town of Stephenville and PWGSC/Ministry of Transport. Land Parcel 4, below Connecticut Drive covers part of the land that is owned by the Town of Stephenville, and part of the coastal strip that is owned by the Port of Stephenville. References to Land Parcel 2 below are deemed to include all of the land owned by NHSL. References to Land Parcel 1 and Land Parcel 4 are deemed to be included in the land that MHAC is proposing to purchase or lease from the Town of Stephenville and the Port of Stephenville.

Date: 1949
Ref: A12156-166

- Picture quality is fair in black and white.
- The surrounding area look like farms and cleared farm land.
- Land around Land Parcel 1 appears to be undeveloped bog land.
- Land around Land Parcel 2 property is undeveloped.
- Port Harmon is isolated from the open ocean by a sand bar.
- Abitibi road is present (gravel surface), only route between Stephenville and Stephenville Crossing.

Date: 1966
Ref: NFLD A 19466

- Eighteen USAF large circular fuel storage tanks are present at several locations southeast of the property.
- A marine terminal has been constructed on the north side of Port Harmon.
- Farms and farm houses are no longer visible.
- A channel has been dredged though the sand bar to provide ship access to Port Harmon and a break water was constructed on the north side of the channel.
- The sand bar has receded further north and is considerably wider.
- A small body of water on the southeast side of Port Harmon has been isolated with dredge materials or sand from bar erosion.
- Upper road between the two PWGSC properties is present (gravel surface).
- Abitibi road is present (gravel surface).
- Building structure present near the south east end of the upper gravel road (Land Parcel 3). Potential other small structures present (?).
- Land Parcel 2 appears clear, however the effluent polishing field site (Land Parcel 4) appears to have some unidentified activity.

Date: 1973
Ref: 73467-125

- Good quality black and white photograph.
- Three buildings present along the upper gravel road. Potential other small structures present (?).
- Lower property has been worked/cleared.
- Appears to be building structures or equipment on the south east portion (Land Parcel 4) of the site.
- A number of operations are underway at the NLLBC Site.
- Houses and roads are present on sand bar on the north side of the dredged channel to Port Harmon.
- Number of buildings located on property south of site and adjacent to Port Harmon.
- Fifteen large fuel storage tanks are visible.
- It appears as though four of the large fuel storage tanks have been removed to make room for the mill site infrastructure.

- Wood is boomed in Port Harmon, both in the main harbour and in the inner pond. The inner pond is 90% full of boomed logs.
- Berthing dolphins installed in harbour.
- A point has been created that jets out into Port Harmon.

Date: 1974
Ref: NF A 30961-121
- Good quality colour photograph.
- The point that jets out into Port Harmon appears to have a boat tied to it.
- Land Parcel 1 remains to be untouched except for the road that runs from each of the buildings on the PWGSC sites.
- Land Parcel 2 (lower fish hatchery site) has been cleared, however it seems to be free of any structures or equipment.
- Land Parcel 4 (effluent polishing field) has been cleared, however it seems to have a number of small structures/equipment present, along with some piles of wood. The rail way line that runs from the NLLBC is present on the same property.
- Fourteen large fuel storage tanks are visible.
- The inner pond is 40% full of boomed logs.
- Similar conditions in surrounding areas.

Date: 1982
Ref: 82015-059
- Fair quality colour photograph and difficult to make out features.
- Land parcel 4 appears to have a small water body present near the southern corner.

Date: 1984
Ref: 84007-177 and 84017-6
- Good quality colour photograph.
- Many more houses visible on the north side of the dredged channel.
- Additional berthing dolphins installed in harbour.
- Fourteen tanks are visible.
- Some shrub cover visible on the lower properties.

Date: 1995
Ref: 95048-40 & 58
- Fair quality black and white photograph.
- Sites becoming covered with shrubs, with minor exception of some minor roads.
- Nine tanks visible.
- No wood in harbour.

Date: 1997
Ref: 97009-46 and 97014-21
- Good quality colour photograph.

- Eight tanks visible.
- Vegetation continuing to encroach on properties.

Date: 2016
Ref: Google Earth Imagery
- Good Quality Color image.
- The NHSL fish hatchery buildings have been constructed.
- The NHSL well field has been constructed.
- The color aerial image shows a small area on the south east corner of the subject property where discoloration suggests that the vegetation is stressed. This may indicate that there is run-off from the Newco leased property unto the subject property.
- The subject property is approximately 60% covered by mature forest.

3.3 Evaluation of Findings

The information gathered during the 2009 Environmental Screening has been evaluated in terms of the presence of actual (observed) versus potential (probable) contamination. A finding of actual contamination would indicate that air, soil or water was impacted (e.g., oil stains on surface soil) or previously identified and documented according to a credible/reliable source. Potential contamination is described in terms of the potential for, or probability of, contamination to exist in soil, water or air based on the nature of historical and recent (not future) activities on and around the subject site, or the presence of visible/olfactory indicators (e.g., iron floc in surface water or unusual odours).

3.3.1 Actual Contamination

Actual contamination on the property of interest was neither observed by Fracflow staff during the 2009 Phase I ESA nor was it documented in any of the previous reports that were available to Fracflow for review.

3.3.2 Sources of Potential Contamination

1. The original use of the site as a USAF base with usages varying from a temporary tent base with heating oil and vehicles operating at the site. Petroleum hydrocarbons (gasoline, diesel, hydraulic oils) may have leaked or spilled, in small quantities, from this usage; however, no visual evidence of such spills or leaks were observed at the ground surface or on surface water during the site inspection. In Fracflow's opinion, the risk that such potential contamination a the surface would pose to the subject site appears to be low.

2. A second potential source of contamination would be unknown buried materials on the site. Automobile parts, scrap metal, wood, steel cables and plastics were visible on the ground surface during the site walkover. These materials could be left over from the historical USAF operations or are the result of unauthorized dumping in more recent years. In Fracflow's opinion, the risk that such potential contamination would pose to the subject site appears to be low to medium.

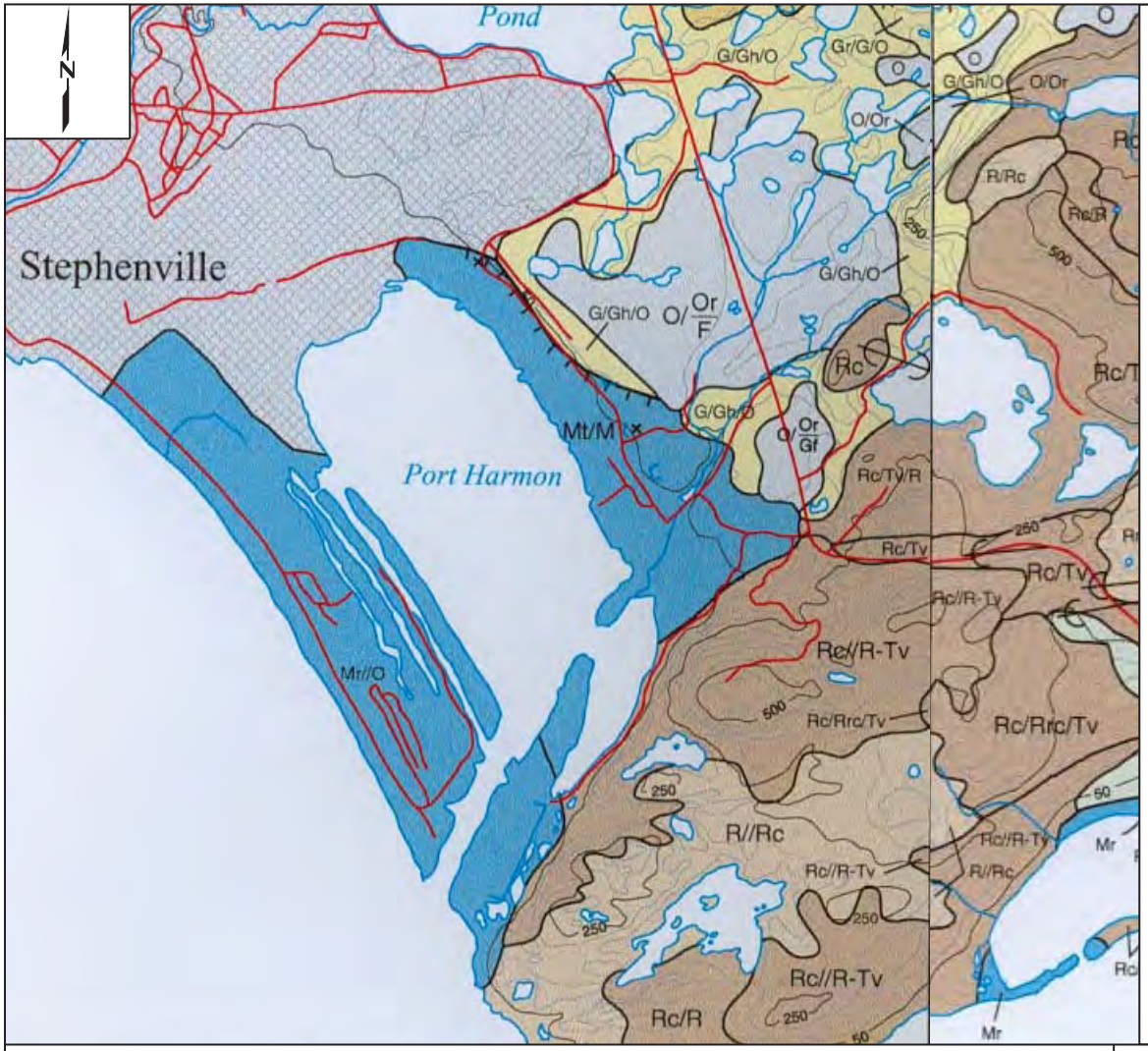
3. A third source of potential contamination to the site would be leakage from the abandoned buried fuel lines that run along and parallel to old Abitibi road (between the lower and upper sites). It is suspected these fuel lines are empty; however, this is unknown. It is Fracflow's opinion that the risk of potential contamination from this source is medium given that the fuel lines are up-gradient from the lower property.

4. Another source of potential contamination would be from a feature identified in a report (MGI, 2004) that illustrates a feature, designated 'A/G' that pass along the top or through the up-gradient edge of Land Parcels 2 and 4, in a direction parallel to the road extending from the airport to the sea port. It remains unclear whether this indicates the presence of an above ground pipeline or a buried pipeline used for AVGAS. During the site visit on May 29 and 30, 2009, it was apparent that if they were above ground pipelines, they had been decommissioned and dismantled. No surface pipelines were found during the December 7, 2017 walkover for this Phase I ESA. It is Fracflow's opinion that the risk of potential contamination from a decommissioned surface pipeline source, if one existed, is medium.

5. Buried fuel storage tanks were located at the Transmitter and Receiver communication buildings on the PWGSC properties at one time. From previous work conducted at the site by PWSGC, soil analytical results reported for BTEX and TPH concentrations were within the Atlantic PIRI Tier I Look Up Table values in all of the samples submitted. In Fracflow's opinion, the risk that such potential contamination would pose to the subject site appears to be low.

6. Another source of potential contamination is Land Parcel 4 (proposed effluent polishing field). This site contains former above ground tank cribs and three monitoring wells that are placed at, and down-gradient from, the tank cribs. A faint fuel odour is present from inside the monitoring wells. It is Fracflow's opinion that the risk that such a potential contamination would pose to the subject site appears to be low given that the gradient from the tanks appears to run parallel to the property and the tanks are no longer present.

7. A final source of potential contamination that was identified relates to the former usage of the property as a laydown area for NLLBC. Predominantly, the area was used to store pulp wood and some equipment for the construction of the mill. In Fracflow's opinion, the risk that such potential contamination would pose to the subject site appears to be low.



Legend

Symbol	Description
F	Alluvium consisting of silt and clay to bouldery gravel
G	Fine grained sand to coarse grained cobbly gravel
M	Clay, silt, gravel and diamicton; sand in some areas
O	Poorly drained peat, peat moss, and other organic matter
R	Bedrock
T	Glacial till composed of diamicton with no significant sorting
c	Vegetation mat over colluvium or rock fragments overlying bedrock
f	Gently sloping fan of stream deposited debris in a lowland area
h	Random assemblage of knobs, mounds, ridges and depressions
r	Narrow, elongated, steep-sided feature of varied composition
t	Elongated, step-like surface of till, glaciofluvial or lacustrine
v	Deposit less than 1.5 m thick; underlying morphology evident

Notes

- Basemap: Newfoundland Department of Mines and Energy, Maps 2001-15 & 2001-16

0 750 1500 3000

Scale, m

Figure 3.1 Surficial geology of the Northern Harvest Sea Farms site, the potential MHAC site, and surrounding area.

Project No.	Scale
3113	As Shown
Location	**Date**
Stephenville, NL	July 2018

FFC

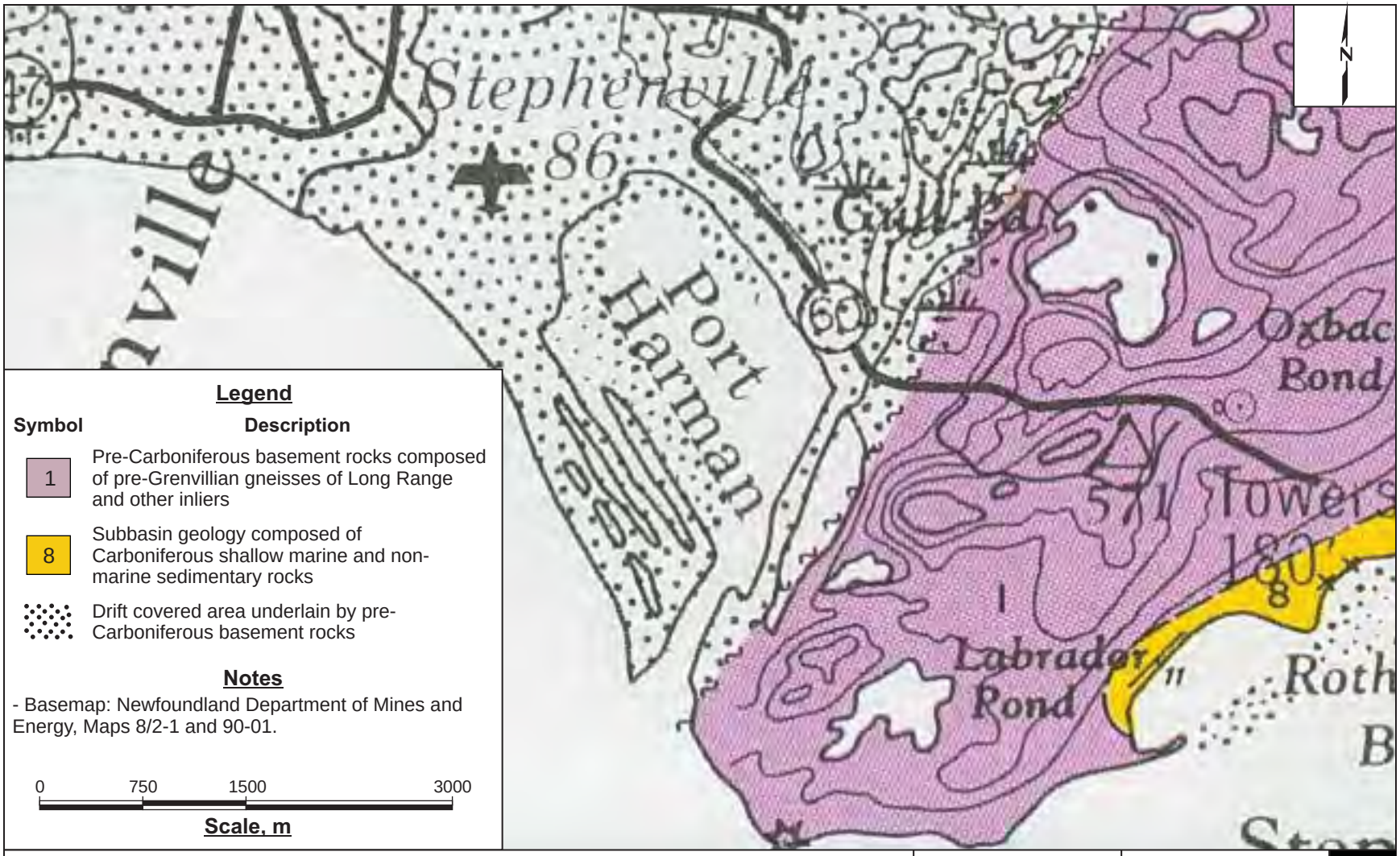


Figure 3.2 Bedrock geology of the Northern Harvest Sea Farms, the potential MAHC fish hatchery site, and surrounding area.

Project No. 3113	Scale As Shown
Location Stephenville, NL	Date July 2018

FFC

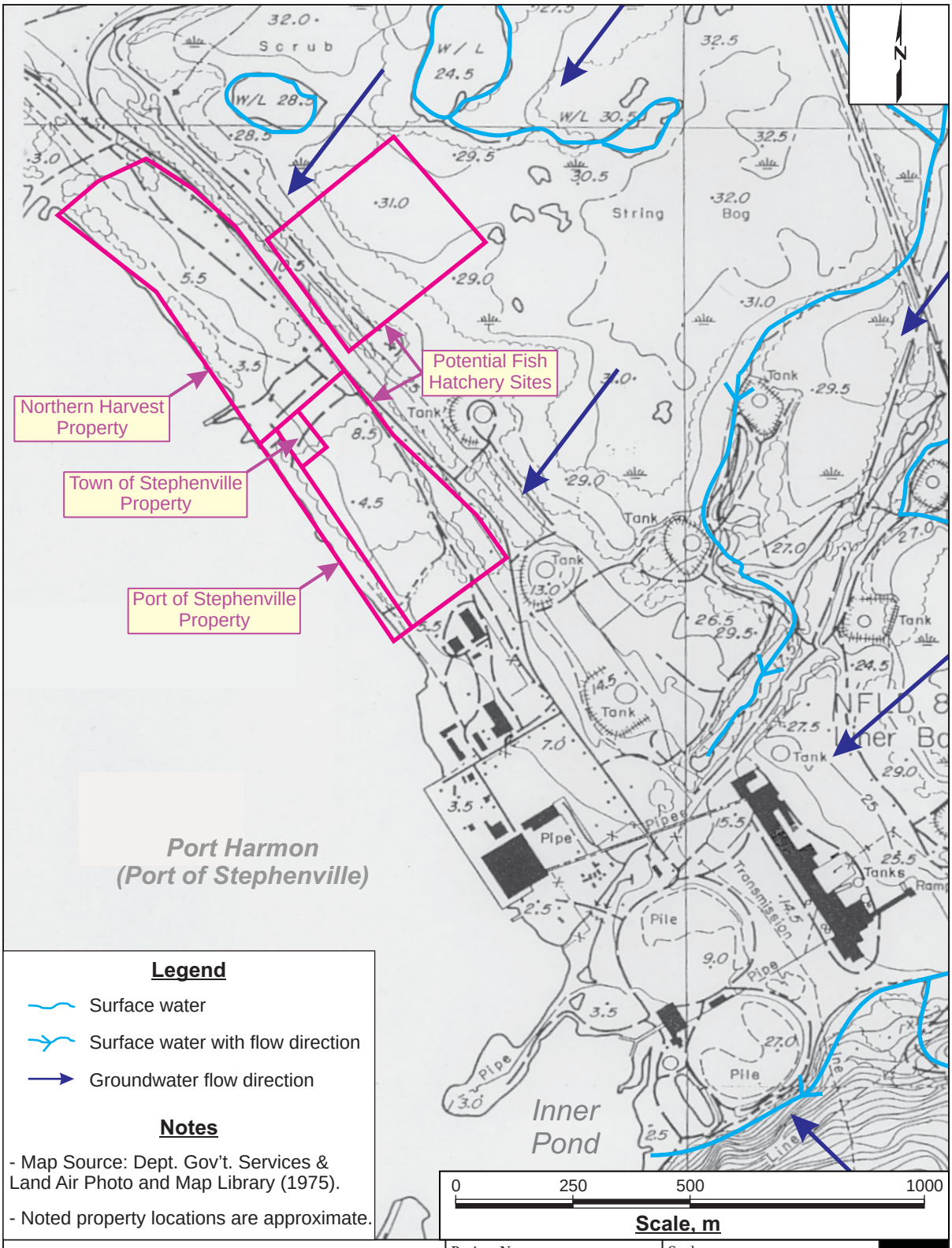


Figure 3.3 Surface water drainage patterns and inferred directions of groundwater flow.

Project No.	Scale
3113	As Shown
Location	**Date**
Stephenville, NL	July 2018

FFC

4.0 PHASE I CONCLUSIONS AND RECOMMENDATIONS

Fracflow Consultants Inc. has completed an Environmental Screening of the two parcels of land that MHAC proposes to purchase or lease for the purposes of expanding the existing fish hatchery in Stephenville, NL (**Figures 1.4a** and **1.4b**) following the general principles outlined in the CSA standard. The scope of work consisted of updating Fracflow's 2010 Phase I report which include an extensive review of documents and aerial photographs that record the various physical and historical aspects of the site and surrounding areas, contact with the provincial regulating agencies, interviews, and a site walkover on May 30 and 31, 2009. In addition, a site walkover was completed on the properties of interest by the lead assessor on December 7, 2017.

It is Fracflow's opinion that the risk of any contaminated soil or water existing on the subject site appears to be low to medium given the history as a former USAF site and laydown area for the former pulp and paper mill. There does not appear to be the possibility of any existing air quality issues. There was no evidence, either documented, observed, or reported to indicate that there is actual contamination on any part of the subject site.

Seven potential sources of contamination were identified, using available information, that may have affected soil and groundwater quality at the subject site. The potential sources that pose the greatest risk to soil and groundwater quality of this site are:

1. Buried waste materials - automobile parts, scrap metal, wood, and plastics were visible on the ground surface during the site walkover;

2. Petroleum hydrocarbons - the abandoned buried fuel lines that run along and parallel to old Abitibi road, at or below Connecticut Drive and the abandoned surface fuel lines that run across the upper side of this property, parallel to the old Abitibi road, may have leaked petroleum into the subsurface. Depending on the timing, product type, and volume of any fuel released, some of the chemical constituents of petroleum can persist in the subsurface for long periods of time and migrate from point-to-point in response to horizontal and vertical hydraulic gradients;

3. Former railway line - chemical residues from the treated railway ties, as well as from possible herbicide applications along the margins of the railway tracks, could be present in the subsurface;

4. Laydown area of the former pulp and paper mill - materials that were handled and stored in the laydown area by the former owners of the pulp and paper mill may have impacted subsurface soil and groundwater quality.

It is Fracflow's understanding the site is zoned for commercial/industrial use and the property will be developed for use as an aquaculture facility. It is Fracflow's opinion that the new development will pose a significantly lower risk to the environment compared with the risk

posed by the potential sources identified in this report. If MHAC decides to acquire the property(ies) in question, MHAC should ensure that it is released from any past or future liabilities associated with the existing condition of the property(ies). It is also important that MHAC confirm that there is no actual contamination of soil and groundwater on the property that would effect the construction and operation of the proposed fish hatchery. Therefore, a subsurface investigation was recommended.

5.0 PHASE II INTRUSIVE INVESTIGATIONS

The Phase I part of this report notes that the primary environmental concerns for the potential purchase and utilization of the subject property relate to (1) the presence of several concrete supports that appear to have been used as gravity-fed fuel tank supports and known hydrocarbon impacts in the general area of those concrete tank supports, (2) an up-gradient group of three valve chambers for fuel lines that were assumed to cut across the property, (3) two up-gradient properties located northeast of Connecticut Avenue one of which was or is owned by Transport Canada whose land usage is unknown and a separate parcel of land that was owned by Irving Oil or its affiliates and is reported to have been used to store hydrocarbons, (4) the use of the area as an initial camping ground by the US military in the 1940s which may have utilized distributed fuel sources over the entire tent city campground plus an unknown level of continued military usage on this property until the late 1960s, and (5) the site usage as a laydown area and wood storage area by the old linerboard mill in the 1970s. The Phase I part of this report provides a detailed description of those activities and summarizes the reports of various site investigations that have been completed on or close to the subject property.

A ground elevation survey was completed by Enos Fudge Surveys and the spot elevation data were used to generate a contour map of the subject property (**Figure 5.1**). The surface of the land rises from approximately 1 m (LNT) at the shoreline to approximately 3 m within 25 m of the shoreline and then rises gradually to approximately 9 m on the west side of the subject property. On the east side of the subject property, the same pattern is repeated except that the ground surface rises quickly in the upper 75 m to 100 m of the subject property from approximately 8 m to 15 m at the northeastern corner of the subject property. This area of higher relief forms a wedge that tapers out to the west and flattens at approximately the middle of the subject property on the edge of Connecticut Avenue. The contour map shows the overall general relief on the property.

5.1 Scope of the Phase II Environmental Work

The scope of the work for this current Phase II ESA was informed by the previous site history as a former military base and other historical site activities, both on the property and on adjacent up-gradient properties. The intrusive environmental site investigations were completed in conjunction with the geotechncial site investigations (**Appendix A**).

Hydrocarbon impacts were known to exist on the west to southwest corner of the property and it was known that a fuel line was or fuel lines were located under part of the property. The distribution of hydrocarbons in the sub-surface on the west to southwest corner of the property are presented in Technical Memorandum FFC-NL-3113-004, dated February 26, 2018 (**Appendix B**).

The overall scope of work that was completed for this geotechnical and environmental site assessment included auguring eight boreholes/monitoring wells, the installation of two-level piezometers in three of those eight monitoring wells. In each borehole, Standard Penetration Tests (SPTs), using split spoons, were completed on a continuous basis over the upper part of the borehole, and Direct Cone Penetration Tests (DCPTs) were then completed by driving the DCPTs out through the open end of the augers to some agreed depth. Soil samples were collected from each split spoon and stored for future geotechnical work and two soil samples from each borehole, one in the 1 m zone above the water table and one in the 1 m zone below the water table, were collected and submitted for BTEX/TPH analysis.

Falling/rising head or constant head flow tests were completed in each piezometer to provide data needed to calculate the permeability of the formation around the piezometer well screens. The water in each well was purged and water samples were collected for BTEX/TPH analysis and for both total metals and dissolved metals in selected monitoring wells. Static water levels were measured to provide an initial measurement of the water table or hydraulic heads across the subject property.

The property that is located northeast of Connecticut Drive and which is owned by the Town of Stephenville had no historical record of any site activities. Also, the site walkover of this property did not indicate any environmental issues of concern and as a result this current Phase II environmental site investigations were not extended to this property.

5.2 Results of the Phase II Environmental Site Investigations

The laboratory data from this intrusive environmental site investigation are provided in Fracflow 2018a, attached as **Appendix A**. Three soil samples were submitted for analysis of metals in soil. The three soil samples show a systematic increase in copper, lead, nickel and zinc from the up-gradient location close to Connecticut Drive to the down-gradient locations suggesting that this increase is fuel related. None of the other metals show a similar strong increase in the down-gradient direction.

The BTEX/TPH data for soil samples from the three up-gradient boreholes (**Figure 5.1**) show modified TPH concentrations that ranged from 30 to 86 mg/kg. There were no BTEX components in either soil sample and the hydrocarbons detected were in the C21 to C32 range, a lube oil fraction. The modified TPH concentration in the borehole located on the east side of the property (FHM8) was less than 20 mg/kg or below detection levels.

Soil samples were also collected from the five boreholes in the middle of the property and down-gradient from Connecticut Drive and analyzed for BTEX/TPH. Two of the boreholes, FHM2 and FHM3 (**Figure 5.1**), are in the area of known hydrocarbon impacts and the hydrocarbons in those two samples, at 23 and 390 mg/kg, respectively, are in the light hydrocarbon range or they

resemble a gas fraction. The soil sample from FHM9 also showed a BTEX/TPH of 42 mg/kg but this was in the heavy oil, C21 to C32, range.

The BTEX/TPH data for the water samples that were collected from two of the up-gradient monitoring wells, FHM4 and FHM8, show dissolved hydrocarbons in the heavy oil range, close to the detection levels. For the remaining monitoring wells, only the water samples from FHM2 and FHM3 show dissolved BTEX/TPH as expected since both monitoring wells are in the area with known hydrocarbon impacts. The measured dissolved hydrocarbons were classified as being gas fraction. None of the water samples from the other monitoring wells showed dissolved hydrocarbons above detection levels.

Note that most of these water samples were analyzed using low level detection procedures and that all of the measured dissolved hydrocarbon levels are below the Tier I criteria of 20 mg/L. The measured dissolved hydrocarbon levels may represent migration of hydrocarbons from up-gradient sources but the lack of information regarding what impacts if any that exist on the up-gradient properties prevent one from drawing any firm conclusions as to the source of these low level dissolved heavy hydrocarbons in the groundwater.

Hydrocarbon impacts were known or assumed to exist in the overburden under the west to southwest corner of the subject property that is being considered for purchase MHAC. The source and extent of the hydrocarbon impacts in the subsurface were not known. However, several concrete supports that appear to have been used as gravity-fed fuel tank supports and an up-gradient group of three valve chambers for fuel lines that cut across the property are considered to be possible sources. The tank supports are approximately 2.0 to 3.0 m in height. As noted in the Phase I section of this report, this area was used as an initial camping ground by the US military in the 1940s and it is reported that there were distributed fuel sources over the entire tent city campground. More recently the site was used as a laydown area and wood storage area by the old linerboard mill in the 1970s.

Eighteen (18) test pits (**Appendix B**) were excavated to the water table along four lines that were located across the suspected area of hydrocarbon impacts. Soil samples were collected from the excavator bucket when each test pit reached the water table or when water was visible in the bottom of the test pit. Only two of the trenches produced soil samples that provided TPH concentrations that exceeded the commercial criteria for gasoline, P3-2 at 1,270 mg/kg and P4-2 at 1,650 mg/kg. The test pit from which soil sample P3-2 was collected is located on the block of land that was not included in the proposed land purchase. The test pit from which soil sample P4-2 was collected is located on or near the boundary between the proposed land purchase (**Figure 1.4b**) and the strip of land that is reported to be owned by the Port of Stephenville.

The laboratory reported that the oil resemblance was a mixture of gas fraction (GF), plus Fuel Oil Fraction (FOF) plus Lube Oil Fraction (LOF). However, the greatest percentage of the oil was in the light oil category (C6 to C10 and C10 to C16). Only one of the samples contained a significant level of heavy oil fraction.

The hydrocarbon impacts in this area appear to be located at or close to the water table. Normal water table fluctuations would be responsible for smearing the hydrocarbons over a short vertical section, estimated at 1.5 m, at the water table. It is assumed that the hydrocarbons that have been detected in the sub-surface originated at the ground surface. It is possible that the source of the hydrocarbons is (1) either accidental or deliberate releases of hydrocarbons at the old valve chambers and/or (2) releases at the old elevated fuel tank locations, or (3) a series of distributed releases or leaks over time. It should be noted that an old fuel tank is located near the shoreline immediately down gradient from test pit P4-3. This old fuel tank has been crushed and flattened and has been abandoned at this location for some period of time.

The distribution of hydrocarbon impacts, from the test pit samples and the three monitoring wells in this area, is consistent with a hydrocarbon plume that is migrating from several sources, from different locations, with natural attenuation eliminating or degrading the hydrocarbons in the up-gradient part of the plume and near the surface. It is expected that the most significant hydrocarbon impacts exist on the property that is owned or controlled by the Port of Stephenville.

The hydrocarbons in the test pit soil samples are primarily low-weight gas fraction hydrocarbons and are highly aromatic or volatile. None of the samples contained any Benzene and only a few of the soil samples contained any of the other BTEX components. The impacted soils will produce a strong hydrocarbon smell and could produce hydrocarbon vapours that exceed the lower explosive limit (LEL) if exposed in a confined space with no venting during site construction work. However, the light weight nature of the hydrocarbons means that the hydrocarbons fumes as well as the residual hydrocarbons will dissipate or degrade quickly over a period of several weeks when aerated.

Based on the laboratory data from the test pit soil sampling program (**Figure 5.2**), three blocks of land have been identified that have impacts (**Figure 1.4b**). Those three blocks of land, A, B and C, in **Figure 1.4b** may or may not be included in the land purchase. Blocks A and B are currently owned by the Town of Stephenville and Block C is assumed to be owned or controlled by the Port of Stephenville. Based on the normal way that oil migrates, it is expected that Block C will be the most heavily hydrocarbon-impacted area.

5.3 Location of Old Fuel Lines

An old fuel line or fuel lines were postulated to cross the property that is being proposed as the site for the MHAC fish hatchery. A potable water line was reported to be located under the shoulder of the paved road and to not cross the property. To determine if fuel pipe lines existed under the property, and if so how many pipelines, a slit trench (ST1) was excavated from just below the shoulder of the road down across the property. At a point immediately down-gradient from borehole FHM4, a 200 mm diameter pipeline (**Figure 5.3**) was encountered at approximately 1.3 m of depth below ground surface. Excavation then continued and,

approximately 2 m down gradient, five metal fuel lines (one pipeline 10 cm in diameter and four pipelines 15 cm in diameter) were uncovered.

A second slit trench (ST2) was then excavated close to monitoring well FHMW8 and the water line and fuel lines were located at this second point. The two locations of the exposed fuel lines were surveyed and then used, with the location of the old valve chambers on the northwest corner of the property, to provide the actual location of the old fuel lines across the property. These old fuel lines will have to be vented, purged as required, and removed before site preparation and construction can be undertaken.

Figure 5.1 Elevation contour map of MHAC site based on topographic survey by Enos Fudge Surveys.

Project No.	Document Reference
3113	FFC-NL-3113-011
Location	**Date**
Stephenville, NL	July 2018

FFC

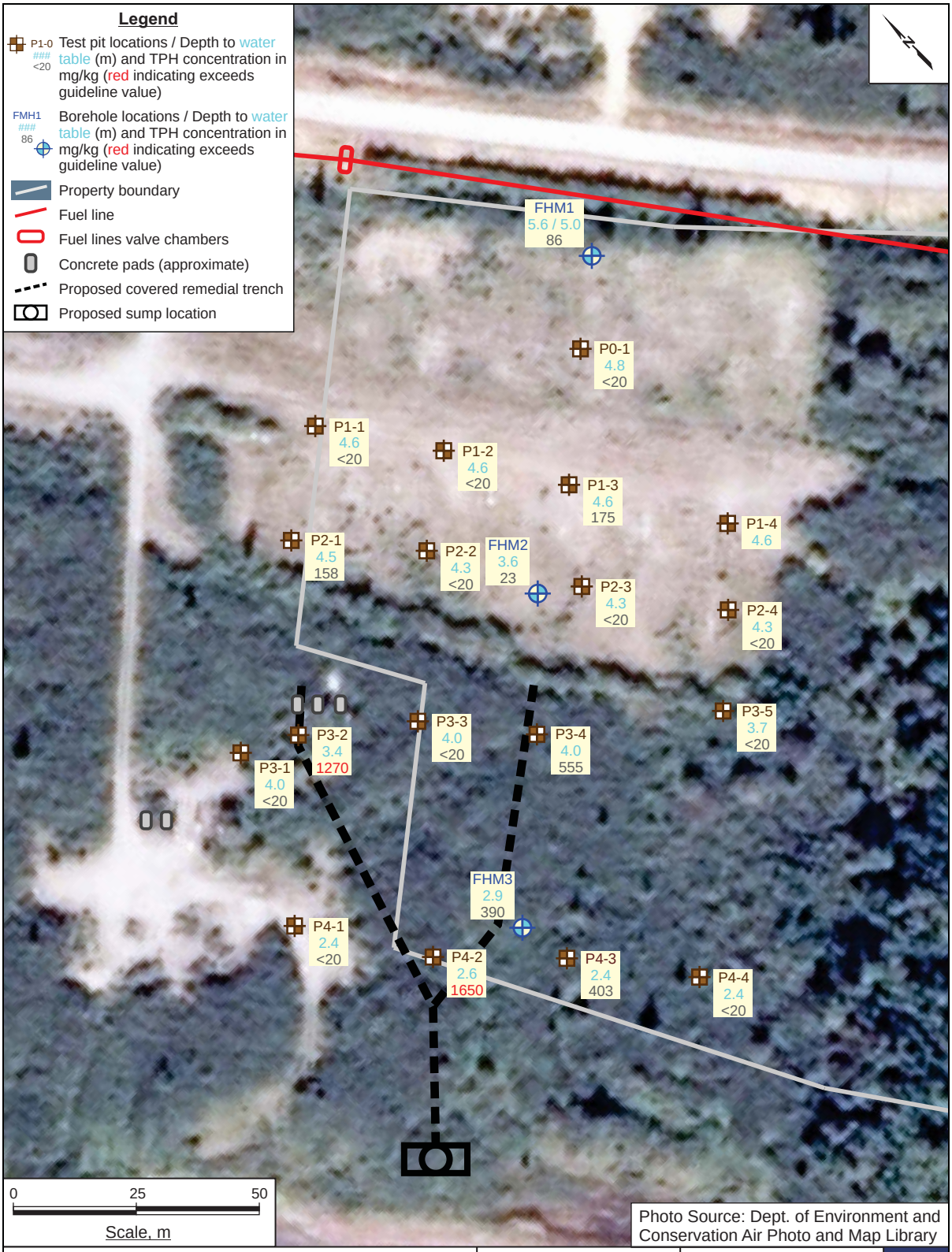


Figure 5.2 Location of the proposed covered remedial trench, Stephenville, NL.

Project No.	Document Reference
3113	FFC-NL-3113-011
Location	**Date**
Stephenville, NL	July 2018

FFC

Figure 5.3 Photograph of staff member standing on the potable water line with the old fuel lines uncovered in the foreground of the slit trench.

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APPENDIX A

Technical Memorandum FFC-NL-3113-005

Geotechnical and Environmental Assessment of the Town of Stephenville Property that is Being Considered for Purchase by Marine Harvest Atlantic Canada for a Fish Hatchery Construction Site

Fracflow Consultants Inc.

Environmental, Hydrogeological and
Geotechnical Engineering Consultants

TECHNICAL MEMORANDUM

TO: Dean Guest, Marine Harvest Atlantic Canada FFC-NL-3113-005

FROM: Fracflow Consultants Inc.

DATE: February 26, 2018

SUBJECT: **Geotechnical and Environmental Assessment of the Town of Stephenville Property that is Being Considered for Purchase by Marine Harvest Atlantic Canada for a Fish Hatchery Construction Site**

1. Background

Figure 1 shows the survey boundaries of the land that Marine Harvest Atlantic Canada (MHAC) is proposing to purchase from the Town of Stephenville for construction of a new fish hatchery – referred to here as the "subject property". The subject property was part of the US military's Harmon Air Force base from the early 1940s into the 1960s. The subject property eventually passed to the Newfoundland and Labrador Housing Corporation which then transferred this particular parcel of land to the Town of Stephenville. The subject property is located on the north side of what was known previously as Port Harmon and which is now referred to as the Port of Stephenville. The Registry of Deeds has been searched using the available names of potential owners and former owners. The collected records have been passed to Marine Harvest Atlantic Canada and to Enos Fudge Surveys for the compilation of a map showing the known owners of properties that are located in areas through which easements may be required or land may need to be purchased or leased for the operation of a new fish hatchery. The final title searches and confirmation of ownership of the relevant properties will be conducted by or provided by legal counsel retained by Marine Harvest Atlantic Canada.

Environmental concerns for the potential purchase and utilization of the subject property relate to (1) the presence of several concrete supports that appear to have been used as gravity-fed fuel tank supports and known hydrocarbon impacts in the general area of those concrete tank supports, (2) an up-gradient group of three valve chambers for fuel lines that were assumed to cut across the property, (3) two up-gradient properties located north of Connecticut Avenue one of which was or is owned by Transport Canada whose land usage is unknown and a separate parcel of land that was owned by Irving Oil or its affiliates and is reported to have been used to store hydrocarbons, (4) the use of the area as an initial camping ground by the US military in the 1940s which may have utilized distributed fuel sources over the entire tent city campground plus

an unknown level of continued military usage on this property until the late 1960s, and (5) the site usage as a laydown area and wood storage area by the old linerboard mill in the 1970s.

2. Description of the Subject Property

The subject property (**Figure 1**) that is currently being considered for purchase by Marine Harvest Atlantic Canada is primarily owned by the Town of Stephenville and is located north of the high water line of what was formerly known as Port Harmon and now is referred to as the Port of Stephenville. A strip of land that extends along the entire southern length of the subject property and is approximately 40 to 50 m wide, when measured from the shoreline of the harbour, is claimed by the Port of Stephenville. The subject property is bounded on the north by Connecticut Avenue, on the west by property that is owned by Northern Harvest Smolt Limited and on the east by property that is leased from the Town of Stephenville to Newco, a metal recycling operation. The land on the southeast corner of the subject property is owned by Nfld Hardwoods and abuts onto the shoreline strip that is claimed by the Port of Stephenville and a 15 m to 20 m wide strip of land that lies between the property that is leased to Newco and the shoreline strip that is claimed by the Port of Stephenville. The area of the subject property is 9.027 hectares. There are no known easements across the subject property but old buried fuel lines and a potable water line were reported to exist either along the edge of the property or under part of the subject property.

As part of the initial work for a Phase I report, a walking tour **(Figure 2**) of the subject property was undertaken. Approximately 55% to 60% of the property is covered by mature trees that are large enough to supply sawmill logs or pulpwood and will have to be harvested in those areas in which buildings will be placed. Approximately 25% to 30% of the property is covered by alders and other small brush with the occasional large birch tree, and approximately 10% to 20% is open cleared areas. Part of the alder covered area has now been partly cleared for site investigations.

This site walk-over identified areas in the middle of the subject property where the water table was close to or at the ground surface. It was unclear whether this high water table was formed by a perched water table on top of an organic layer or if it is a local groundwater discharge area. In addition, a small stream cuts across the eastern end of the subject property and discharges into the harbour water and it is expected that this stream forms a local recharge area for the underlying overburden. This stream is located approximately 60 m west of the boundary with the Newco metal leased property and was flowing at approximately150 to 200 litres per minute at the time of the site walk-over.

The site walk-over identified several small areas on the eastern side of the subject property where the mature trees have been cut by local residents for firewood or for lumber. There is some spillover of materials from the Newco property unto the subject property and a small gravel road, approximately 50 to 70 m in length, has been pushed into the property from the Newco leased property. Also, the aerial photographs show a small area on the south east corner of the subject property where discoloration suggests that the vegetation is stressed. This may

indicate that there is run-off from the Newco leased property unto the subject property and should be tested by completing several small test pits.

The site walk-over also identified areas with metal debris and minor garbage. Several large piles, having a cumulative weight that is estimated at two tons, of coiled galvanized steel cables (**Figure 3**) are located at the edge of the tree line on the southwest side of the area of mature trees. A large section of metal plate with a large open collar is present near the harbour shoreline (**Figure 4**) and a large semi-circular section of metal, possibly from an old fuel tank, is located close to the old concrete tank supports on the west side of the subject property. It is expected that many of the raised soil berms will also contain garbage and metal debris and that other debris from the military activities, the linerboard mill operations and local activities will be encountered when the site is cleared for construction. Fracflow Consultants could not identify any individuals that had specific and first-hand knowledge of the historical site activities other than those activities outlined in this document.

A ground elevation survey was completed by Enos Fudge Surveys and the spot elevation data were used to generate a contour map of the subject property (**Figure 5**). The surface of the land rises from approximately 1 m (LNT) at the shoreline to approximately 3 m within 25 m of the shoreline and then rises gradually to approximately 9 m on the west side of the subject property. On the east side of the subject property, the same pattern is repeated except that the ground surface rises quickly in the upper 75 m to 100 m of the subject property from approximately 8 m to 15 m at the northeastern corner of the subject property. This area of higher relief forms a wedge that tapers out to the west and flattens at approximately the middle of the subject property on the edge of Connecticut Avenue. The contour map shows the overall general relief on the property.

Several rabbits were encountered during the site walk-over and fresh moose droppings were noted in the mature treed area. The shoreline of the harbour can be expected to support nesting water fowl.

3. Scope of Geotechnical and Environmental Work

The scope of the work for this geotechnical and environmental site assessment was informed by the previous site history as a former military base and other historical site activities, both on the property and on adjacent up-gradient properties. Hydrocarbon impacts were known to exist on the west to southwest corner of the property and it was known that a fuel line was or fuel lines were located under part of the property. These two issues were investigated by Fracflow Consultants Inc. and their investigation resulted in the location of five buried fuel lines and a potable water line. This work also identified the nature and extent of the distribution of hydrocarbons in the sub-surface on the west to southwest corner of the property. Those findings are presented in Technical Memorandum FFC-NL-3113-004, dated February 26, 2018, and it is incorporated by reference in this current Technical Memorandum.

This environmental property assessment represents part of a combined Phase I and intrusive Phase II Environmental Site Assessment. The geotechnical investigations were completed in conjunction with the intrusive environmental investigations. The overall scope of work that was completed for this geotechnical and environmental site assessment included auguring eight boreholes/monitoring wells, the installation of two-level piezometers in three of those eight monitoring wells. The original plan for the site investigation included ten boreholes over three lines across the property and a test pit in the southeast corner of the subject property but site access across a bog area and weather conditions increased the time required to complete the work and forced the scope of work to be reduced to eight boreholes and the test pit in the southeast corner of the property to be deleted from the scope of work.

In each borehole, Standard Penetration Tests (SPTs), using split spoons, were completed on a continuous basis over the upper part of the borehole, and Direct Cone Penetration Tests (DCPTs) were then completed by driving the DCPTs out through the open end of the augers to some agreed depth. Soil samples were collected from each split spoon and stored for future geotechnical work and two soil samples from each borehole, one in the one metre zone above the water table and one in the one metre zone below the water table, were collected and submitted for BTEX/TPH analysis.

Falling/rising head or constant head flow tests were completed in each piezometer to provide data needed to calculate the permeability of the formation around the piezometer well screens. The water in each well was purged and water samples were collected for BTEX/TPH analysis and for both total metals and dissolved metals in selected monitoring wells. The elevation of the ground surface at each monitoring well was surveyed, including the stick-up of the piezometer pipes. Static water levels were measured to provide an initial measurement of the water table or hydraulic heads across the subject property.

4. Geotechnical Properties Based on SPT and DCPT Data

The borehole logs are provided in **Appendix A**. These logs provide soil descriptions and monitoring well installation data plus water level measurements. The SPT blow counts and N-Values for the upper part of each borehole are also included. The N-Values provide the basis for estimating the bearing capacity of the overburden as a function of depth using the empirical procedures that are provided in the Canadian Foundation Engineering Manual.

The allowable bearing pressure for a footing on sand can be estimated from the results of a Standard Penetration Test (SPT) by means of the relationship between the SPT index or N-Values (the sum of the blow counts for the second and third set of blow counts from the SPT) and the footing width (CGS, 1992; Chapter 10). Values determined using this empirical approach correspond to the situation where the groundwater table is located deep below the proposed footing foundation elevation. If the water table rises to the foundation level, no more than half the pressure values that are determined using this approach should be used. Given the groundwater table elevations at the proposed MHAC site, the need for this correction to the computed bearing capacities will be determined by the depth of the proposed building and tank

foundations and by any decision to under-drain the site to lower the water table. In addition, for shallow footings where the effective overburden pressure is less than 100 kPa (about 5 m of depth) an additional adjustment has to be made to the computed bearing capacities. The allowable bearing capacities that are computed using this empirical approach are expected to produce settlements that are smaller than 25 mm (CGS, 1992). This approach is applicable to cohesionless soils and can only be used as a guideline for cohesive soils. At the proposed MHAC site, cohesive soils were not identified in any of the eight boreholes that were completed as part of this site investigation.

For this site, we can use the formulae proposed by Meyerhof (1956) to compute the allowable bearing capacity where the footing is less than 1.2 m in width. In this case the allowable bearing pressure q_a is given by:

$q_a = (12000\ N\ K_d)$ where all parameters are given in SI units (Pa and m),

where N is the SPT index number or N-Value and K_d is the depth coefficient.

The depth coefficient is computed in terms of the footing width and the footing depth such that;

$K_d = (1 + D/3B)$ where the depth D is less than the footing width B.

When the footing width is greater than or equal to 1.2 m, then,

$q_a = (8000\ N\ K_d)((B+0.3)/B)^2$.

When the depth D is greater than the footing width, B, $K_d = 1.3$, which is the condition that is expected to exist for the structures that will be constructed at the MHAC site. Since we expect that the footings will be more than 1.2 m wide and that the depth of the footing will be greater than the width of the footing, the last equation will be used to compute allowable bearing capacities.

For the SPT data for FHM1, if we combine the second and third blow counts, we obtain N-Values that range from 55 to 92 for the first 4.5 m of depth, and this will produce an allowable bearing capacity or allowable bearing pressure q_a that ranges from 1,430 kPa to 1,924 kPa. Since the groundwater level will be at or just below the footing level, without passive drainage, the allowable bearing capacity is reduced by 50% giving a range of 715 kPa to 962 kPa. However, no corrections have been made for the effective vertical overburden pressure at the depth at which the SPTs were completed (see Figure 10.2 in the Canadian Foundation Engineering Manual, 3rd Edition, 1992, as published by the Canadian Geotechnical Society).

The water table at the time the monitoring wells were completed was between 4.784 m and 4.863 m below the ground surface. For the SPT data for FHM1 from approximately 5 m to 12 m of depth, the N-Values range from 8 to 82 which produces a range of computed allowable bearing capacities of that ranges from 104 kPa to 1,066 kPa when the values are corrected for water table depth. The borehole log for FHM1 identifies the zones where sand up-coned into the

augers when the auger plug was pulled. When the sand flows up into the augers it weakens the sand or formation immediately below the augers and when the SPT is conducted in this weaken material, low blow counts are produced. If the N-Values for those zones are ignored, the range of computed allowable bearing capacities is approximately 300 kPa to 1,066 kPa.

Once a decision is made as to the depth to which the footings and tanks will be placed and if the site will be under-drained, the final allowable bearing capacities can be computed. Normally, the bearing capacities that are computed from N-Values are then adjusted to reflect the assigned safety factors.

The water levels were measured in the eleven piezometers that were completed in the eight monitoring wells – three monitoring wells with two piezometer points (nested piezometers) in each well and five wells that are completed as single piezometers. The depth to water for each piezometer is provided in the borehole logs. The elevation data for each monitoring well was used to compute the hydraulic head for the groundwater in each monitoring well. **Figure 6** shows the hydraulic heads that were computed for each piezometer. These data show that along the up-gradient side of the MHAC property the deeper piezometers have lower hydraulic head values indicating that this is a groundwater recharge area and not a groundwater discharge area. One can also infer from this pattern of hydraulic heads that there are no confining or low permeability layers in the depth interval over which these piezometers were constructed. This indicates that the site would be amenable to passive under-draining to lower the water table to a level that would not interfere with the building footings and tank locations. If the site is under-drained by a passive drainage system, then the much higher bearing capacities can be applied in foundation design.

The hydraulic head data also show that while the hydraulic heads decrease down across the property, they increase as one moves from the west side of the property to the east end of the property. This most likely reflects the role of the small stream in recharging the local groundwater system on the east end of the property and supports the need to bury the stream in a culvert at the level of the high-water mark.

5. BTEX/TPH and Metals in Soil and Groundwater

The laboratory analyses reports are provided in **Appendix B**. Three soil samples were submitted for analysis of metals in soil, P1-3 on the up-gradient side of the group of test pits, sample P2-2 down-gradient from P1-3 and soil sample P3-2 down-gradient from P2-2. The three soil samples show a systematic increase in copper, lead, nickel and zinc from the up-gradient location to the down-gradient locations suggesting that this increase is fuel related. None of the other metals show a similar strong increase in the down-gradient direction. The tests pit soil metals data are presented in Technical Memorandum FFC-NL-3113-004, dated February 26, 2018.

Table 1 provides the BTEX/TPH data for soil samples from the three up-gradient boreholes. The soil samples from both FHM1 and FHM4 show modified TPH concentrations of 86 and 30 mg/kg, respectively. There are no BTEX components in either soil sample and the

hydrocarbons detected are in the C21 to C32 range, a lube oil fraction. The modified TPH concentration in FHM8 was less than 20 mg/kg or below detection levels.

Table 2 provides the BTEX/TPH data for the soil samples from the five lower boreholes. Two of the boreholes, FHM2 and FHM3 are in the area of known hydrocarbon impacts and the hydrocarbons in those two samples, at 23 and 390 mg/kg, respectively, are in the light hydrocarbon range or they resemble a gas fraction. The soil sample from FHM9 also showed a BTEX/TPH of 42 mg/kg but this was in the heavy oil, C21 to C32, range but it was not classified by the laboratory.

Table 3 presents the BTEX/TPH data for the water samples from two of the up-gradient monitoring wells, FHM4 and FHM8. Both monitoring wells show dissolved hydrocarbons in the heavy oil range, close to the detection levels.

Table 4 presents the BTEX/TPH data from the remaining monitoring wells. Only, FHM2 and FHM3 monitoring wells show dissolved BTEX/TPH as expected since both monitoring wells are in the area with known hydrocarbon impacts. The measured dissolved hydrocarbons are classified as being gas fraction. None of the water samples from the other monitoring wells showed dissolved hydrocarbons above detection levels.

Note that most of these water samples were analyzed using low level detection procedures and that all of the measured dissolved hydrocarbon levels are below the Tier I criteria of 20 mg/L. The measured dissolved hydrocarbon levels may represent migration of hydrocarbons from up-gradient sources but the lack of information regarding what impacts if any that exist on the up-gradient properties prevent one from drawing any firm conclusions as to the source of these low level dissolved heavy hydrocarbons in the groundwater.

6. Hydraulic Conductivity from Monitoring Well Tests

Table 5 provides the hydraulic conductivity (K) data from the falling head tests on selected monitoring wells. The K-Values range from 1.42 to 5.28 x 10^{-4} m/s and are consistent with the low water table and indicate that the site can be passively under-drained by a well-designed pattern of sub-surface drains.

7. Site Preparation

Site preparation should consist of first removing the brush, such as alders and other shrubs, using an excavator mounted mulcher to permit ready access for detailed site surveying, and fuel line and potable water line removal. The large birch trees and full size deciduous trees should be preserved during this initial site preparation. The stacks of alders and soil that were created as part of delineating the hydrocarbon impacts in the southwest corner of the subject property should be separated and the soil spread. At the same time, the metal debris, parts of old fuel tanks and the piles of old steel cables can be removed and recycled where feasible. The goal

should be to minimize the volume of material that has to be transported to a landfill. It is expected that some of the soil ridges contain buried stumps and other debris that will have to be removed. Excavation of the slit trench on the east side of the property to locate the buried fuel lines also exposed timber cribbing and these timber cribs may exist in other areas along the old fuel pipelines. It is expected that an area outside the footprint of the main buildings will have to be set aside for sorting and storing this debris on a temporary basis.

During the auguring of FHM9, the auger encountered a hard, buried, object at 2.5 m to 3 m of depth and rusty material was brought to the surface on the augur flights. It is recommended that this area be excavated as part of the site preparation to determine if the buried material is an issue.

Once the proposed fish hatchery building foot print, easements and laydown areas have been finalized, the mature trees will have to be cut with very low stumpage and the wood harvested to the extent that is required to accommodate the buildings. It is important that the mature trees be preserved wherever possible to retain a natural setting. This will require that the area that is to be cut or cleared is well marked.

It is expected that the small stream on the eastern end of the property will have to be directed to a culvert that is placed at the elevation of the high tide water level at the shoreline with a two to three percent grade. This is required to reduce recharge to the local groundwater system which is producing an elevated water table.

The mulched area will have to be grubbed to remove the root mat. The stumps and root mat from the areas where the mature trees are cut will also have to be grubbed. The organic layer or bog that is producing the perched water table in the area between boreholes 5 and 7, and below borehole 9, will have to be excavated. It is estimated that this bog or zone of soft organic material is approximately 100 to 200 m in length and approximately 20 m to 25 m wide and up to 2 m or more in depth. One should expect to encounter some free running water, which will have to be controlled, when this material is being excavated. Other zones of soft organic material may exist between the areas that were drilled and the shoreline. Placing the small stream in a deep culvert will help minimize the volume of water to be handled.

Once the fish hatchery design has been decided, primarily the depth to which the ground has to be excavated to accommodate the tanks and foundations, then a decision can be made as to whether or not the site needs to be under-drained. The 3D flow and transport model mesh has been constructed such that the drainage system can be simulated to determine which design or drainage pattern and depth would meet the project requirements.

8. References

CGS, 1992. Canadian Foundation Engineering Manual, 3rd Edition, Published by the Canadian Geotechnical Society, B-Tech Publishers, Ltd, Richmond, BC.

Meyerhof, G.G., 1956. Penetration Tests and Bearing Capacity of Cohesionless Soils. American Society of Civil Engineers, ASCE, Journal for Soil Mechanics and Foundation Engineering, Vol. 82, SM1, pp 1-19.

Table 1 Soil Analytical Results of the nested monitoring wells for Phase II assessment in Stephenville, NL.

Project 3113 - Geotechnical and Environmental Assessment								
Fracflow Sample ID	**Units**	**Tier I (mg/kg)**	**RDL**	**3113-FHM1-SS6**	**3113-FHM1-SS7**	**3113-FHM4-SS8**	**3113-FHM4-SS9**	**3113-FHM8-2-SS7**
Sampling Date				01/17/2018	01/17/2018	01/23/2018	01/23/2018	01/27/2018
AGAT ID				9028190	9028200	9028210	9028211	9050551
Petroleum Hydrocarbons								
Benzene	mg/kg	2.5	0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Toluene	mg/kg	10000	0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Ethylbenzene	mg/kg	10000	0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Xylene (Total)	mg/kg	110	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C6-C10 (less BTEX)	mg/kg		3	<3	<3	<3	<3	<3
>C10-C16 Hydrocarbons	mg/kg		15	<15	<15	<15	<15	<15
>C16-C21 Hydrocarbons	mg/kg		15	<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg		15	<15	86	30	<15	<15
Modified TPH (Tier 1)	mg/kg	870	20	<20	86	30	<20	<20
Resemblance Comment				NR	LOF	LR	NR	NR
Return to Baseline at C32				Y	Y	Y	Y	Y
Surrogate Recovery (%)								
Isobutylbenzene - EPH	%			92	95	92	97	103
Isobutylbenzene - VPH	%			121	116	116	120	92
n-Dotriacontane - EPH	%			92	99	94	96	107
Inorganics								
% Moisture	%			11	19	16	23	15

Comments:

- Tier I - Atlantic RBCA Version 3 Minimum requirements and reference guidelines for environmental assessments of petroleum impacted sites in Atlantic Canada (Non-potable residential for coarse-grained soils).
- **Bold/Shaded** - Exceeds Tier I Criteria.
- RDL - Reported Detection Limit;
- G / S - Guideline / Standard
- Results are based on the dry weight of the soil.
- Resemblance Comment Key:

FOF - Fuel Oil Fraction
FR - Product in Fuel Oil Range
GF - Gasoline Fraction
GR - Product in Gasoline Range
LOF - Lube Oil Fraction
LR - Lube Range
NA - Not Applicable
NR - No Resemblance
UC - Unidentified Compounds
WFOF - Weathered Fuel Oil Fraction
WGF - Weathered Gasoline Fraction

Table 2 Soil Analytical Results of the monitoring wells for Phase II assessment in Stephenville, NL.

Project 3113 - Geotechnical and Environmental Assessment											
Fracflow Sample ID	**Units**	**Tier I (mg/kg)**	**RDL**	**3113-FHM2-SS2**	**3113-FHM2-SS3**	**3113-FHM3-SS2**	**3113-FHM3-SS3**	**3113-FHM5-SS2**	**3113-FHM5-SS3**	**3113-FHM7-2-SS3**	**3113-FHM9-SS3**
Sampling Date				01/20/2018	01/20/2018	01/19/2018	01/19/2018	01/25/2018	01/25/2018	01/29/2018	01/26/2018
AGAT ID				9028202	9028205	9028206	9028208	9050547	9050549	9050550	9050552
Petroleum Hydrocarbons											
Benzene	mg/kg	2.5	0.03	<0.03	<0.03	<0.03	0.03	<0.03	<0.03	<0.03	<0.03
Toluene	mg/kg	10000	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Ethylbenzene	mg/kg	10000	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Xylene (Total)	mg/kg	110	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C6-C10 (less BTEX)	mg/kg		3	8	<3	<3	261	<3	<3	<3	<3
>C10-C16 Hydrocarbons	mg/kg		15	<15	<15	<15	129	<15	<15	<15	<15
>C16-C21 Hydrocarbons	mg/kg		15	<15	<15	<15	<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg		15	15	<15	15	<15	<15	<15	<15	42
Modified TPH (Tier 1)	mg/kg	870	20	23	<20	<20	390	<20	<20	<20	42
Resemblance Comment				GR+LR	NR	LR	GF	NR	NR	NR	UC
Return to Baseline at C32				Y	Y	Y	Y	Y	Y	Y	Y
Surrogate Recovery (%)											
Isobutylbenzene - EPH	%			97	90	96	106	106	99	105	107
Isobutylbenzene - VPH	%			118	118	116	118	95	100	98	94
n-Dotriacontane - EPH	%			97	90	95	92	113	98	111	115
Inorganics											
% Moisture	%			10	11	12	16	10	10	21	20

Comments:

- Tier I - Atlantic RBCA Version 3 Minimum requirements and reference guidelines for environmental assessments of petroleum impacted sites in Atlantic Canada (Non-potable residential for coarse-grained soils).
- **Bold/Shaded** - Exceeds Tier I Criteria.
- RDL - Reported Detection Limit;
- G / S - Guideline / Standard
- Results are based on the dry weight of the soil.
- Resemblance Comment Key:

FOF - Fuel Oil Fraction	LOF - Lube Oil Fraction	UC - Unidentified Compounds
FR - Product in Fuel Oil Range	LR - Lube Range	WFOF - Weathered Fuel Oil Fraction
GF - Gasoline Fraction	NA - Not Applicable	WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range	NR - No Resemblance	

Table 3 Water Analytical Results of the monitoring wells for Phase II assessment in Stephenville, NL.

Project 3113 - Geotechnical and Environmental Assessment						
Fracflow Sample ID	**Units**	**Tier I (mg/kg)**	**RDL**	**3113-FHM4-1.0-WS1**	**3113-FHM8-2-1.0-WS1**	**3113-FHM8-2-1.25-WS1**
Sampling Date				02/03/2018	02/03/2018	02/02/2018
AGAT ID				9050693	9050695	9050696
Petroleum Hydrocarbons						
Benzene	mg/L	20	0.001	<0.001	<0.001	<0.001
Toluene	mg/L	20	0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	20	0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	20	0.001	<0.001	<0.001	<0.001
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.05	<0.05	<0.05	<0.05
>C21-C32 Hydrocarbons	mg/L		0.01	0.09	0.12	<0.01
Modified TPH (Tier 1)	mg/L	20	0.1	<0.1	0.1	<0.1
Resemblance Comment				LOF	LOF	NR
Return to Baseline at C32				Y	Y	Y
Surrogate Recovery (%)						
Isobutylbenzene - EPH	%			115	87	99
Isobutylbenzene - VPH	%			86	78	81
n-Dotriacontane - EPH	%			120	96	77

Comments:

- Tier I - Atlantic RBCA Version 3 Minimum requirements and reference guidelines for environmental assessments of petroleum impacted sites in Atlantic Canada (Non-potable residential for coarse-grained soils).
- **Bold/Shaded** - Exceeds Tier I Criteria.
- RDL - Reported Detection Limit;
- G / S - Guideline / Standard
- Results are based on the dry weight of the soil.
- Resemblance Comment Key:

FOF - Fuel Oil Fraction
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GF - Gasoline Fraction
GR - Product in Gasoline Range
LOF - Lube Oil Fraction
LR - Lube Range
NA - Not Applicable
NR - No Resemblance
UC - Unidentified Compounds
WFOF - Weathered Fuel Oil Fractio
WGF - Weathered Gasoline Fractio

Table 4 Water Analytical Results of the monitoring wells for Phase II assessment in Stephenville, NL.

Project 3113 - Geotechnical and Environmental Assessment											
Fracflow Sample ID	**Units**	**Tier I (mg/kg)**	**RDL**	**3113-FHM1-1.0-WS1**	**3113-FHM1-1.25-WS1**	**3113-FMH2-2.0-WS1**	**3113-FHM3-2.0-WS1**	**3113-FHM4-1.25-WS1**	**3113-FHM5-2.0-WS1**	**3113-FHM7-2-2.0-WS1**	**3113-FHM9-2.0-WS1**
Sampling Date				02/04/2018	02/04/2018	02/05/2018	02/05/2018	02/04/2018	02/05/2018	02/06/2018	02/05/2018
AGAT ID				9063713	9063716	9063717	9063718	9063719	9063720	9063721	9063722
Petroleum Hydrocarbons											
Benzene	mg/L	20	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	20	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Ethylbenzene	mg/L	20	0.001	<0.001	<0.001	0.008	<0.001	<0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	20	0.002	<0.002	<0.002	0.015	<0.002	<0.002	<0.002	<0.002	<0.002
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01	1.93	3.62	<0.01	<0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05	0.26	0.3	<0.05	<0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
>C21-C32 Hydrocarbons	mg/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Modified TPH (Tier 1)	mg/L	20	0.1	<0.1	<0.1	2.2	3.9	<0.1	<0.1	<0.1	<0.1
Resemblance Comment				NR	NR	GF	GF	NR	NR	NR	NR
Return to Baseline at C32				Y	Y	Y	Y	Y	Y	Y	Y
Surrogate Recovery (%)											
Isobutylbenzene - EPH	%			111	107	99	114	113	113	99	116
Isobutylbenzene - VPH	%			81	80	80	78	77	78	77	78
n-Dotriacontane - EPH	%			118	115	111	121	120	120	106	121

Comments:

- Tier I - Atlantic RBCA Version 3 Minimum requirements and reference guidelines for environmental assessments of petroleum impacted sites in Atlantic Canada (Non-potable residential for coarse-grained soils).
- **Bold/Shaded** - Exceeds Tier I Criteria.
- RDL - Reported Detection Limit;
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FR - Product in Fuel Oil Range	LR - Lube Range	WFOF - Weathered Fuel Oil Fraction
GF - Gasoline Fraction	NA - Not Applicable	WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range	NR - No Resemblance	

Table 5 Hydraulic conductivity calculated from the slug tests using Hvorslev method.

Borehole ID	K	
	cm/s	m/s
FHM1 (Shallow)	5.28E-02	5.28E-04
FHM1 (Deep)	3.20E-02	3.20E-04
FHM2	5.04E-02	5.04E-04
FHM3	3.95E-02	3.95E-04
FHM4 (Shallow)	1.42E-02	1.42E-04
FHM4 (Deep)	1.96E-02	1.96E-04
FHM8-2 (Shallow)	5.28E-02	5.28E-04
FHM8-2 (Deep)	2.11E-02	2.11E-04
FHM9	1.95E-02	1.95E-04

Figure 1 Site boundaries.

Project No.	Document Reference
3113	FFC-NL-3113-005
Location	**Date**
Stephenville, NL	February 2018

FFC

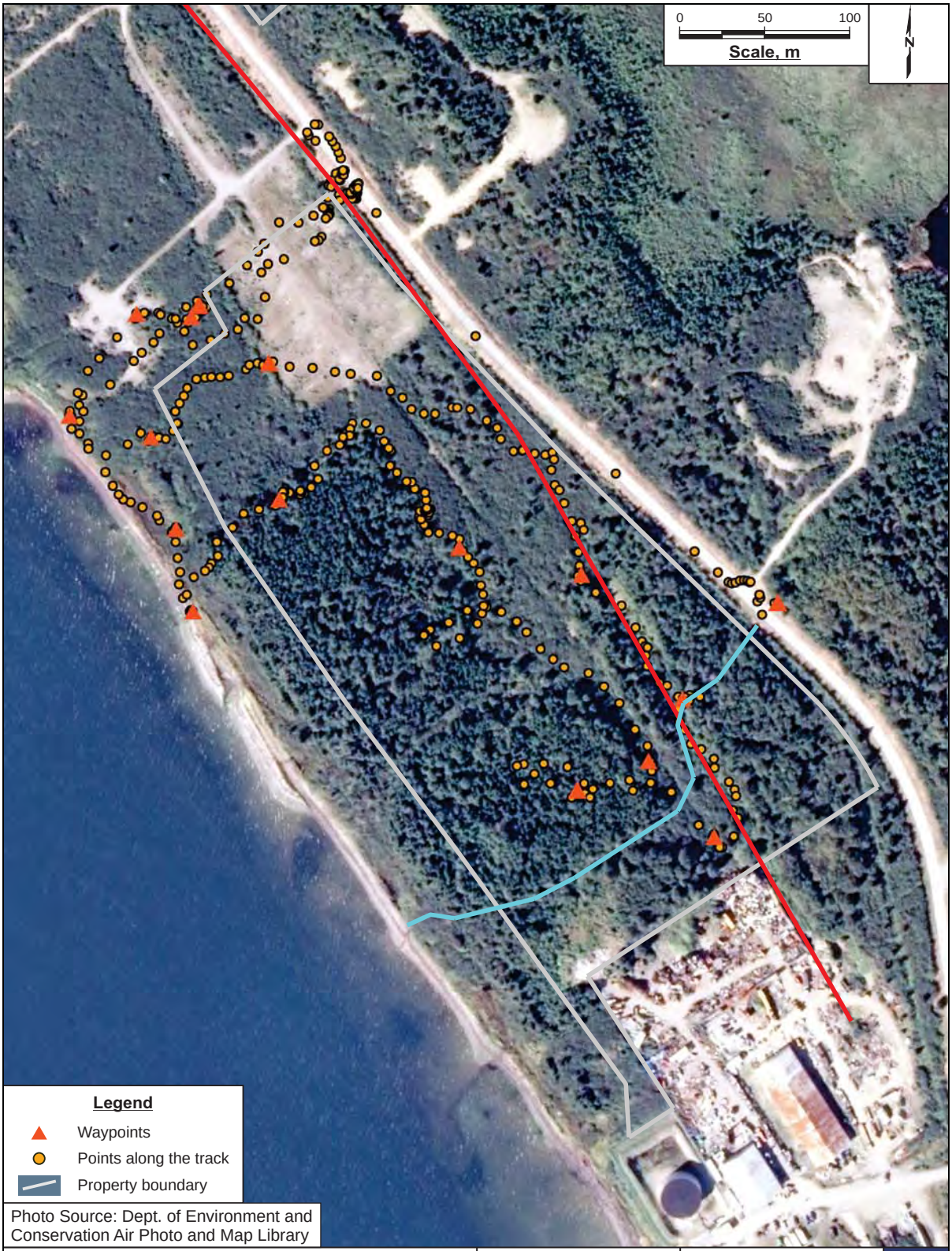

Figure 2 Air photo map showing the path followed for the walking Phase I tour.

Project No.	Document Reference
3113	FFC-NL-3113-005
Location	Date
Stephenville, NL	February 2018

FFC

Figure 3 Photograph of large piles of old steel cable.

Figure 4 Large section of abandoned steel plate or a tank near the shoreline of the port of Stephenville.

Figure 5 Elevation contour map of MHAC site based on topographic survey by Enos Fudge Surveys.

Project No.	Document Reference
3113	FFC-NL-3113-005
Location	**Date**
Stephenville, NL	February 2018

FFC

Figure 6 Measured hydraulic heads from the eight monitoring wells at the MHAC site.

Project No.	Document Reference
3113	FFC-NL-3113-005
Location	**Date**
Stephenville, NL	February 2018

FFC

APPENDIX A

Borehole Logs

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM1

Project No: 3113

Date: January 17, 2018

SUBSURFACE PROFILE				SAMPLE								
Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data - Shallow	Well Data - Deep	Well Description
0 / 0		Ground Surface (GS)	7.92									
1		Augering	7.13									Native sand packing from 0 m to 1.37 m
2 / 1		SPT: 12 / 22 / 33 / 47 / 24 Dry, brown/grey, fine to medium sand, some gravel	6.37	SS	1	55	45					0.025 m dia. riser from 0 m to 2.79 m
3		SPT: 8 / 34 / 57 Damp, brown, fine to medium sand	5.91	SS	2	91	25					Bentonite packing from 1.37 m to 2.13 m
4 / 2		Augering	5.64									0.031 m dia. riser from 0 m to 8.36 m
5		SPT: 11 / 54 / 38 / 18 / 28 Damp, fine to medium sand with gravel	4.88	SS	3	92	32					0.025 m dia. screen from 2.79 m to 5.84 m
6 / 3		SPT: 13 / 26 / 39 / 28 / 22 Damp, brown, fine to medium sand with gravel	4.12	SS	4	65	33					Native sand packing from 2.13 m to 5.84 m
7		Augering										
8 / 4		SPT: 12 / 40 / 34 / 25 / 22 Damp, brown, fine to medium sand with gravel	3.35	SS	5	74	22					(Shallow Well) 4.78 m BGS
9		SPT: 8 / 18 / 18 / 14 / 8 Wet, brown, medium sand with gravel	2.59	SS	6	36	17					4.86 m BGS (Deep Well) on Feb. 4, 2018
10 / 5		Augering										
11		SPT: 7 / 12 / 18 / 23 / 16 Wet, brown, fine to medium sand, some gravel	1.68	SS	7	30	33					Screw-on cap
12 / 6		SPT: 11 / 11 / 12 / 12 Wet, brown, medium sand, some rock fragments *Up-coning sand	1.07	SS	8	23	38					Bentonite packing from 5.84 m to 6.40 m Native sand packing from 6.40 m to 12.31 m
13		Augering										
14 / 7		SPT: 10 / 12 / 12 / 14 / 22 Wet, brown, fine to medium sand, some rock fragments	0.147	SS	9	24	20					0.031 m dia. riser from 0 m to 8.36 m
15							29					
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101

Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM1

Project No: 3113

Date: January 17, 2018

SUBSURFACE PROFILE				SAMPLE								
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data - Shallow	Well Data - Deep	Well Description
27		SPT: 18 / 30 / 52 / 18 Wet, brown, fine to medium sand with gravel	-0.475	SS	10	82	29					
28		SPT: 12 / 46 / 24 / 63 / 25 Wet, brown, fine to medium sand with gravel, some rock fragments	-1.22	SS	11	70	20					0.031m dia. screen from 8.36 m to 11.41 m
29	9	SPT: 25 / 26 / 24 / 25 / 17 Wet, brown, fine to medium sand with rock fragments	-1.95	SS	12	50	23					
30		SPT: 15 / 24 / 25 / 15 / 16 Wet, brown, very fine to medium sand with gravel	-2.71	SS	13	49	27					Native sand packing from 6.40 m to 12.31 m
31		SPT: 18 / 24 / 24 / 23 / 20 Wet, brown, very fine to medium sand * Up-coning sand	-3.47	SS	14	48	47					
32		Augering										Screw-on cap
33	10	SPT: 1 / 3 / 5 / 10 / 21 Wet, brown, very fine to medium sand * Up-coning sand	-4.38	SS	15	8	5					
34		End of Borehole										
35												
36	11											
37												
38												
39	12											
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43	13											
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46	14											
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48												
49	15											
50												
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52												

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM2

Project No: 3113

Date: January 19, 2018

Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
0 / 0		Ground Surface (GS)	5.73					
1 /		Augering						
2 /			4.88					
3 / 1		SPT: 12 / 19 / 15 / 12 / 10 Damp, brown, medium to coarse sand and gravel, some organic material	4.11	SS	1	34	28	
6 / 2		SPT: 13 / 12 / 15 / 12 Wet, brown/grey, fine to medium sand, some gravel, some rock fragments	3.5	SS	2	27	48	
8 /		SPT: 13 / 27 / 28 / 21 / 15 Wet, brown, fine to medium sand, some gravel	2.74	SS	3	55	17	
10 / 3		SPT: 9 / 13 / 8 / 14 / 14 Wet, brown, fine to medium sand, some gravel with rock fragments	1.98	SS	4	21	18	
12 /		Augering						
13 / 4		SPT: 7 / 13 / 16 / 17 / 19 Wet, grey, fine to medium sand, some gravel Hydrocarbon odour, visible sheen	1.1	SS	5	29	58	
15 /		Augering						
16 / 5		SPT: 4 / 7 / 11 / 15 / 17 Wet, grey, fine sand Hydrocarbon odour	0.26	SS	6	18	27	
18 /		Augering						
19 /		SPT: 1 for 0.52 m / 2 for 0.09 m Wet, brown-grey, medium sand	-0.363	SS	7	1	2	
20 / 6		SPT: 4 / 7 / 8 / 10 Wet, grey, fine to medium sand Faint hydrocarbon odour * Up-coning sand	-0.972	SS	8	15	38	
22 /			-1.17					
23 / 7		Augering						
24 /		Augering * Up-coning sand	-1.78					
25 /		End of Borehole						
26 /								

Standard Penetration Test "N" Value per 300 mm (20, 60)

Well Data

Well Description:

- Native sand packing from 0 m to 1.05 m
- Bentonite packing from 1.05 m to 1.51 m
- 0.05 m dia. riser from 0 m to 2.62 m
- 3.18 m BGS on Feb. 5, 2018
- 0.05 m dia. screen from 2.62 m to 5.67 m
- Native sand packing from 1.51 m to 7.51 m
- Screw-on cap

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 1 of 1

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM3

Project No: 3113

Date: January 19, 2018

Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
0 / 0		Ground Surface (GS)	4.25						Native sand packing from 0 m to 0.31 m
1 /		Augering	3.38						Bentonite packing from 0.31 m to 0.76 m
3 / 1		SPT: 8 / 11 / 11 / 9 / 6 Damp, brown, medium sand with gravel, some rock fragments	2.62	SS	1	22	42		0.05 m dia. riser from 0 m to 0.93 m
6 / 2		SPT: 5 / 10 / 11 / 10 Wet, brown, medium sand with gravel, some rock fragments	2.01	SS	2	21	25		2.34 m BGS on Feb. 5, 2018
8 /		Augering							
9 / 3		SPT: 4 / 6 / 5 / 3 / 8 Wet, brown, fine to medium sand with gravel, some rock fragments Strong hydrocarbon odour, visible sheen	1.08	SS	3	11	20		
11 /		SPT: 8 / 6 / 12 / 12 Wet, brown, very fine to medium sand, some gravel Strong hydrocarbon odour, visible sheen	0.47	SS	4	18	19		0.05 m dia. screen from 0.93 m to 5.51 m
13 / 4		SPT: 19 / 25 / 25 / 23 / 19 Wet, brown-grey, fine to medium sand, some gravel Hydrocarbon odour, visible sheen * Up-coning sand	-0.292	SS	5	50	28		Native sand packing from 0.76 m to 7.08 m
16 / 5		SPT: 5 / 11 / 20 / 17 / 16 Wet, brown to grey, very fine to medium sand with gravel * Up-coning sand	-1.05	SS	6	31	68		Screw-on cap
19 /		Augering							
20 / 6		SPT: 5 / 8 / 12 / 20 / 19 / 15 Wet, brown-grey, very fine to medium sand, some gravel * Up-coning sand	-2.07	SS	7	20	68		
22 / 7		SPT: 8 / 11 / 14 / 19 / 20 Wet, brown, very fine sand	-2.83	SS	8	25	2		
23 /		End of Borehole							

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM4

Project No: 3113

Date: January 23, 2018

SUBSURFACE PROFILE				SAMPLE								
Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data - Shallow	Well Data - Deep	Well Description
0 / 0		Ground Surface (GS)	9.59									
1		Augering	8.76									Native sand packing from 0 m to 0.76 m
3 / 1		SPT: 12 / 16 / 11 / 10 / 10 Damp, medium sand, some rock fragments with organic material	7.99	SS	1	27	45					Bentonite packing from 0.76 m to 1.22 m
6 / 2		SPT: 10 / 9 / 11 / 10 Damp, brown, fine to medium sand	7.38	SS	2	20	69					0.025 m dia. riser from 0 m to 2.60 m
		Augering										
9 / 3		SPT: 7 / 9 / 8 / 8 / 9 Damp, brown, fine to medium sand	6.49	SS	3	17	55					0.031m dia. riser from 0 m to 8.70 m
11		SPT: 7 / 6 / 8 / 7 / 9 Damp, brown, fine to medium sand	5.73	SS	4	14	55					0.025 m dia. screen from 2.60 m to 5.65 m
13 / 4		SPT: 5 / 8 / 7 / 7 / 8 Damp, brown, fine to medium sand	4.97	SS	5	15	62					Native sand packing from 1.22 m to 7.62 m
16 / 5		SPT: 6 / 7 / 7 / 9 / 10 Damp, brown, fine to medium sand	4.21	SS	6	14	57					Screw-on cap (Shallow Well) 5.99 m BGS on Feb 3, 2018
19 / 6		SPT: 6 / 12 / 19 / 23 / 22 Damp, brown, fine to medium sand, some gravel, some rock fragments	3.45	SS	7	31	57					6.02 m BGS on Feb. 4, 2018 (Deep Well)
22		SPT: 11 / 12 / 10 / 11 / 11 Wet, brown, fine to medium sand with gravel, some rock fragments	2.68	SS	8	22	40					
23 / 7		SPT: 5 / 6 / 11 / 15 / 17 Wet, brown, fine to medium sand with gravel * Up-coning sand	1.92	SS	9	17	43					0.031m dia. riser from 0 m to 8.70 m
26							44					

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM4

Project No: 3113

Date: January 23, 2018

SUBSURFACE PROFILE				SAMPLE								
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data - Shallow	Well Data - Deep	Well Description
27		SPT: 9 / 15 / 20 / 27 Wet, brown, fine to medium sand with gravel * Up-coning sand	1.31	SS	10	35	44					Bentonite packing from 7.62 m to 8.38 m
28		Augering	1.05									
29		SPT: 24 / 24 / 16 / 10 / 10 Wet, brown, fine to medium sand, some gravel		SS	11	40	8					
30	9		0.291									0.031 m dia. screen from 8.70 m to 11.75 m
31		SPT: 7 / 9 / 12 / 14 Wet, brown, fine to medium sand, some gravel, some rock fragments * Up-coning sand		SS	12	21	40					
32			-0.318									
33	10											
34		SPT: 8 / 14 / 13 / 12 / 11 Wet, brown, very fine to medium sand with gravel		SS	13	27	33					Native sand packing from 8.38 m to 12.96 m
35			-1.08									
36	11	SPT: 6 / 8 / 9 / 12 / 10 Wet, brown, very fine to medium sand * Up-coning sand		SS	14	17	5					
37			-1.84									
38		SPT: 7 / 7 / 11 / 22 / 22 Wet, brown, fine to medium sand with gravel and rock fragments * Up-coning sand		SS	15	18	30					Screw-on cap
39	12		-2.6									
40		SPT: 4 / 8 / 11 / 16 / 24 Wet, brown/grey, very fine to medium sand * Up-coning sand		SS	16	19	47					
41			-3.37									
42												
43	13	End of Borehole										
44												
45												
46	14											
47												
48												
49	15											
50												
51												
52												

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

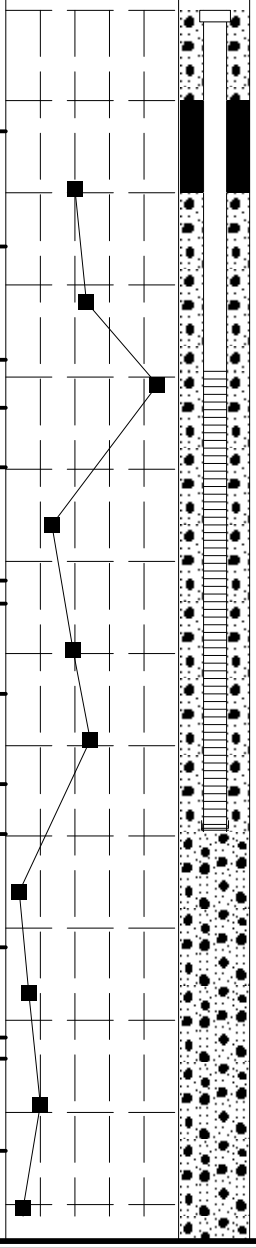
Location: Stephenville, NL

Log of Monitoring Well: FHM5

Project No: 3113

Date: January 25, 2018

Depth (ft / m)	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
0 / 0	Ground Surface (GS)	6.07					
	Augering	5.27					
3 / 1	SPT: 7 / 26 / 15 / 23 / 23 Dry, brown, fine to medium sand with gravel and rock fragments	4.51	SS	1	41	34	
6 / 2	SPT: 9 / 17 / 30 / 41 / 20 Wet, brown, fine to medium sand with gravel	3.74	SS	2	47	23	
8	SPT: 8 / 36 / 52 for 0.03 m (Refusal) Wet, fine to medium sand with gravel, some rock fragments	3.41	SS	3	88	38	
9 / 3	Augering	3.03					
10	SPT: 10 / 13 / 14 / 14 / 16 Wet, brown, fine to medium sand with gravel	2.27	SS	4	27	60	
12 / 4	Augering						
13	SPT: 3 / 9 / 30 / 38 Wet, brown, fine to medium sand with gravel, some rock fragments	1.53	SS	5	39	75	
15	SPT: 40 / 30 / 19 / 11 Wet, brown, very fine to medium sand, some gravel * Up-coning sand	0.918	SS	6	49	42	
16 / 5	Augering	0.607					
18	SPT: 3 / 4 / 4 / 5 / 6 Wet, brown, sand, trace gravel	-0.155	SS	7	8	2	
19 / 6	SPT: 3 / 5 / 9 / 9 Wet, fine sand with gravel * Up-coning sand	-0.765	SS	8	14	2	
22 / 7	Augering						
23	SPT: 4 / 9 / 12 / 11 Wet, brown, very fine to medium sand * Up-coning sand	-1.49	SS	9	21	50	
25	SPT: 1 / 6 / 5 / 7 / 8 Wet, brown, very fine to medium sand					2	



Well Description

- Native sand packing from 0 m to 0.61 m
- Bentonite packing from 0.61 m to 1.22 m
- 0.05 m dia. riser from 0 m to 2.41 m
- 2.85 m BGS on Feb. 5, 2018
- 0.05 m dia. screen from 2.41 m to 5.46 m
- Screw-on cap
- Native sand packing from 1.22 m to 15.11 m

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM5

Project No: 3113

Date: January 25, 2018

SUBSURFACE PROFILE				SAMPLE							
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 60)	Well Data	Well Description
27			-2.26	SS	10	11	2				
28				PC	--	4					
29				PC	--	5					
9				PC	--	5					
30				PC	--	7					
				PC	--	8					
31				PC	--	11					
				PC	--	10					
32				PC	--	12					
				PC	--	13					
10				PC	--	14					
33				PC	--	17					
				PC	--	18					
34				PC	--	20					
				PC	--	14					
35				PC	--	18					
				PC	--	28					
36		DCPT: (Blow counts per 150 mm) 4 / 5 / 5 / 7 / 8 / 11 / 10 / 12 / 13 / 14 / 17 / 18 / 20 / 14 / 18 / 28 / 30 / 29 / 31 / 27 / 21 / 23 / 22 / 23 / 22 / 22 / 25 / 26 / 22 / 24 / 22 / 23 / 25 / 28 / 23 / 28 / 30 / 29 / 30 / 30 / 24 / 25 / 22 / 23 / 25		PC	--	30					Native sand packing from 1.22 m to 15.11 m
11				PC	--	29					
				PC	--	31					
37				PC	--	27					
				PC	--	21					
38				PC	--	23					
				PC	--	22					
39				PC	--	23					
12				PC	--	22					
40				PC	--	22					
				PC	--	25					
41				PC	--	26					
				PC	--	22					
42				PC	--	24					
				PC	--	22					
13				PC	--	23					
43				PC	--	25					
				PC	--	28					
44				PC	--	23					
				PC	--	28					
45				PC	--	30					
				PC	--	29					
46				PC	--	30					
14				PC	--	30					
47				PC	--	24					
				PC	--	25					
48				PC	--	22					
				PC	--	23					
49			-9.03	PC	--	25					
15		End of Borehole									
50											
51											
52											

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM7-2

Project No: 3113

Date: January 29, 2018

Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data	Well Description
0 / 0		Ground Surface (GS)	5.51								
1 – 3 /		Augering	4.62								Native sand packing from 0 m to 0.61 m
3 – 5 / 1		SPT: 2 / 7 / 9 / 9 Wet, black, organic material with some gravel	4.01	SS	1	16	33				Bentonite packing from 0.61 m to 1.22 m
5 – 7 / 2		SPT: 10 / 9 / 6 / 7 Wet, black, organic material with gravel and some rock fragments	3.4	SS	2	15	36				0.05 m dia. riser from 0 m to 1.85 m
7 – 8 /		Augering									
8 – 10 / 3		SPT: 6 / 9 / 10 / 9 / 10 Wet, brown, fine to medium sand with gravel, some rock fragments	2.49	SS	3	19	32				▼ 2.87 m BGS on Feb. 6, 2018
10 – 12 /		SPT: 11 / 7 / 5 / 7 Wet, brown, fine to medium sand with gravel and rock fragments	1.88	SS	4	12	31				0.05 m dia. screen from 1.85 m to 4.89 m
12 – 13 / 4		Augering									
13 – 15 /		SPT: 7 / 17 / 14 / 10 / 11 Wet, brown, very fine to medium sand with gravel, some rock fragments	0.956	SS	5	31	42				
15 – 16 / 5		SPT: 4 / 8 / 14 / 13 Wet, brown, fine to medium sand with gravel, some rock fragments * Up-coning sand	0.347	SS	6	22	67				Screw-on cap
17 – 18 /		Augering	0.115								
18 – 20 / 6		SPT: 7 / 15 / 21 / 26 / 26 Wet, brown, fine to medium sand with gravel	-0.647	SS	7	36	50				
20 – 22 /		SPT: 13 / 17 / 18 / 19 Wet, brown, very fine to medium sand with gravel, some rock fragments * Up-coning sand	-1.26	SS	8	35	52				Native sand packing from 1.22 m to 15.06 m
22 – 26 / 7		DCPT (Blow counts per 150 mm)		PC	--	11					
				PC	--	13					
				PC	--	22					
				PC	--	23					
				PC	--	36					
				PC	--	30					
				PC	--	18					
				PC	--	23					
				PC	--	11					

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM7-2

Project No: 3113

Date: January 29, 2018

SUBSURFACE PROFILE				SAMPLE							
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 60)	Well Data	Well Description
27		DCPT: (Blow counts per 150 mm) 11 / 13 / 22 / 23 / 36 / 30 / 18 / 23 / 11 / 6 / 8 / 7 / 4 / 6 / 7 / 10 / 5 / 7 / 8 / 7 / 8 / 9 / 8 / 8 / 8 / 9 / 10 / 15 / 10 / 9 / 12 / 10 / 9 / 11 / 13 / 15 / 15 / 13 / 13 / 13 / 14 / 14 / 12 / 14 / 19 / 13 / 16 / 15 / 17 / 16 / 19 / 20 / 22 / 20 / 22		PC	--	6					Native sand packing from 1.22 m to 15.06 m
28				PC	--	8					
29				PC	--	7					
9 30				PC	--	4					
31				PC	--	6					
32				PC	--	7					
10 33				PC	--	10					
34				PC	--	5					
35				PC	--	7					
11 36				PC	--	8					
37				PC	--	7					
38				PC	--	8					
12 39				PC	--	9					
40				PC	--	8					
41				PC	--	8					
42				PC	--	8					
13 43				PC	--	9					
44				PC	--	10					
45				PC	--	15					
14 46				PC	--	10					
47				PC	--	9					
48				PC	--	12					
15 49				PC	--	10					
50		End of Borehole	-9.56	PC	--	9					
51				PC	--	11					
52				PC	--	13					
				PC	--	15					
				PC	--	15					
				PC	--	13					
				PC	--	13					
				PC	--	13					
				PC	--	14					
				PC	--	14					
				PC	--	12					
				PC	--	14					
				PC	--	19					
				PC	--	13					
				PC	--	16					
				PC	--	15					
				PC	--	17					
				PC	--	16					
				PC	--	19					
				PC	--	20					
				PC	--	22					
				PC	--	20					
				PC	--	22					

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM8-2

Project No: 3113

Date: January 27, 2018

Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data - Shallow	Well Data - Deep	Well Description
0 / 0		Ground Surface (GS)	9.06									
		Augering	8.17									Native sand packing from 0 m to 0.91 m
3 / 1		SPT: 5 / 26 / 51 / 49 / 32 Wet, brown, fine to medium sand with organic material and rock fragments Sulfur odour	7.41	SS	1	77	60					Bentonite packing from 0.91 m to 1.52 m
6 / 2		Augering SPT: 19 / 16 / 17 / 18 Wet, brown, fine to medium sand with gravel	6.71	SS	2	33	67					0.025 m dia. riser from 0 m to 3.39 m
9 / 3		SPT: 6 / 8 / 8 / 7 / 10 Wet, brown, fine to medium sand with gravel	5.95	SS	3	16	50					0.031 m dia. riser from 0 m to 9.06 m
11 / 4		Augering SPT: 10 / 10 / 12 / 10 Wet, brown, very fine to medium sand with gravel	5.25	SS	4	22	50					Native sand packing from 1.52 m to 7.62 m
13 / 4		SPT: 5 / 11 / 13 / 16 / 18 Damp, brown, fine to medium sand with red and white particles, some gravel	4.49	SS	5	24	53					0.025 m dia. screen from 3.39 m to 6.43 m
16 / 5		SPT: 10 / 13 / 19 / 21 / 20 Damp, brown, very fine to medium sand	3.73	SS	6	32	53					(Shallow Well) 5.24 m BGS on Feb. 3, 2018
18 / 5		Augering										
19 / 6		SPT: 6 / 10 / 14 / 10 / 13 Wet, fine to medium sand, some gravel	2.84	SS	7	24	53					5.27 m BGS on Feb 2, 2018 (Deep Well)
21 / 6		SPT: 9 / 14 / 14 / 17 Wet, brown, fine to medium sand, some gravel * Up-coning sand	2.23	SS	8	28	52					Screw-on cap
23 / 7		Augering SPT: 8 / 16 / 13 / 14 / 18 Wet, brown, fine to medium sand, some gravel	1.31	SS	9	29	38					0.031 m dia. riser from 0 m to 9.06 m
26							33					Bentonite packing from 7.62 m to 8.23 m

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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

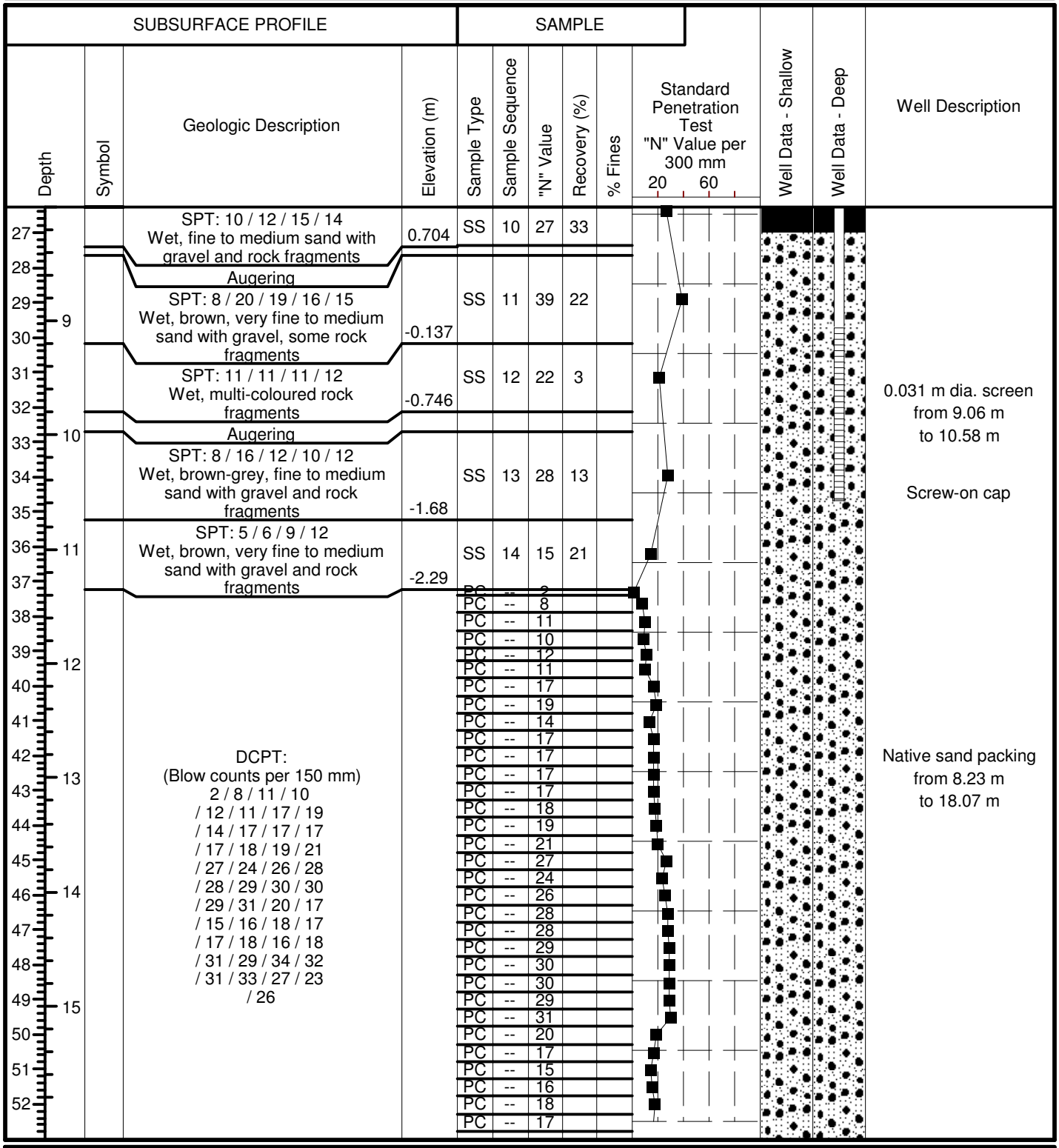
Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM8-2

Project No: 3113

Date: January 27, 2018



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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM8-2

Project No: 3113

Date: January 27, 2018

SUBSURFACE PROFILE				SAMPLE								
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data - Shallow	Well Data - Deep	Well Description
53				PC	--	17						
54				PC	--	18						
55				PC	--	16						
56	17	DCPT (Blow counts per 150 mm)		PC	--	18						
57				PC	--	31						
58				PC	--	29						
59	18		-9.02	PC	--	34						
60		End of Borehole		PC	--	32						
61				PC	--	31						
62	19			PC	--	33						
63				PC	--	27						
64				PC	--	23						
65				PC	--	26						
66	20											Native sand packing from 8.23 m to 18.07 m
67												
68												
69	21											
70												
71												
72	22											
73												
74												
75	23											
76												
77												
78												

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101

Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

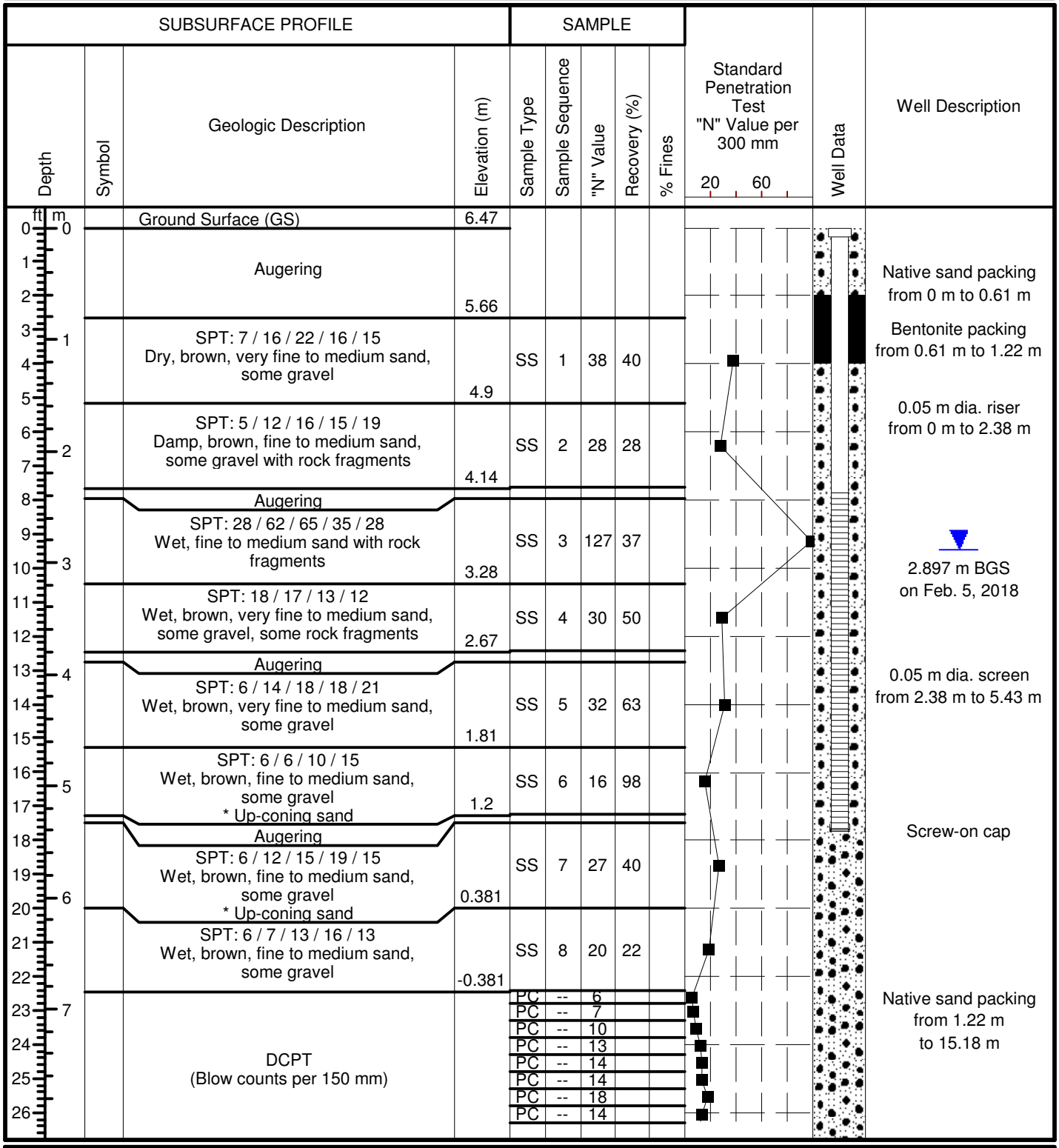
Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM9

Project No: 3113

Date: January 26, 2018



Fracflow Consultants Inc.
154 Major's Path
St. John's, NL A1A 5A1
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Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical/Environmental Assessment

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Monitoring Well: FHM9

Project No: 3113

Date: January 26, 2018

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data	Well Description
27		DCPT: (Blow counts per 150 mm) 6 / 7 / 10 / 13 / 14 / 14 / 18 / 14 / 12 / 11 / 13 / 14 / 14 / 12 / 12 / 11 / 12 / 15 / 17 / 14 / 21 / 16 / 16 / 16 / 20 / 17 / 14 / 15 / 15 / 15 / 16 / 18 / 21 / 16 / 18 / 19 / 20 / 20 / 19 / 23 / 20 / 23 / 24 / 28 / 31 / 26 / 32 / 34 / 38 / 33 / 30 / 29 / 31 / 32 / 32		PC	--	12					
28				PC	--	11					
29				PC	--	13					
9				PC	--	14					
30				PC	--	14					
31				PC	--	12					
32				PC	--	12					
10				PC	--	11					
33				PC	--	12					
34				PC	--	15					
35				PC	--	17					
36				PC	--	14					
11				PC	--	21					
37				PC	--	16					
38				PC	--	16					
39				PC	--	16					
12				PC	--	20					
40				PC	--	17					
41				PC	--	14					
42				PC	--	15					
13				PC	--	15					
43				PC	--	15					
44				PC	--	16					
45				PC	--	18					
14				PC	--	21					
46				PC	--	16					
47				PC	--	18					
48				PC	--	19					
49				PC	--	20					
15				PC	--	20					
50			-8.71	PC	--	19					
51		End of Borehole		PC	--	23					
52				PC	--	20					
				PC	--	23					
				PC	--	24					
				PC	--	28					
				PC	--	31					
				PC	--	26					
				PC	--	32					
				PC	--	34					
				PC	--	38					
				PC	--	33					
				PC	--	30					
				PC	--	29					
				PC	--	31					
				PC	--	32					
				PC	--	32					

Native sand packing from 1.22 m to 15.18 m

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101

Drilling Method: Hollow Stem Augering

Driller: Formation Drilling Ltd.

Datum: Geodetic

APPENDIX B

Laboratory Analyses Reports

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

CLIENT NAME: FRACFLOW CONSULTANTS
154 MAJOR'S PATH
ST. JOHN'S PATH, NL A1A5A1
(709) 739-7270

ATTENTION TO: John Gale

PROJECT: 3113-Stephenville,NL

AGAT WORK ORDER: 18K305158

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Jan 31, 2018

PAGES (INCLUDING COVER): 7

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

57 Old Pennywell Road, Unit I
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CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18K305158

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-01-25

DATE REPORTED: 2018-01-31

				SAMPLE DESCRIPTION:	3113-FHM1-SS6	3113-FHM1-SS7	3113-FHM2-SS2	3113-FHM2-SS3	3113-FHM3-SS2	3113-FHM3-SS3	3113-FHM4-SS8
				SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil
				DATE SAMPLED:	2018-01-17	2018-01-17	2018-01-20	2018-01-20	2018-01-19	2018-01-19	2018-01-23
Parameter	Unit	G / S: A	G / S: B	RDL	9028190	9028200	9028202	9028205	9028206	9028208	9028210
Benzene	mg/kg	2.5	2.5	0.03	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	0.030[<A]	<0.03[<A]
Toluene	mg/kg	10000	10000	0.04	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]
Ethylbenzene	mg/kg	10000	10000	0.03	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Xylene (Total)	mg/kg	110	110	0.05	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]
C6-C10 (less BTEX)	mg/kg			3	<3	<3	8	<3	<3	261	<3
>C10-C16 Hydrocarbons	mg/kg			15	<15	<15	<15	<15	<15	129	<15
>C16-C21 Hydrocarbons	mg/kg			15	<15	<15	<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg			15	<15	86	15	<15	15	<15	30
Modified TPH (Tier 1)	mg/kg	870	10000	20	<20[<A]	86[<A]	23[<A]	<20[<A]	<20[<A]	390[<A]	30[<A]
Resemblance Comment					NR	LOF	GR+LR	NR	LR	GF	LR
Return to Baseline at C32					Y	Y	Y	Y	Y	Y	Y
Surrogate	Unit	Acceptable Limits									
Isobutylbenzene - EPH	%	60-140			92	95	97	90	96	106	92
Isobutylbenzene - VPH	%	60-140			121	116	118	118	116	118	116
n-Dotriacontane - EPH	%	60-140			92	99	97	90	95	92	94

Certified By:

AGAT Laboratories

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St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18K305158

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-01-25

DATE REPORTED: 2018-01-31

			SAMPLE DESCRIPTION:		3113-FHM4-SS9
			SAMPLE TYPE:		Soil
			DATE SAMPLED:		2018-01-23
Parameter	Unit	G / S: A	G / S: B	RDL	9028211
Benzene	mg/kg	2.5	2.5	0.03	<0.03[<A]
Toluene	mg/kg	10000	10000	0.04	<0.04[<A]
Ethylbenzene	mg/kg	10000	10000	0.03	<0.03[<A]
Xylene (Total)	mg/kg	110	110	0.05	<0.05[<A]
C6-C10 (less BTEX)	mg/kg			3	<3
>C10-C16 Hydrocarbons	mg/kg			15	<15
>C16-C21 Hydrocarbons	mg/kg			15	<15
>C21-C32 Hydrocarbons	mg/kg			15	<15
Modified TPH (Tier 1)	mg/kg	870	10000	20	<20[<A]
Resemblance Comment					NR
Return to Baseline at C32					Y
Surrogate	Unit		Acceptable Limits		
Isobutylbenzene - EPH	%		60-140		97
Isobutylbenzene - VPH	%		60-140		120
n-Dotriacontane - EPH	%		60-140		96

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: A Refers to PIRI Tier 1 Soil Commercial Non-potable Coarse Jan 2015, B Refers to PIRI Tier 1 Soil Commercial Non-potable Coarse Jan 2015

Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

9028190-9028211 Results are based on the dry weight of the soil.

Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

Certified By:

AGAT Laboratories

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18K305158

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Moisture

DATE RECEIVED: 2018-01-25

DATE REPORTED: 2018-01-31

SAMPLE DESCRIPTION:				3113-FHM1-SS6	3113-FHM1-SS7	3113-FHM2-SS2	3113-FHM2-SS3	3113-FHM3-SS2	3113-FHM3-SS3	3113-FHM4-SS8	3113-FHM4-SS9
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2018-01-17	2018-01-17	2018-01-20	2018-01-20	2018-01-19	2018-01-19	2018-01-23	2018-01-23
Parameter	Unit	G / S	RDL	9028190	9028200	9028202	9028205	9028206	9028208	9028210	9028211
% Moisture	%			11	19	10	11	12	16	16	23

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:

AGAT Laboratories
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TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 18K305158
PROJECT: 3113-Stephenville,NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Trace Organics Analysis

RPT Date: Jan 31, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved															
Benzene	1	9030328	< 0.03	< 0.03	NA	< 0.03	98%	60%	140%	106%	60%	140%	NA		
Toluene	1	9030328	< 0.04	< 0.04	NA	< 0.04	98%	60%	140%	103%	60%	140%	NA		
Ethylbenzene	1	9030328	< 0.03	< 0.03	NA	< 0.03	99%	60%	140%	100%	60%	140%	NA		
Xylene (Total)	1	9030328	< 0.05	< 0.05	NA	< 0.05	100%	60%	140%	103%	60%	140%	NA		
C6-C10 (less BTEX)	1	9030328	< 3	< 3	NA	< 3	80%	60%	140%	124%	60%	140%	NA	30%	130%
>C10-C16 Hydrocarbons	1	9029967	<15	16	NA	< 15	97%	60%	140%	92%	60%	140%	114%	30%	130%
>C16-C21 Hydrocarbons	1	9029967	< 15	< 15	NA	< 15	93%	60%	140%	92%	60%	140%	114%	30%	130%
>C21-C32 Hydrocarbons	1	9029967	< 15	< 15	NA	< 15	112%	60%	140%	92%	60%	140%	114%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

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http://www.agatlabs.com

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K305158

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC

AGAT Laboratories
Unit 122 • 11 Morris Drive
Dartmouth, NS
B3B 1M2
webearth.agatlabs.com • www.agatlabs.com
P: 902.468.8718 • F: 902.468.8924

Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 3.7
Hold Time:
AGAT Job Number: 18K305158
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3860

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☑ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☐ Total ☐ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P205)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
3113-FHM1-SS6	January 17, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓													
3113-FHM1-SS7	January 17, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓													
3113-FHM2-SS2	January 20, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓													
3113-FHM2-SS3	January 20, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓													
3113-FHM3-SS2	January 19, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓													
3113-FHM3-SS3	January 19, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓													
3113-FHM4-SS8	January 23, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓													
3113-FHM4-SS9	January 23, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓													

Samples Relinquished By (Print Name):	Date/Time	Samples Received By (Print Name):	Date/Time
Eunjeong Seok	Jan. 25/18	SK	2018/01/25
Samples Relinquished By (Sign):	Date/Time	Samples Received By (Sign):	Date/Time
Eunjeong Seok	11:50		11:50 am

Pink Copy - Client
Yellow Copy - AGAT
White Copy - AGAT

Page 1 of 1
Nº: FFC-3113-COC-03

AGAT Laboratories

57 Old Pennywell Road, Unit I
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CLIENT NAME: FRACFLOW CONSULTANTS
154 MAJOR'S PATH
ST. JOHN'S PATH, NL A1A5A1
(709) 739-7270

ATTENTION TO: John Gale

PROJECT: 3113-Stephenville,NL

AGAT WORK ORDER: 18K309193

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Feb 14, 2018

PAGES (INCLUDING COVER): 6

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 18K309193

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-02-07

DATE REPORTED: 2018-02-14

SAMPLE DESCRIPTION:				3113-FHM5-SS2	3113-FHM5-SS3	3113-FHM7-2-SS3	3113-FHM8-2-SS7	3113-FHM9-SS3	3113-FHS1-2-SS1	3113-FHS1-2-SS2
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2018-01-25	2018-01-25	2018-01-29	2018-01-27	2018-01-26	2018-02-01	2018-02-01
Parameter	Unit	G / S	RDL	9050547	9050549	9050550	9050551	9050552	9050554	9050557
Benzene	mg/kg		0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Toluene	mg/kg		0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Ethylbenzene	mg/kg		0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Xylene (Total)	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C6-C10 (less BTEX)	mg/kg		3	<3	<3	<3	<3	<3	<3	<3
>C10-C16 Hydrocarbons	mg/kg		15	<15	<15	<15	<15	<15	<15	<15
>C16-C21 Hydrocarbons	mg/kg		15	<15	<15	<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg		15	<15	<15	<15	<15	42	16	<15
Modified TPH (Tier 1)	mg/kg		20	<20	<20	<20	<20	42	<20	<20
Resemblance Comment				NR	NR	NR	NR	UC	UC	NR
Return to Baseline at C32				Y	Y	Y	Y	Y	Y	Y
Surrogate	Unit	Acceptable Limits								
Isobutylbenzene - EPH	%	60-140		106	99	105	103	107	103	102
Isobutylbenzene - VPH	%	60-140		95	100	98	92	94	91	92
n-Dotriacontane - EPH	%	60-140		113	98	111	107	115	110	108

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9050547-9050557 Results are based on the dry weight of the soil.

Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

Certified By:

AGAT Laboratories

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
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FAX (709 747-2139
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Certificate of Analysis

AGAT WORK ORDER: 18K309193

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Moisture

DATE RECEIVED: 2018-02-07

DATE REPORTED: 2018-02-14

SAMPLE DESCRIPTION:				3113-FHM5-SS2	3113-FHM5-SS3	3113-FHM7-2-SS3	3113-FHM8-2-SS7	3113-FHM9-SS3	3113-FHS1-2-SS1	3113-FHS1-2-SS2
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2018-01-25	2018-01-25	2018-01-29	2018-01-27	2018-01-26	2018-02-01	2018-02-01
Parameter	Unit	G / S	RDL	9050547	9050549	9050550	9050551	9050552	9050554	9050557
% Moisture	%			10	10	21	15	20	15	14

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:

AGAT Laboratories

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St. John's, NL
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FAX (709 747-2139
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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K309193

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Trace Organics Analysis

RPT Date: Feb 14, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved															
Benzene	1	9060344	< 0.03	< 0.03	NA	< 0.03	76%	60%	140%	90%	60%	140%	NA		
Toluene	1	9060344	< 0.04	< 0.04	NA	< 0.04	78%	60%	140%	91%	60%	140%	NA		
Ethylbenzene	1	9060344	< 0.03	< 0.03	NA	< 0.03	78%	60%	140%	90%	60%	140%	NA		
Xylene (Total)	1	9060344	< 0.05	< 0.05	NA	< 0.05	81%	60%	140%	93%	60%	140%	NA		
C6-C10 (less BTEX)	1	9060344	< 3	< 3	NA	< 3	84%	60%	140%	95%	60%	140%	94%	30%	130%
>C10-C16 Hydrocarbons	1	9050551	< 15	< 15	NA	< 15	83%	60%	140%	107%	60%	140%	NA	30%	130%
>C16-C21 Hydrocarbons	1	9050551	< 15	< 15	NA	< 15	80%	60%	140%	107%	60%	140%	NA	30%	130%
>C21-C32 Hydrocarbons	1	9050551	< 15	< 15	NA	< 15	83%	60%	140%	107%	60%	140%	NA	30%	130%

Comments: Matrix spike not available (NA). Results based on blank spike recoveries.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K309193

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 2 4
Hold Time:
AGAT Job Number: 18F309193
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3865

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☑ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☐ Total ☐ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P2O5)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
3113-FHM5-SS2	January, 25, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓												
3113-FHM5-SS3	January, 25, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓												
3113-FHM7-2-SS3	January, 29, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓												
3113-FHM8-2-SS7	January, 27, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓												
3113-FHM9-SS3	January, 26, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓												
3113-FHS1-2-SS1	February 1, 2018	Soil	1x40, 1x250 mL	1 of 40 ml vial with preservative											✓												
3113-FHS1-2-SS2	February 1, 2018	Soil	2x40, 1x250 mL	2 of 40 ml vial with preservative											✓												

Samples Relinquished By (Print Name):	Date/Time	Samples Received By (Print Name):	Date/Time
Shawn Thompson	Feb. 07/18	Harry	02/07/2018
Samples Relinquished By (Sign):	Date/Time	Samples Received By (Sign):	Date/Time
	13:30		1:30

Pink Copy - Client
Yellow Copy - AGAT
White Copy- AGAT

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CLIENT NAME: FRACFLOW CONSULTANTS
154 MAJOR'S PATH
ST. JOHN'S PATH, NL A1A5A1
(709) 739-7270

ATTENTION TO: John Gale

PROJECT: 3113-Stephenville,NL

AGAT WORK ORDER: 18K309240

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Feb 16, 2018

PAGES (INCLUDING COVER): 5

VERSION*: 2

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES
VERSION 2:Version 2.0 supersedes Version 1.0. Updated report to PIRI - Low Level analysis. Issued Feb. 16, 2018.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories
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Certificate of Analysis

AGAT WORK ORDER: 18K309240

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level

DATE RECEIVED: 2018-02-07

DATE REPORTED: 2018-02-16

				3113-FHM4-1.	3113-FHM8-2-	3113-FHM8-2-
SAMPLE DESCRIPTION:				0-WS1	1.0-WS1	1.25-WS1
SAMPLE TYPE:				Water	Water	Water
DATE SAMPLED:				2018-02-03	2018-02-03	2018-02-02
Parameter	Unit	G / S	RDL	9050693	9050695	9050696
Benzene	mg/L	20	0.001	<0.001	<0.001	<0.001
Toluene	mg/L	20	0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	20	0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	20	0.001	<0.001	<0.001	<0.001
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.05	<0.05	<0.05	<0.05
>C21-C32 Hydrocarbons	mg/L		0.01	0.09	0.12	<0.01
Modified TPH (Tier 1)	mg/L	20	0.1	<0.1	0.1	<0.1
Resemblance Comment				LOF	LOF	NR
Return to Baseline at C32				Y	Y	Y
Surrogate	Unit	Acceptable Limits				
Isobutylbenzene - EPH	%	70-130		115	87	99
Isobutylbenzene - VPH	%	70-130		86	78	81
n-Dotriacontane - EPH	%	70-130		120	96	77

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PIRI Tier 1 GW Commercial Non-potable coarse Jan 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

9050693-9050696 Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

Certified By:

AGAT Laboratories

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K309240

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Trace Organics Analysis

RPT Date: Feb 16, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level															
Benzene	1	9050693	< 0.001	< 0.001	NA	< 0.001	84%	70%	130%	89%	70%	130%	NA		
Toluene	1	9050693	< 0.001	< 0.001	NA	< 0.001	86%	70%	130%	88%	70%	130%	NA		
Ethylbenzene	1	9050693	< 0.001	< 0.001	NA	< 0.001	89%	70%	130%	90%	70%	130%	NA		
Xylene (Total)	1	9050693	< 0.001	< 0.001	NA	< 0.001	91%	70%	130%	93%	70%	130%	NA		
C6-C10 (less BTEX)	1	9050693	< 0.01	< 0.01	NA	< 0.01	96%	70%	130%	117%	70%	130%	112%	70%	130%
>C10-C16 Hydrocarbons	1	9050693	< 0.05	< 0.05	NA	< 0.05	97%	70%	130%	105%	70%	130%	94%	70%	130%
>C16-C21 Hydrocarbons	1	9050693	< 0.05	< 0.05	NA	< 0.05	95%	70%	130%	105%	70%	130%	94%	70%	130%
>C21-C32 Hydrocarbons	1	9050693	0.09	0.07	25.0%	< 0.01	97%	70%	130%	105%	70%	130%	94%	70%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K309240

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
>C10-C16 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Benzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Modified TPH (Tier 1)	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Return to Baseline at C32	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 2.4
Hold Time:
AGAT Job Number: 18K309240
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3865

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☑ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment
3113-FHM4-1.0-WS1	February 3, 2018	Water	3x40, 2x250 mL	All bottles with preservatives
3113-FHM8-2-1.0-WS1	February 3, 2018	Water	3x40, 1x250 mL	All bottles with preservatives
3113-FHM8-2-1.25-WS1	February 2, 2018	Water	3x40, 2x250 mL	All bottles with preservatives

Field Filtered/Preserved	Standard Water Analysis	Metals: ☐ Total ☐ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P205)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☑ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
										✓													
										✓													
										✓													

Samples Relinquished By (Print Name): Shaun Thompson
Samples Relinquished By (Sign):
Date/Time: Feb. 07/18
Date/Time: 13:30
Samples Received By (Print Name): A Canning
Samples Received By (Sign):
Date/Time: 02/07/2018
Date/Time: 1:30

Pink Copy - Client
Yellow Copy - AGAT
White Copy - AGAT

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CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

CLIENT NAME: FRACFLOW CONSULTANTS
154 MAJOR'S PATH
ST. JOHN'S PATH, NL A1A5A1
(709) 739-7270

ATTENTION TO: John Gale

PROJECT: 3113 - Stephenville, NL

AGAT WORK ORDER: 18K310811

SOIL ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

WATER ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

DATE REPORTED: Feb 21, 2018

PAGES (INCLUDING COVER): 18

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories
57 Old Pennywell Road, Unit I
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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Available Metals in Soil

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

SAMPLE DESCRIPTION:				3113-P1-3-SS1	3113-P2-2-SS1	3113-P3-2-SS1
SAMPLE TYPE:				Soil	Soil	Soil
DATE SAMPLED:				2018-02-07	2018-02-07	2018-02-07
Parameter	Unit	G / S	RDL	9063732	9063734	9063738
Aluminum	mg/kg		10	6520	4990	6440
Antimony	mg/kg		1	<1	<1	<1
Arsenic	mg/kg		1	4	3	4
Barium	mg/kg		5	20	20	38
Beryllium	mg/kg		2	<2	<2	<2
Boron	mg/kg		2	<2	<2	<2
Cadmium	mg/kg		0.3	<0.3	<0.3	<0.3
Chromium	mg/kg		2	23	17	21
Cobalt	mg/kg		1	7	6	8
Copper	mg/kg		2	18	23	39
Iron	mg/kg		50	13500	12700	13500
Lead	mg/kg		0.5	3.7	5.2	13.4
Lithium	mg/kg		5	7	7	8
Manganese	mg/kg		2	183	211	218
Molybdenum	mg/kg		2	<2	<2	<2
Nickel	mg/kg		2	18	22	26
Selenium	mg/kg		1	<1	<1	<1
Silver	mg/kg		0.5	<0.5	<0.5	<0.5
Strontium	mg/kg		5	7	6	6
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	3	3	3
Uranium	mg/kg		0.1	0.3	0.4	0.4
Vanadium	mg/kg		2	31	23	31
Zinc	mg/kg		5	22	27	28

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9063732-9063738 Results are based on the dry weight of the sample.

Certified By:

AGAT Laboratories

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St. John's, NL
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FAX (709 747-2139
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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

						SAMPLE DESCRIPTION:	3113-P0-1-SS1	3113-P1-1-SS1	3113-P1-2-SS1	3113-P1-3-SS1	3113-P2-1-SS1	3113-P2-2-SS1
						SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
						DATE SAMPLED:	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07
Parameter	Unit	G / S: A	G / S: B	G / S: C	RDL		9063729	9063730	9063731	9063732	9063733	9063734
Benzene	mg/kg	2.5	2.5	2.5	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Toluene	mg/kg	10000	10000	10000	0.04		<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]
Ethylbenzene	mg/kg	10000	10000	10000	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Xylene (Total)	mg/kg	110	110	110	0.05		<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]
C6-C10 (less BTEX)	mg/kg				3		<3	<3	<3	108	158	<3
>C10-C16 Hydrocarbons	mg/kg				15		<15	<15	<15	67	<15	<15
>C16-C21 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15	<15
Modified TPH (Tier 1)	mg/kg	4000	870	10000	20		<20[<B]	<20[<B]	<20[<B]	175[<B]	158[<B]	<20[<B]
Resemblance Comment							NR	NR	NR	GF+FOF	GF	NR
Return to Baseline at C32							Y	Y	Y	Y	Y	Y
Surrogate	Unit	Acceptable Limits										
Isobutylbenzene - EPH	%	60-140					99	100	102	99	102	102
Isobutylbenzene - VPH	%	60-140					93	91	91	94	96	96
n-Dotriacontane - EPH	%	60-140					100	102	103	100	103	105

Certified By:

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

						SAMPLE DESCRIPTION:	3113-P2-3-SS1	3113-P2-4-SS1	3113-P3-1-SS1	3113-P3-2-SS1	3113-P3-3-SS1	3113-P3-4-SS1
						SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
						DATE SAMPLED:	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07
Parameter	Unit	G / S: A	G / S: B	G / S: C	RDL		9063735	9063736	9063737	9063738	9063739	9063740
Benzene	mg/kg	2.5	2.5	2.5	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Toluene	mg/kg	10000	10000	10000	0.04		<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]
Ethylbenzene	mg/kg	10000	10000	10000	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Xylene (Total)	mg/kg	110	110	110	0.05		<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]
C6-C10 (less BTEX)	mg/kg				3		<3	<3	<3	680	<3	449
>C10-C16 Hydrocarbons	mg/kg				15		<15	<15	<15	193	<15	106
>C16-C21 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg				15		<15	<15	<15	393	<15	<15
Modified TPH (Tier 1)	mg/kg	4000	870	10000	20		<20[<B]	<20[<B]	<20[<B]	1270[B-A]	<20[<B]	555[<B]
Resemblance Comment							NR	NR	NR	GF+FOF+LOF	NR	GF+FOF
Return to Baseline at C32							Y	Y	Y	Y	Y	Y
Surrogate	Unit	Acceptable Limits										
Isobutylbenzene - EPH	%	60-140					99	102	99	130	96	109
Isobutylbenzene - VPH	%	60-140					91	90	93	101	95	101
n-Dotriacontane - EPH	%	60-140					102	106	104	101	97	113

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

						SAMPLE DESCRIPTION:	3113-P3-5-SS1	3113-P4-1-SS1	3113-P4-2-SS1	3113-P4-3-SS1	3113-P4-4-SS1
						SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil
						DATE SAMPLED:	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07
Parameter	Unit	G / S: A	G / S: B	G / S: C	RDL		9063741	9063742	9063743	9063744	9063745
Benzene	mg/kg	2.5	2.5	2.5	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Toluene	mg/kg	10000	10000	10000	0.04		<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]
Ethylbenzene	mg/kg	10000	10000	10000	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Xylene (Total)	mg/kg	110	110	110	0.05		<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]
C6-C10 (less BTEX)	mg/kg				3		<3	<3	1610	344	<3
>C10-C16 Hydrocarbons	mg/kg				15		<15	<15	38	59	<15
>C16-C21 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15
Modified TPH (Tier 1)	mg/kg	4000	870	10000	20		<20[<B]	<20[<B]	1650[B-A]	403[<B]	<20[<B]
Resemblance Comment							NR	NR	GF+WFOF	GF+FOF	NR
Return to Baseline at C32							Y	Y	Y	Y	Y
Surrogate	Unit		Acceptable Limits								
Isobutylbenzene - EPH	%		60-140				100	99	100	105	96
Isobutylbenzene - VPH	%		60-140				97	94	101	100	98
n-Dotriacontane - EPH	%		60-140				105	104	104	107	103

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: A Refers to PIRI Tier 1 Soil Commercial Non-potable Coarse Jan 2015, B Refers to PIRI Tier 1 Soil Commercial Non-potable Coarse Jan 2015, C Refers to PIRI Tier 1 Soil Commercial Non-potable Coarse Jan 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

9063729-9063745 Results are based on the dry weight of the soil.

Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Water (Version 3.0)

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

				3113-FHM1-1.	3113-FHM1-1.	3113-FMH2-2.	3113-FHM3-2.	3113-FHM4-1.	3113-FHM5-2.	3113-FHM7-2-	3113-FHM9-2.
SAMPLE DESCRIPTION:				0-WS1	25-WS1	0-WS1	0-WS1	25-WS1	0-WS1	2.0-WS1	0-WS1
SAMPLE TYPE:				Water	Water	Water	Water	Water	Water	Water	Water
DATE SAMPLED:				2018-02-04	2018-02-04	2018-02-05	2018-02-05	2018-02-04	2018-02-05	2018-02-06	2018-02-05
Parameter	Unit	G / S	RDL	9063713	9063716	9063717	9063718	9063719	9063720	9063721	9063722
Benzene	mg/L	20	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	20	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Ethylbenzene	mg/L	20	0.001	<0.001	<0.001	0.008	<0.001	<0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	20	0.002	<0.002	<0.002	0.015	<0.002	<0.002	<0.002	<0.002	<0.002
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01	1.93	3.62	<0.01	<0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05	0.26	0.30	<0.05	<0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
>C21-C32 Hydrocarbons	mg/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Modified TPH (Tier 1)	mg/L	20	0.1	<0.1	<0.1	2.2	3.9	<0.1	<0.1	<0.1	<0.1
Resemblance Comment				NR	NR	GF	GF	NR	NR	NR	NR
Return to Baseline at C32				Y	Y	Y	Y	Y	Y	Y	Y
Surrogate	Unit	Acceptable Limits									
Isobutylbenzene - EPH	%	70-130		111	107	99	114	113	113	99	116
Isobutylbenzene - VPH	%	70-130		81	80	80	78	77	78	77	78
n-Dotriacontane - EPH	%	70-130		118	115	111	121	120	120	106	121

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PIRI Tier 1 GW Commercial Non-potable coarse Jan 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

9063713-9063722 Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Moisture

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-P0-1-SS1 / SAMPLE TYPE: Soil / DATE SAMPLED: 2018-02-07 / 9063729	3113-P1-1-SS1 / Soil / 2018-02-07 / 9063730	3113-P1-2-SS1 / Soil / 2018-02-07 / 9063731	3113-P1-3-SS1 / Soil / 2018-02-07 / 9063732	3113-P2-1-SS1 / Soil / 2018-02-07 / 9063733	3113-P2-2-SS1 / Soil / 2018-02-07 / 9063734	3113-P2-3-SS1 / Soil / 2018-02-07 / 9063735	3113-P2-4-SS1 / Soil / 2018-02-07 / 9063736
% Moisture	%			19	11	13	18	15	11	9	15

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-P3-1-SS1 / SAMPLE TYPE: Soil / DATE SAMPLED: 2018-02-07 / 9063737	3113-P3-2-SS1 / Soil / 2018-02-07 / 9063738	3113-P3-3-SS1 / Soil / 2018-02-07 / 9063739	3113-P3-4-SS1 / Soil / 2018-02-07 / 9063740	3113-P3-5-SS1 / Soil / 2018-02-07 / 9063741	3113-P4-1-SS1 / Soil / 2018-02-07 / 9063742	3113-P4-2-SS1 / Soil / 2018-02-07 / 9063743	3113-P4-3-SS1 / Soil / 2018-02-07 / 9063744
% Moisture	%			16	12	12	16	9	11	12	15

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-P4-4-SS1 / SAMPLE TYPE: Soil / DATE SAMPLED: 2018-02-07 / 9063745
% Moisture	%			14

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Dissolved Metals

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

Parameter	Unit	G / S	RDL	3113-FHM1-1. 0-WS1 Water 2018-02-04 9063713	3113-FHM1-1. 25-WS1 Water 2018-02-04 9063716	3113-FMH2-2. 0-WS1 Water 2018-02-05 9063717	3113-FHM3-2. 0-WS1 Water 2018-02-05 9063718	3113-FHM4-1. 25-WS1 Water 2018-02-04 9063719	3113-FHM7-2-2.0-WS1 Water 2018-02-06 9063721	3113-FHM9-2. 0-WS1 Water 2018-02-05 9063722
SAMPLE DESCRIPTION:										
SAMPLE TYPE:										
DATE SAMPLED:										
Dissolved Aluminum	ug/L		5	16	8	5	23	8	7	12
Dissolved Antimony	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Arsenic	ug/L		2	<2	<2	5	8	<2	<2	<2
Dissolved Barium	ug/L		5	19	36	47	47	43	16	16
Dissolved Beryllium	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Bismuth	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Boron	ug/L		5	10	9	8	7	12	8	6
Dissolved Cadmium	ug/L		0.017	0.020	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Dissolved Chromium	ug/L		1	2	3	3	3	7	3	3
Dissolved Cobalt	ug/L		1	<1	<1	1	1	<1	4	<1
Dissolved Copper	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Iron	ug/L		50	<50	<50	1880	4490	<50	127	<50
Dissolved Lead	ug/L		0.5	<0.5	<0.5	3.2	2.8	<0.5	<0.5	<0.5
Dissolved Manganese	ug/L		2	171	47	506	713	10	1060	84
Dissolved Molybdenum	ug/L		2	2	4	<2	<2	<2	<2	<2
Dissolved Nickel	ug/L		2	7	<2	<2	3	4	5	3
Dissolved Selenium	ug/L		1	<1	<1	<1	<1	<1	<1	<1
Dissolved Silver	ug/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Strontium	ug/L		5	89	72	58	50	148	55	57
Dissolved Thallium	ug/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Tin	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Titanium	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Uranium	ug/L		0.1	0.8	0.2	0.2	0.2	1.3	<0.1	0.2
Dissolved Vanadium	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Zinc	ug/L		5	<5	<5	<5	<5	<5	10	7

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9063713-9063722 Analysis completed on a filtered sample.

Certified By:

AGAT Laboratories

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Guideline Violation

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
9063738	3113-P3-2-SS1	NS-PIRI-ComCNPSoilG	Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved	Modified TPH (Tier 1)	mg/kg	870	1270
9063743	3113-P4-2-SS1	NS-PIRI-ComCNPSoilG	Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved	Modified TPH (Tier 1)	mg/kg	870	1650

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Soil Analysis

RPT Date: Feb 21, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Available Metals in Soil															
Aluminum	9052260		6920	7740	11.2%	< 10	99%	80%	120%	105%	80%	120%	84%	70%	130%
Antimony	9052260		<1	<1	NA	< 1	91%	80%	120%	111%	80%	120%	70%	70%	130%
Arsenic	9052260		11	9	NA	< 1	97%	80%	120%	105%	80%	120%	103%	70%	130%
Barium	9052260		22	25	NA	< 5	103%	80%	120%	115%	80%	120%	75%	70%	130%
Beryllium	9052260		<2	<2	NA	< 2	108%	80%	120%	116%	80%	120%	85%	70%	130%
Boron	9052260		<2	<2	NA	< 2	103%	80%	120%	111%	80%	120%	84%	70%	130%
Cadmium	9052260		<0.3	<0.3	NA	< 0.3	97%	80%	120%	106%	80%	120%	83%	70%	130%
Chromium	9052260		13	14	4.9%	< 2	93%	80%	120%	105%	80%	120%	85%	70%	130%
Cobalt	9052260		6	6	1.4%	< 1	98%	80%	120%	105%	80%	120%	81%	70%	130%
Copper	9052260		30	23	NA	< 2	98%	80%	120%	104%	80%	120%	91%	70%	130%
Iron	9052260		32700	28100	15.1%	< 50	95%	80%	120%	111%	80%	120%	74%	70%	130%
Lead	9052260		28.3	26.9	4.8%	< 0.5	97%	80%	120%	108%	80%	120%	70%	70%	130%
Lithium	9052260		24	34	NA	< 5	112%	70%	130%	125%	70%	130%	83%	70%	130%
Manganese	9052260		255	258	1.1%	< 2	98%	80%	120%	106%	80%	120%	87%	70%	130%
Molybdenum	9052260		3	3	NA	< 2	84%	80%	120%	97%	80%	120%	70%	70%	130%
Nickel	9052260		13	12	8.1%	< 2	100%	80%	120%	110%	80%	120%	83%	70%	130%
Selenium	9052260		<1	<1	NA	< 1	95%	80%	120%	102%	80%	120%	70%	70%	130%
Silver	9052260		<0.5	<0.5	NA	< 0.5	82%	80%	120%	87%	80%	120%	70%	70%	130%
Strontium	9052260		<5	<5	NA	< 5	88%	80%	120%	95%	80%	120%	94%	70%	130%
Thallium	9052260		<0.1	<0.1	NA	< 0.1	99%	80%	120%	113%	80%	120%	NA	70%	130%
Tin	9052260		3	3	NA	< 2	96%	80%	120%	108%	80%	120%	81%	70%	130%
Uranium	9052260		0.9	0.8	5.0%	< 0.1	96%	80%	120%	105%	80%	120%	74%	70%	130%
Vanadium	9052260		15	18	15.9%	< 2	94%	80%	120%	105%	80%	120%	77%	70%	130%
Zinc	9052260		49	55	12.1%	< 5	87%	80%	120%	96%	80%	120%	80%	70%	130%

Certified By:

AGAT Laboratories

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Trace Organics Analysis

RPT Date: Feb 21, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbons in Water (Version 3.0)															
Benzene	1	9063713	< 0.001	< 0.001	NA	< 0.001	84%	70%	130%	81%	70%	130%	NA		
Toluene	1	9063713	< 0.001	< 0.001	NA	< 0.001	86%	70%	130%	81%	70%	130%	NA		
Ethylbenzene	1	9063713	< 0.001	< 0.001	NA	< 0.001	89%	70%	130%	83%	70%	130%	NA		
Xylene (Total)	1	9063713	< 0.002	< 0.002	NA	< 0.002	91%	70%	130%	87%	70%	130%	NA		
C6-C10 (less BTEX)	1	9063713	< 0.01	< 0.01	NA	< 0.01	101%	70%	130%	100%	70%	130%	92%	70%	130%
>C10-C16 Hydrocarbons	1	9063721	< 0.05	< 0.05	NA	< 0.05	98%	70%	130%	107%	70%	130%	110%	70%	130%
>C16-C21 Hydrocarbons	1	9063721	< 0.10	< 0.10	NA	< 0.10	98%	70%	130%	107%	70%	130%	110%	70%	130%
>C21-C32 Hydrocarbons	1	9063721	<0.1	<0.1	NA	< 0.1	104%	70%	130%	107%	70%	130%	110%	70%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved															
Benzene	1	9063729	< 0.03	< 0.03	NA	< 0.03	83%	60%	140%	79%	60%	140%	NA		
Toluene	1	9063729	< 0.04	< 0.04	NA	< 0.04	88%	60%	140%	76%	60%	140%	NA		
Ethylbenzene	1	9063729	< 0.03	< 0.03	NA	< 0.03	89%	60%	140%	76%	60%	140%	NA		
Xylene (Total)	1	9063729	< 0.05	< 0.05	NA	< 0.05	92%	60%	140%	80%	60%	140%	NA		
C6-C10 (less BTEX)	1	9063729	< 3	< 3	NA	< 3	93%	60%	140%	87%	60%	140%	83%	30%	130%
>C10-C16 Hydrocarbons	1	9063867	< 15	< 15	NA	< 15	100%	60%	140%	108%	60%	140%	121%	30%	130%
>C16-C21 Hydrocarbons	1	9063867	< 15	< 15	NA	< 15	99%	60%	140%	108%	60%	140%	121%	30%	130%
>C21-C32 Hydrocarbons	1	9063867	< 15	< 15	NA	< 15	106%	60%	140%	108%	60%	140%	121%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

AGAT Laboratories

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Water Analysis

RPT Date: Feb 21, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Dissolved Metals															
Dissolved Aluminum	9063722	9063722	12	13	NA	< 5	111%	80%	120%	107%	80%	120%	87%	70%	130%
Dissolved Antimony	9063722	9063722	<2	<2	NA	< 2	102%	80%	120%	111%	80%	120%	111%	70%	130%
Dissolved Arsenic	9063722	9063722	<2	<2	NA	< 2	102%	80%	120%	102%	80%	120%	109%	70%	130%
Dissolved Barium	9063722	9063722	16	16	NA	< 5	101%	80%	120%	101%	80%	120%	111%	70%	130%
Dissolved Beryllium	9063722	9063722	<2	<2	NA	< 2	113%	80%	120%	111%	80%	120%	119%	70%	130%
Dissolved Bismuth	9063722	9063722	<2	<2	NA	< 2	108%	80%	120%	115%	80%	120%	NA	70%	130%
Dissolved Boron	9063722	9063722	6	6	NA	< 5	113%	80%	120%	111%	80%	120%	112%	70%	130%
Dissolved Cadmium	9063722	9063722	<0.017	<0.017	NA	< 0.017	100%	80%	120%	102%	80%	120%	105%	70%	130%
Dissolved Chromium	9063722	9063722	3	3	NA	< 1	102%	80%	120%	103%	80%	120%	101%	70%	130%
Dissolved Cobalt	9063722	9063722	<1	<1	NA	< 1	103%	80%	120%	102%	80%	120%	100%	70%	130%
Dissolved Copper	9063722	9063722	<2	<2	NA	< 2	105%	80%	120%	106%	80%	120%	100%	70%	130%
Dissolved Iron	9063722	9063722	<50	<50	NA	< 50	106%	80%	120%	111%	80%	120%	98%	70%	130%
Dissolved Lead	9063722	9063722	<0.5	<0.5	NA	< 0.5	106%	80%	120%	105%	80%	120%	101%	70%	130%
Dissolved Manganese	9063722	9063722	84	85	1.8%	< 2	104%	80%	120%	107%	80%	120%	NA	70%	130%
Dissolved Molybdenum	9063722	9063722	<2	<2	NA	< 2	99%	80%	120%	105%	80%	120%	85%	70%	130%
Dissolved Nickel	9063722	9063722	3	3	NA	< 2	105%	80%	120%	109%	80%	120%	106%	70%	130%
Dissolved Selenium	9063722	9063722	<1	<1	NA	< 1	101%	80%	120%	99%	80%	120%	108%	70%	130%
Dissolved Silver	9063722	9063722	<0.1	<0.1	NA	< 0.1	105%	80%	120%	103%	80%	120%	85%	70%	130%
Dissolved Strontium	9063722	9063722	57	59	2.9%	< 5	103%	80%	120%	104%	80%	120%	NA	70%	130%
Dissolved Thallium	9063722	9063722	<0.1	<0.1	NA	< 0.1	106%	80%	120%	112%	80%	120%	108%	70%	130%
Dissolved Tin	9063722	9063722	<2	<2	NA	< 2	98%	80%	120%	103%	80%	120%	97%	70%	130%
Dissolved Titanium	9063722	9063722	<2	<2	NA	< 2	109%	80%	120%	111%	80%	120%	95%	70%	130%
Dissolved Uranium	9063722	9063722	0.2	0.2	NA	< 0.1	104%	80%	120%	104%	80%	120%	103%	70%	130%
Dissolved Vanadium	9063722	9063722	<2	<2	NA	< 2	100%	80%	120%	102%	80%	120%	103%	70%	130%
Dissolved Zinc	9063722	9063722	7	8	NA	< 5	100%	80%	120%	101%	80%	120%	107%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Modified TPH (Tier 1)	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
% Moisture		Calculation	GRAVIMETRIC

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	SM 3125	ICP-MS

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 4.3
Hold Time:
AGAT Job Number: 18K310811
Notes: metals for soil

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☐ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3868

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☑ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☐ Total ☑ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P205)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
3113-FHM1-1.0-WS1	February 4, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservatives			✓								✓												
3113-FHM1-1.25-WS1	February 4, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservatives			✓								✓												

Samples Relinquished By (Print Name):	Date/Time	Samples Received By (Print Name):	Date/Time
David Gale	Feb. 13/18	Emma Penney	Feb. 13/18
Samples Relinquished By (Sign):	Date/Time	Samples Received By (Sign):	Date/Time
		Emma Penney	10:46pm

Pink Copy - Client
Yellow Copy - AGAT
White Copy- AGAT

Document ID: DM-133-1501.002
Date revised: January 2016

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 4.3
Hold Time:
AGAT Job Number: 18K310811
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3868

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☑ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☐ Total ☑ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P205)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
3113-FHM2-2.0-WS1	February 5, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-FHM3-2.0-WS1	February 5, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-FHM4-1.25-WS1	February 4, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-FHM5-2.0-WS1	February 5, 2018	Water	3x40, 2x250 mL	All bottles with preservative											✔													
3113-FHM7-2-2.0-WS1	February 6, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-FHM9-2.0-WS1	February 5, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-P0-1-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P1-1-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P1-2-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P1-3-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative			✔								✔													
3113-P2-1-SS1	February 7, 2018	Soil	2x40, 1x250mL	2 of 40 mL vial with preservative											✔													
3113-P2-2-SS1	February 7, 2018	Soil	2x40. 1x250 mL	2 of 40 mL vial with preservative			✔								✔													

Samples Relinquished By (Print Name):	Date/Time	Samples Received By (Print Name):	Date/Time
David Gale	Feb. 13/18	Emma Penney	Feb. 13/18
Samples Relinquished By (Sign):	Date/Time	Samples Received By (Sign):	Date/Time
		Emma Penney	10:40am

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N°: FFC-3113-COC-06

Document ID: UG-133-1501.002
Date revised: January 2016

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 4.3
Hold Time:
AGAT Job Number: 18K310811
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To
Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3868

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☑ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube

☐ CCME
☐ Industrial
☐ Commercial
☐ Res/Park
☐ Agricultural
☐ FWAL
☐ Sediment

☐ CDWQ
☐ NSEQS-Cont Sites
☐ HRM 101
☐ Storm Water
☐ Waste Water
☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☐ Total ☑ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P205)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
3113-P2-3-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P2-4-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P3-1-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P3-2-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative			✔								✔													
3113-P3-3-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P3-4-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P3-5-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P4-1-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P4-2-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P4-3-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P4-4-SS1	February 7, 2018	Soil	2x40, 1x250mL	2 of 40 mL vial with preservative											✔													

Samples Relinquished By (Print Name):	Date/Time	Samples Received By (Print Name):	Date/Time
David Gale	Feb. 13/18	Emma Penney	Feb-13/18
Samples Relinquished By (Sign):	**Date/Time**	**Samples Received By (Sign):**	**Date/Time**
		Emma Penney	10:46 am

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N°: FFC-3113-COC-06

Document ID: DIV-133-1501.002
Date revised: January 2016

APPENDIX B

Technical Memorandum FFC-NL-3113-004

Assessment of Hydrocarbon Impacts on the Southwest Corner of the Proposed Fish Hatchery Property and Location of Old Fuel Lines

Fracflow Consultants Inc.

Environmental, Hydrogeological and
Geotechnical Engineering Consultants

TECHNICAL MEMORANDUM

TO: Dean Guest, Marine Harvest Atlantic Canada FFC-NL-3113-004

FROM: Fracflow Consultants Inc.

DATE: February 26, 2018

SUBJECT: **Assessment of Hydrocarbon Impacts on the Southwest Corner of the Proposed Fish Hatchery Property and Location of Old Fuel Lines.**

1. Background

Hydrocarbon impacts are known to exist in the overburden under the west to southwest corner of the property (**Figure 1**) that is being considered for purchase by Marine Harvest Atlantic Canada (MHAC). The source and extent of the hydrocarbon impacts in the subsurface were not known. However, several concrete supports that appear to have been used as gravity fed fuel tank supports and an up gradient group of three valve chambers for fuel lines that cut across the property exist on the property (**Figure 2**). The tank supports are approximately 2.0 to 3.0 m in height. This area was used as an initial camping ground by the US military in the 1940s and there may have been distributed fuel sources over the entire tent city campground. More recently the site was used as a laydown area and wood storage area by the old linerboard mill in the 1970s.

Eighteen (18) test pits were excavated to the water table along four (4) lines that were located across the suspected area of hydrocarbon impacts (**Figure 3**). In addition, two (2) of the site geotechnical and environmental monitoring wells are located in the area that was assumed to be impacted.

In addition, two (2) trenches (ST1 and ST2) were excavated across the assumed location of the old fuel supply pipelines (**Figure 4**).

2. Distribution of Hydrocarbon Impacts in the Southwest Corner of the Property

Soil samples were collected from the excavator bucket when each test pit reached the water table or when water was visible in the bottom of the test pit. **Table 1** provides the test pit locations, depth to the water table below ground surface, and the TPH laboratory data. The general description of the overburden that was encountered in each test pit along with scaled photographs of each test pit is provided in **Appendix A**. **Appendix B** provides the laboratory data for the soil samples from all 18 test pits.

In general, the test pit walls consisted of approximately 0.5 to 0.80 m of frozen soil with a high percentage of beach gravel or rounded pebbles. The test pit walls were stable and remained vertical for the short period of time that each test pit was open. The pit walls did slump somewhat at the water table where the sandy material was saturated and when the pit was excavated below the water table. The overburden column in the test pits varied from fine sand to coarse sand with varying amounts of gravel or rounded pebbles. The test pits did not encounter any obvious layers of silt or clay. The water table is relatively deep and the hydraulic gradient is approximately 0.005 m/m, representing a fairly flat gradient despite the tidal influences. Note that the water table elevations for the test pits are approximate, measured to the nearest 0.25 m.

Only two (2) of the trenches soil samples that provided TPH concentrations that exceeded the commercial criteria for gasoline, P3-2 at 1,270 mg/kg and P4-2 at 1,650 mg/kg. The test pit from which soil sample P3-2 was collected is located on the block of land that was not included in the proposed land purchase. The test pit from which soil sample P4-2 was collected is located on the boundary between the proposed land purchase and the strip of land that is reported to be owned by the Port of Stephenville.

The laboratory reported (**Appendix B**) that the oil resemblance was a mixture of gas fraction (GF), plus Fuel Oil Fraction (FOF) plus Lube Oil Fraction (LOF). However, the greatest percentage of the oil was in the light oil category (C6 to C10 and C10 to C16). Only one of the samples contained a significant level of heavy oil fraction. Based on this the Risk Based Corrective Action (RBCA) criteria for gasoline on a commercial site was used as the reference for remediation.

3. Remedial Options for the Hydrocarbon Impacted Area

The hydrocarbon impacts appear to be located at or close to the water table. Normal water table fluctuations would be responsible for smearing the hydrocarbons over a short vertical section, estimated at 1.5 m, at the water table. It is assumed that the hydrocarbons that have been detected in the sub-surface originated at the ground surface. It is possible that the source of the hydrocarbons is (1) either accidental or deliberate releases of hydrocarbons at the old valve chambers and/or (2) releases at the old elevated fuel tank locations or (3) a series of distributed releases or leaks over time. It should be noted that an old fuel tank is located near the shoreline immediately down gradient from test pit P4-3. This old fuel tank has been crushed and flattened and has been abandoned at this location for some period of time.

The distribution of hydrocarbon impacts, from the test pit samples and the three (3) monitoring wells in this area, is consistent with a hydrocarbon plume that is migrating from several sources, from different locations, with natural attenuation eliminating or degrading the hydrocarbons in the up-gradient part of the plume and near the surface. It is expected that the most significant hydrocarbon impacts exist on the property that is owned or controlled by the Port of Stephenville.

The hydrocarbons in the soil are primarily low-weight gas fraction hydrocarbons and are highly aromatic or volatile. None of the samples contained any Benzene and only a few of the soil

samples contained any of the other BTEX components. The impacted soils will produce a strong hydrocarbon smell and could produce hydrocarbon vapours that exceed the lower explosive limit (LEL) if exposed in a confined space with no venting during site construction work. However, the light weight nature of the hydrocarbons means that the hydrocarbons fumes as well as the residual hydrocarbons will dissipate or degrade quickly over a period of several weeks when aerated.

Based on the laboratory data from the test pit soil sampling program, three blocks of land have been identified that have impacts that will require some degree of remediation. Those three blocks of land, A, B and C in **Figure 5** may or may not be included in the land purchase. Blocks A and B are currently owned by the Town of Stephenville and Block C is assumed to be owned or controlled by the Port of Stephenville. Based on the normal way that oil migrates, it is expected that Block C will be the most heavily hydrocarbon-impacted area.

The low level hydrocarbon impacts around test pits P1-3 and P2-1 and around monitoring well FHM2 are best addressed by excavating the impacted soil until clean boundaries are encountered. Because the site is impacted by light, highly aromatic, hydrocarbons, clean boundaries can be determined by smell or by using a hand held Photoionization Detector (PID). The recommended remedial procedures for the areas where the test pit soil samples had hydrocarbon levels below commercial criteria would consist of the following steps:

1. Excavate the upper 2 to 3 m of clean soil, or until impacted soil is encountered, and place the clean soil on one side of the excavation.

2. Excavate the impacted soil that is located in a 1.5 m thick layer just above and below the water table and place this impacted material on the opposite side of the excavation.

3. Excavate to clean boundaries based on smell and PID readings.

4. Once clean boundaries are reached and the impacted material has been removed from the bottom of the excavation, place a 20 cm thick layer of crushed stone or Class A material over the bottom of the trench to produce a high permeability drainage layer.

5. Place the clean material back in the trench and compact in 30 cm to 40 cm lifts.

6. Place the impacted material on top of the clean material but do not compact. Add a nutrient mix to the impacted soil as it is being placed.

7. Use an excavator or backhoe to turn and aerate the soil on a two-week basis for a ten-week period.

8. Collect soil samples for PID analysis and olfactory tests to confirm that the soil has been remediate to levels that eliminate the strong hydrocarbon vapours.

Based on the test pit data, it is estimated that it will require approximately 30 to 40 hours of excavator time to excavate the clean soil and the impacted soil and place the crushed stone and refill the excavations at a cost of approximately $5,500 plus HST. Approximately 10 to 15 cubic metres of crushed stone or Class A material will be required to cover the bottom of the excavations at a delivered cost of approximately $1,000 plus HST, including the cost of an environmental technician, travel costs, and the rental of a PID, provision of nutrients, rental of a vehicle and support costs, with rental of a backhoe or small excavator for five (5) different turnings of the soil (one every two weeks), followed by a letter report at the completion of the work, the estimated cost to remediate this section of the impacted area to remove the hydrocarbon vapours is $16,000 plus HST.

For the areas where elevated hydrocarbon concentrations were encountered, P3-2, P3-4, FHM3, P4-2 and P4-3, and groundwater impacts were visible in the form of an oily sludge or sheens on the test pit water, a more aggressive remedial approach is required to address both the hydrocarbon vapour issue, the groundwater impacts and the soil impacts. If the land is purchased, the following is the recommended approach to remediation:

1. Excavate a 1 m wide trench to a depth of approximately 0.5 to 1.0 m below the water table in a Y shaped pattern (**Figure 6**) starting from approximately 10 m up-gradient of P3-2 and continuing down to test pit P4-2. Start a second trench at approximately 10 m up-gradient of test pit P3-4 and orient the trench to pass approximately 5 m west of monitoring well FHM3 and to connect with the first trench approximately 10 m below test pit P4-2. Continue the combined trench in a line perpendicular to the shoreline to within 15 m of the shoreline. The length of the combined trench segments will be approximately 150 m.

2. As the trench is being excavated, place a 15 cm thick bed of crushed stone in the bottom of the trench below the water table.

3. Place a continuous length of perforated sewer pipe and three lines of weeping tile around the sewer pipe. Cover the pipe bundle with a 15 cm thick layer of crushed stone. Place a layer of 3/8 chipboard on top of the crushed stone and then back fill the trench sections.

4. At the down-gradient end of the pipe bundle, excavate a sump pit approximately 1 m to 1.5 m below the water table. Complete the sump using a culvert that is perforated at the bottom over a 1.5 m to 2.0 m length. Place crushed stone around the bottom of the culvert up to and over the perforated section. Connect the pipe bundle to holes cut in the perforated section of the culvert.

5. Complete the sump by backfilling around the outside of the sump with native material with layers of bentonite at every metre of depth above the perforated section.

6. Place a sump pump in the bottom of the sump. Seal the top of the culvert and construct bulkhead seals to fit the sump pump power cord and discharge pipe. Connect the pump discharge to drum style particle filters and oil absorbent filters with the process water

being discharge to the ground. Periodic sampling of the water will confirm that the process water meets discharge criteria.

7. Add a discharge port to the top of the culvert cap and connect two blowers to this cap that are rated at approximately 50 cfm each. Operate the blowers on a continuous basis using a small shed for shelter and security for both the blowers and the filters.

This system will recover and remediate the oil impacted groundwater, remove the hydrocarbon vapours and gradually reduce the residual phase hydrocarbons. This is the recommended approach since the hydrocarbons exist as light hydrocarbons that will volatize readily. The trench system will create an effective linear flow system for both the hydrocarbon soil vapours as well as the impacted groundwater. Carbon drums can be used to eliminate any excessive hydrocarbon vapours from the blower discharge. The sandy nature of the overburden at the level of the impacted soil retains a limited residual phase hydrocarbon.

This system will create a small negative air pressure in the trench and reduce any risk that might exist from hydrocarbon vapours migrating up through the soil column. It is expected that the system will have to operate for 12 to 18 months to fully remediate the areas in the vicinity of the trenches. The advantage of this approach is that one does not have to excavate the impacted soil and send it to a soil recycler. In addition, the system will operate continuously with only minor maintenance related to filter changes and periodic checking to confirm that the water quality meets discharge criteria.

4. Metals in Soils in the Hydrocarbon Impacted area

Three (3) soil samples were submitted for analysis of metals in soil, P1-3 on the up-gradient side of the group of test pits, sample P2-2 down-gradient from P1-3 and soil sample P3-2 down-gradient from P2-2. The three (3) soil samples show a systematic increase in copper, lead, nickel and zinc from the up-gradient location to the down-gradient locations suggesting that this increase is fuel related (A**ppendix B**). None of the other metals show a similar strong increase in the down-gradient direction.

5. Location of Old Fuel Lines

An old fuel line or fuel lines were postulated to cross the property that is being proposed as the site for the Marine Harvest Atlantic Canada fish hatchery. A potable water line was reported to be located under the shoulder of the paved road and to not cross the property. To determine if fuel pipe lines existed under the property, and if so how many pipelines, a slit trench (ST1) was excavated (**Figure 4**) from just below the shoulder of the road down across the property. At a point immediately down-gradient from borehole FHM4, a 200 mm diameter pipeline (**Figure 7**) was encountered at approximately 1.3 m of depth below ground surface. This pipeline was contacted by the excavator bucket teeth. When the soil was removed from around the pipeline using a shovel, the soil was saturated and a small leak of a litre per minute from two points on the exposed pipeline was detected and the Town of Stephenville staff were notified that their potable water line had been located. Excavation then continued and, approximately 2 m down

gradient, five (5) metal fuel lines (one pipeline 10 cm in diameter and four pipelines 15 cm in diameter) were uncovered (**Figure 8** and **Figure 9**). The Town of Stephenville staff mobilized to the site, uncovered a section of the pipeline and installed a compression patch over the potable water line, sealing the leaking section of the potable water line.

A second slit trench (ST2) was then excavated close to monitoring well FHMW8 and the water line and fuel lines were located at this second point. The two (2) locations of the exposed fuel lines were surveyed and then used, with the location of the old valve chambers on the northwest corner of the property, to provide the actual location of the old fuel lines across the property (**Figure 4**).

6. Relocation of the Potable Water Line and Removal of the Old Fuel Lines

The 200 mm diameter potable water line is estimated to be more than 40 years old. The line is not located under the shoulder of the road as expected but cuts across a critical area of the property that will be required for building construction if the site is purchased for a new fish hatchery.

It is understood or assumed that removal and relocation of the potable water line will be the responsibility of the Town of Stephenville. The water line would have to be relocated to the shoulder of the paved road, Connecticut Avenue, or placed at some depth below any central road that may be constructed across the proposed Marine Harvest Atlantic Canada property.

The old fuel lines have to be removed. The content of the fuel lines, which are supposed to have been decommissioned, is unknown. The steps that need to be taken by a contractor to remove the old fuel lines include:

1. Locate the five (5) fuel lines at the boundary between the proposed MHAC property and the metal recycling property or the property that the metal recycling company leases from the Town of Stephenville. Care has to be taken to not break or rupture the potable water line if it has not been relocated. Based on the slope of the ground surface and the local topography, the boundary between the two properties will represent a local low point, for the proposed purchase property, along the pipeline route.

2. Drill or tap into each pipeline using a sealed pressure tap and determine if the pipelines contain either hydrocarbon liquids or hydrocarbon vapours/gasses, or water.

3. If the pipelines contain neither hydrocarbon liquids nor gases nor water with dissolved hydrocarbons, then the lines have to be vented or purged. If hydrocarbons are present in either a liquid, gas or dissolved phase, the pipelines have to be purged, the liquids containerized and disposed of as per regulations and then the pipelines have to be vented.

4. Once the pipelines have been purged, they have to be cut approximately 2 m from the boundary of the leased property and the sections of the pipelines that leave the property have to be capped and sealed.

5. The old pipelines can then be removed across the full length of the property, back to the old valve chambers. The pipelines can be cut within 1 m of the valve chambers and capped unless it is decided that the valve chambers should be removed.

6. The procedure that is used to remove the five (5) fuel lines and to dispose of the metal pipe can be left to the discretion of the contractor. However, since the integrity of the fuel pipeline is unknown, it will be important to check for pipeline leaks along the length of the pipeline. This would require that an excavator with a mulcher attached be used to clear the alders and small brush along the entire pipeline route. Then the pipelines can be uncovered and exposed in sections. It is recommended that the pipeline be cut in manageable lengths and then removed from the excavation as the excavation is advanced. As each section is removed, and before the underlying ground is disturbed, an environmental engineer needs to walk the excavation and conduct olfactory tests for hydrocarbons. Given the high aromatic nature of the hydrocarbons in the impacted area on the southwest corner of the property a smell test will be adequate.

7. The excavation should be back-filled and compacted, section by section, unless the excavation is adaptable to other site preparation activities. It is preferable that the potable water line be removed at the same time as the old fuel lines are removed.

Table 1 Summary of Test Pit Data.

Test Pit ID	Northing	Easting	Elev (m)	Modified TPH (mg/kg)	Approx. Depth to Water (BGS) (m)
P0-1	5377663.268	302639.446	7.237	<20	4.8
P1-1	5377690.152	302590.419	6.62	<20	4.6
P1-2	5377668.285	302605.286	6.66	<20	4.6
P1-3	5377645.415	302618.468	6.64	175	4.6
P1-4	5377617.126	302635.651	6.393	---	4.6
P2-1	5377677.144	302570.648	5.807	158	4.5
P2-2	5377656.39	302588.377	5.558	<20	4.3
P2-3	5377628.968	302605.741	5.856	<20	4.3
P2-4	5377604.957	302623.103	6.008	<20	4.3
P3-1	5377654.277	302533.104	4.915	<20	4.0
P3-2	5377648.632	302543.695	4.761	**1270**	3.4
P3-3	5377633.072	302562.815	4.838	<20	4.0
P3-4	5377615.285	302578.131	4.974	555	4.0
P3-5	5377590.942	302608.034	5.684	<20	3.7
P4-1	5377621.431	302515.895	4.07	<20	2.4
P4-2	5377597.153	302531.077	4.059	**1650**	2.6
P4-3	5377578	302550.16	4.145	403	2.4
P4-4	5377556.237	302566.436	4.164	<20	2.4

Figure 1 Location of property, Stephenville, NL.

Project No.	Document Reference
3113-Phase II	FFC-NL-3113-004
Location	**Date**
Stephenville, NL	February 2018

FFC

Figure 2 Site map showing assumed fuel line routes and property boundaries, Stephenville, NL.

Project No.	Document Reference
3113-Phase II	FFC-NL-3113-004
Location	**Date**
Stephenville, NL	February 2018

FFC

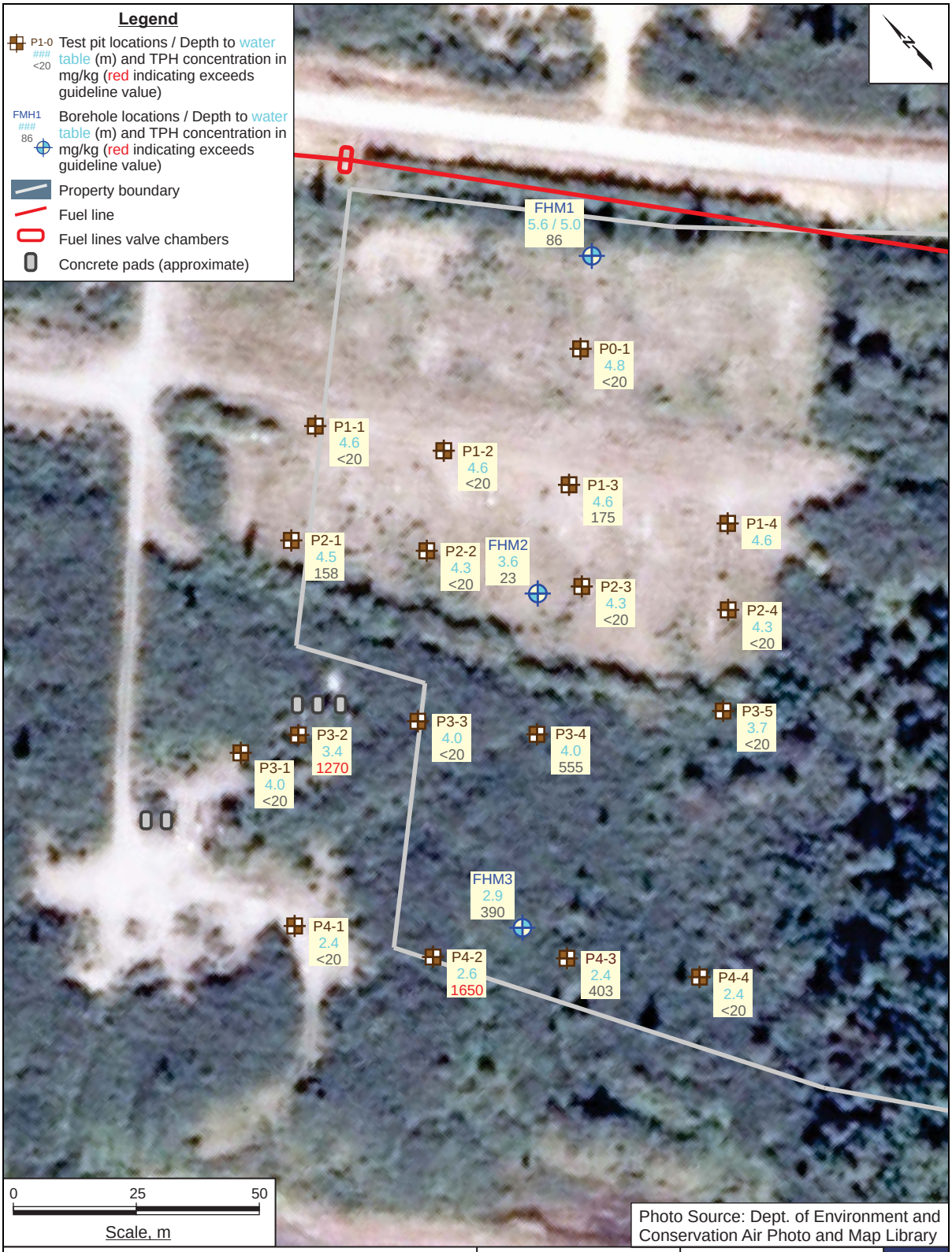


Figure 3 Location of boreholes and test pits, southwest corner of property, Stephenville, NL.

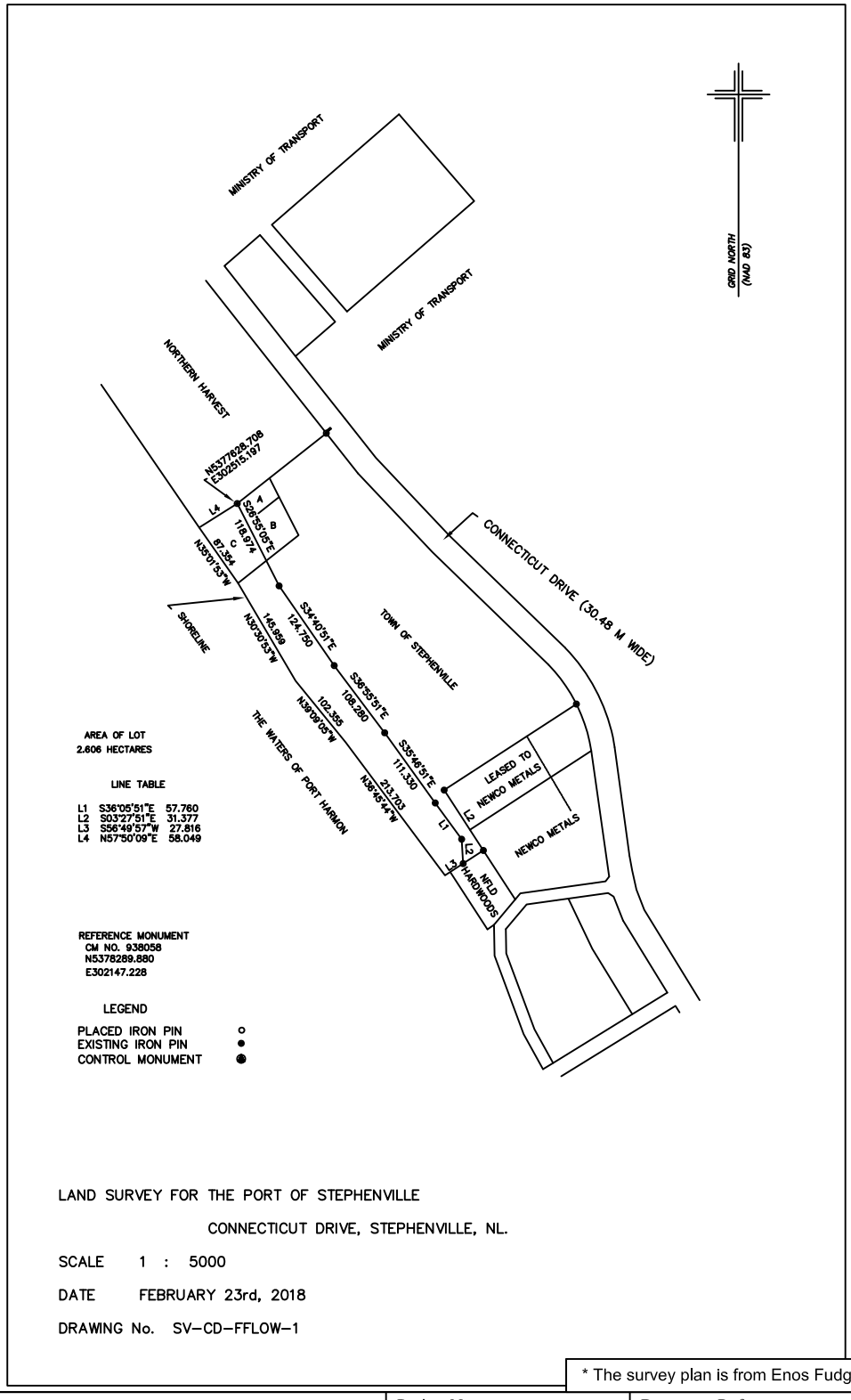
Project No.	Document Reference
3113-Phase II	FFC-NL-3113-004
Location	**Date**
Stephenville, NL	February 2018

FFC

Figure 4 Location of old fuel lines in slit trenches, Stephenville, NL.

Project No.	Document Reference
3113-Phase II	FFC-NL-3113-004
Location	**Date**
Stephenville, NL	February 2018

FFC



* The survey plan is from Enos Fudge Surveys.

Figure 5 Location of land parcels A, B and C on the southwestern corner of the property that may be purchased by Marine Harvest Atlantic Canada.

Project No.	Document Reference
3113	FFC-NL-3113-004
Location	Date
Stephenville, NL	February 2018

FFC

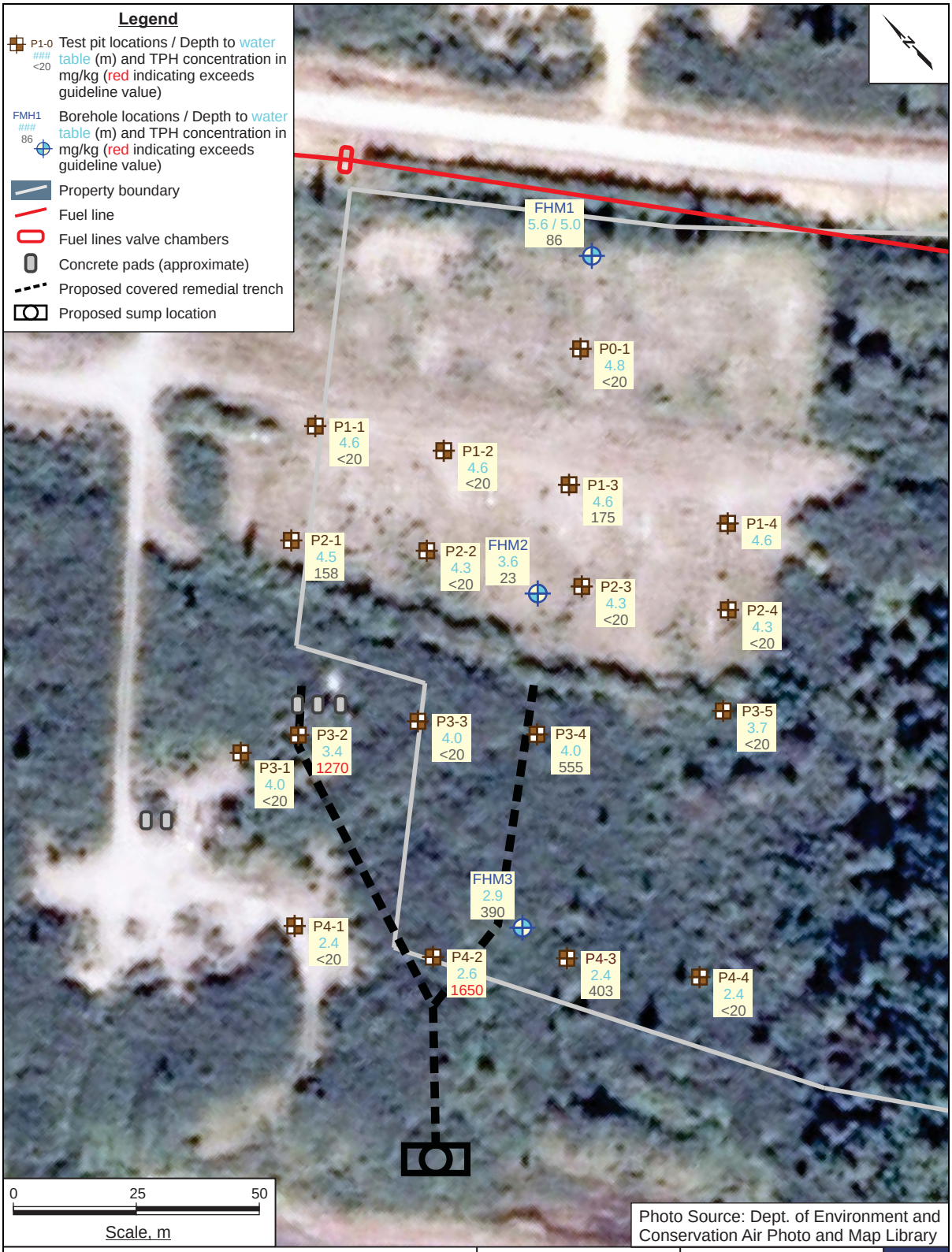


Figure 6 Location of the proposed covered remedial trench, Stephenville, NL.

Project No.	Document Reference
3113-Phase II	FFC-NL-3113-004
Location	**Date**
Stephenville, NL	February 2018

FFC

Figure 7 Photograph of staff member standing on the exposed potable water line.

Figure 8 Photograph of staff member standing on two (2) of old fuel lines uncovered in the slit trench with a third line to the staff member's right and two to his left.

Figure 9 Photograph of staff member standing on the potable water line with the old fuel lines uncovered in the foreground of the slit trench.

APPENDIX A

Description of Test Pits and Photographs

Description of Test Pits

P0-1: The upper layer consists of 0.5 m of frozen, of what appears to be fill material which consisted of beach rocks, sand and organic plant material. This layer was difficult to break with the excavator to reach the underlying unfrozen material. The underlying 2.4 m of material consisted of fine to medium sand with occasional beach rocks. There are distinct layers in this section that varies from brown to a brown/gray colour. Below this 2.4 m thick layer a layer of fine brown sand was exposed in the pit wall that continued to the water table at approximately 4.8 m. The pit walls did not slump, and the material in the excavator bucket was inspected as the excavation approached the water table to ensure that the clean soil and the impacted soil were not mixed. The soil sample at the water table did not have any odour and there were no sheens on the surface of the water. The overburden material at the depth of the water table was sand mixed with beach rock or gravel, both of which were clean and wet. After the samples were collected and the photographs were taken the pit was back-filled.

P1-1: The surface layer at this location was approximately 0.4 thick and consisted of a frozen, fill material, that consisted of beach rock, sand and organic plant material. This frozen layer was difficult to break with the excavator to reach the unfrozen material. The next layer consisted of 2.4 m of fine to medium sand with occasional beach rocks or gravel. The layers in this section varied in color from brown to brown/gray, similar to what was found in test pit P0-1. Below this 2.4 m thick layer, a layer of fine brown sand continued to the water table at approximately 4.4 m below ground surface. The pit walls did not collapse. Each excavator bucket of material was checked for hydrocarbon vapours or fumes. The water table and soil sample did not have any hydrocarbon odours. The material at the bottom of the test pit was sand with intermixed beach rocks, both of which were clean and wet. After the soil sample was collected the pit was refilled.

P1-2: The frozen surface layer, consisting of a mixture of beach rock, gravel, sand and organic plant material, was approximately 0.5 m thick. The next 2.4 m of material consisted of fine to medium sand with intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 2.9 m depth, the formation consisted of a fine brown sand that continued to the water table at 4.4 m below ground surface. The pit walls did not collapse. The soil and the water at the water table did not have a hydrocarbon odour. The material in the bottom of the test pit was a mixture of sand, gravel and beach rock, which were clean and wet. After the soil sample was collected the pit was refilled.

P1-3: The frozen surface layer, consisting of a mixture of beach rock, gravel, sand and organic plant material, was approximately 0.5 m thick. The next 2.4 m of material consisted of fine to medium sand with intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 2.9 m depth, the formation consisted of fine brown sand that continued to the water table at 4.6 m below ground surface. The material in the bottom of the pit was intermixed gravel, beach rocks and medium sand. This pit walls did not collapse. Once the water table was reached the excavated material in the excavator bucket produced a strong hydrocarbon smell. The soil at the bottom of this test pit is impacted with hydrocarbons. Once the soil sample had been collected, the test pit was back-filled with the impacted material being placed in the bottom of the test pit.

P1-4: This pit was excavated on February 6, 2018. The frozen surface layer, consisting of a mixture of beach rock, gravel, sand and organic plant material, was approximately 0.5 m thick. The next 2.4 m of material consisted of fine to medium sand with intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 2.9 m depth, the formation consisted of fine brown sand that continued to the water table at 4.6 m below ground surface. The pit walls did not collapse. The soil and water at the water table did not present any hydrocarbon odours. The wet material in the bottom of the trench was a mixture of clean sand, gravel and beach rocks. The test pit was back-filled.

P2-1: The frozen surface layer, consisting of a mixture of beach rock, gravel, sand and organic plant material, was approximately 0.3 m thick. The next 2.4 m of material consisted of fine to medium sand with intermixed gravel and beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 2.7 m depth, the formation consisted of fine brown sand that continued to the water table at 3.5 m below ground surface. The pit walls did not collapse. Once the water table was reached the excavated material had a strong hydrocarbon smell and this soil was placed in a separate pile next to the test pit. The wet material in the bottom of the trench was a mixture of sand, gravel and beach rocks The overburden in this test pit was impacted with hydrocarbons and a soil sample was collected at roughly 4.5 m below ground surface. The test pit was back-filled with the impacted material being placed in the bottom of the test pit.

P2-2: The frozen surface layer, consisting of a mixture of beach rock, gravel, sand and organic plant material, was approximately 0.3 m thick. The next 2.4 m to 3.0 m of material consisted of fine sand with intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 3.0 m depth, the formation consisted of fine brown sand that continued to the water table at 3.35 m below ground surface. The pit walls did not collapse. Once the water table was reached the excavated material had a strong hydrocarbon smell. The soil in the bottom of this test pit is impacted with hydrocarbons. The wet material in the bottom of the trench was a mixture of sand, gravel and beach rocks The soil sample was collected at roughly 4.25m below ground surface. The test pit was back-filled and the impacted material was placed in the bottom of the test pit.

P2-3: The frozen surface layer, consisting of a mixture of beach rock, gravel, sand and organic plant material, was approximately 0.3 m thick. The next 2.4 m to 3.0 m of material consisted of fine sand with intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 3.0 m depth, the formation consisted of fine brown sand that continued to the water table at 3.4 m below ground surface. The pit walls did not collapse. The water in the test pit and the soil from the bottom of the test pit did not have an hydrocarbon odour. The soil in the bottom of this test pit was not impacted by hydrocarbons. The wet material in the bottom of the trench was a mixture of clean sand, gravel and beach rocks The soil sample was collected at roughly 4.3 m below ground surface. The test pit was back-filled.

P2-4 The surface frozen surface layer, consisting of a mixture of beach rock, gravel, sand and organic plant material, was approximately 0.3 m thick. The next 2.4 m of material consisted of fine sand with intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 2.4 m depth, the formation consisted of fine brown sand that

continued to the water table at 3.4 m below ground surface. The pit walls did not collapse. The water in the test pit and the soil from the bottom of the test pit did not have a hydrocarbon odour. The soil in the bottom of this test pit was not impacted by hydrocarbons. The wet material in the bottom of the trench was a mixture of clean sand, gravel and beach rocks. The soil sample was collected at roughly 4.3 m below ground surface. The test pit was back-filled.

P3-1: This test pit did not have a frozen layer. The first 0.3 m was a dark, organic or soil material. The next 2.1 m to 2.7 m of material consisted of medium to fine sand with some intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 2.7 m depth, the formation consisted of fine brown sand that continued to the water table at 3.4 m below ground surface. The pit walls did not collapse. The water in the test pit and the soil from the bottom of the test pit had a hydrocarbon odour. The soil in the bottom of this test pit is impacted by hydrocarbons. The wet material in the bottom of the trench was a mixture of clean sand, gravel and beach rocks. The soil sample was collected at roughly 3.9 m below ground surface. The test pit was back-filled.

P3-2: This pit started with 0.2 m of frozen, fill material, which consisted of beach rock, sand and organic plant material. The next 1.8 m of material consisted of medium to fine sand with some intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 1.8 m depth, the formation consisted of fine brown sand that continued to the water table at 2.4 m below ground surface. The pit walls did not collapse. Just above the water table, the excavated material started to present a strong hydrocarbon odour. This pit had visible free product on the water surface in the form of oily gray sludge mixed with the water and hydrocarbon sheens. The soil in this test pit is heavily impacted by hydrocarbons and the soil sample was collected at approximately 3.4 m below the ground surface. The test pit was back-filled.

P3-3: The surface layer in this pit was a 0.2 m of frozen, fill material, which consisted of beach rock, sand and organic plant material. The next 1.8 m of material consisted of medium to fine sand with some intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 1.8 m depth, the formation consisted of fine brown sand that continued to the water table at 3.2 m below ground surface. The pit walls did not collapse. Just above the water table, the excavated material started to present a hydrocarbon odour. The soil in this test pit is impacted by hydrocarbons and the soil sample was collected at approximately 4.0 m below the ground surface. The test pit was back-filled.

P3-4: The surface layer in this pit was a 0.3 m of frozen, fill material, which consisted of beach rock, sand and organic plant material. The next 2.7 m of material consisted of medium to fine sand with some intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 1.8 m depth, the formation consisted of fine brown sand that continued to the water table at 3.2 m below ground surface. The pit walls did not collapse. Just above the water table, the excavated material started to present a strong hydrocarbon odour. Below the water table the soil also presented a strong hydrocarbon smell and the water included a gray sludge and sheens. The soil in this test pit is impacted by hydrocarbons and the soil sample was collected at approximately 3.9 m below the ground surface. The test pit was back-filled.

P3-5: The surface layer in this pit was a 0.3 m of frozen, fill material, which consisted of beach rock, sand and organic plant material. The next 2.4 m of material consisted of medium to fine sand with some intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 2.7 m depth, the formation consisted of fine brown sand that continued to the water table at 2.9 m below ground surface. The pit walls did not collapse. The water in the test pit and at the water table and soil sample were clean with no hydrocarbon odour. The material at the bottom of the test pit was a mixture of clean and wet sand, gravel and beach rock. The soil sample was collected at roughly 3.7 m below ground surface. The test pit was back-filled.

P4-1: The surface layer in this pit was a 0.3 m of frozen, fill material, which consisted of beach rock, sand and organic plant material. The next 1.2 m of material consisted of medium to fine sand with some intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 1.5 m depth, the formation consisted of fine brown sand that continued to the water table at 1.7 m below ground surface. The pit walls did not collapse. A gray sludge material was recovered with the water at the water table and hydrocarbon sheens were present. The soil in this test pit is impacted by hydrocarbons and the soil sample was collected at approximately 2.4 m below the ground surface. The test pit was back-filled.

P4-2: The surface layer in this pit was a 0.3 m of frozen, fill material, which consisted of beach rock, sand and organic plant material. The next 1.5 m of material consisted of medium to fine sand with some intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. At the bottom of this section, strong hydrocarbon odours were encountered. Below the 1.8 m depth, the water table, a wet gray hydrocarbon impacted sand with oily sludge and sheens was encountered. The pit walls did not collapse. This test pit was contaminated and the soil sample was collected at roughly 2.6 m below ground surface. The test pit was back-filled.

P4-3: The surface layer in this pit was a 0.2 m of frozen, fill material, which consisted of beach rock, sand and organic plant material. The next 1.5 m of material consisted of medium to fine sand with some intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below this 1.7 m of depth a fine brown sand was encountered and continued to the water table at 1.8 m. The material below the water table was primarily medium sand with intermixed gravel and beach rock. The pit walls did not collapse. Immediately below the water table the excavated material presented a strong hydrocarbon smell. The material in this test pit is impacted and the soil sample was collected at approximately 2.4 m below ground surface. The test pit was back filled.

P4-4: The surface layer in this pit was a 0.2 m of frozen, fill material, which consisted of beach rock, sand and organic plant material. The next 1.5 m of material consisted of medium to fine sand with some intermixed beach rocks. The soil layers in this section, varied from brown to a brown/gray colour. Below the 1.7 m depth, the formation consisted of fine brown sand that continued to the water table at 1.8 m below ground surface. The pit walls did not collapse. When the material was excavated immediately below the water table, the excavated material had a hydrocarbon smell. The material at the bottom of the test pit was a mixture of clean and wet

medium sand, gravel and beach rock. The soil sample was collected at roughly 2.4 m below ground surface. The test pit was back-filled.

Figure A1 Test pit P0-1 at final depth.

Figure A2 Test pit P2-2 scale view.

Project No.	3113
Location	Stephenville, NL
Document Reference	FFC-NL-3113-004
Date	February 2018

Figure A3 Test pit P2-2 soil layers in the pit wall and exposed pit bottom.

Figure A4 Test pit P2-3 scale and sides of test pit.

Figure A5 Test pit P2-3 soil layers and exposed pit bottom.

Figure A6 Test pit P2-4 Scale and sides of test pit. Note the coarse pebble to gravel layer near the surface.

Figure A7 Test pit P2-4 scale showing the depth of the pit.

Figure A8 Test pit P3-1 scale, depth and sides of test pit. Note the vertical nature of the pit walls.

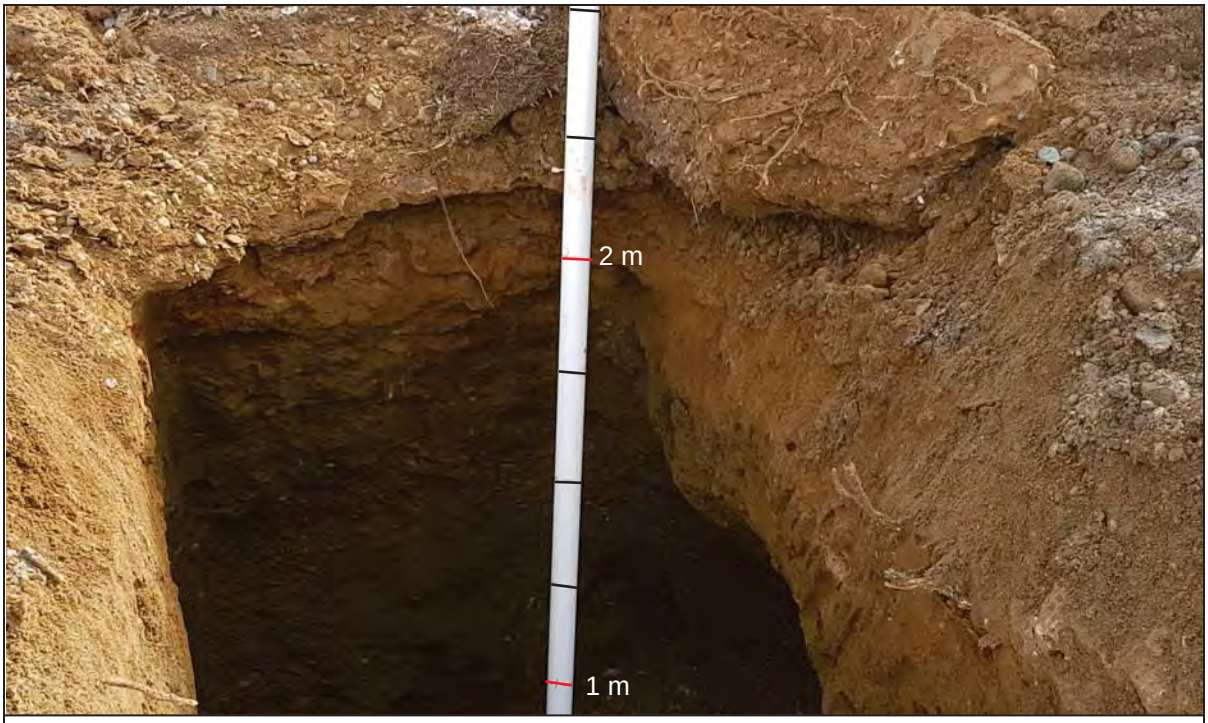


Figure A9 Test pit P3-2 scale for pit depth and near-surface layers .

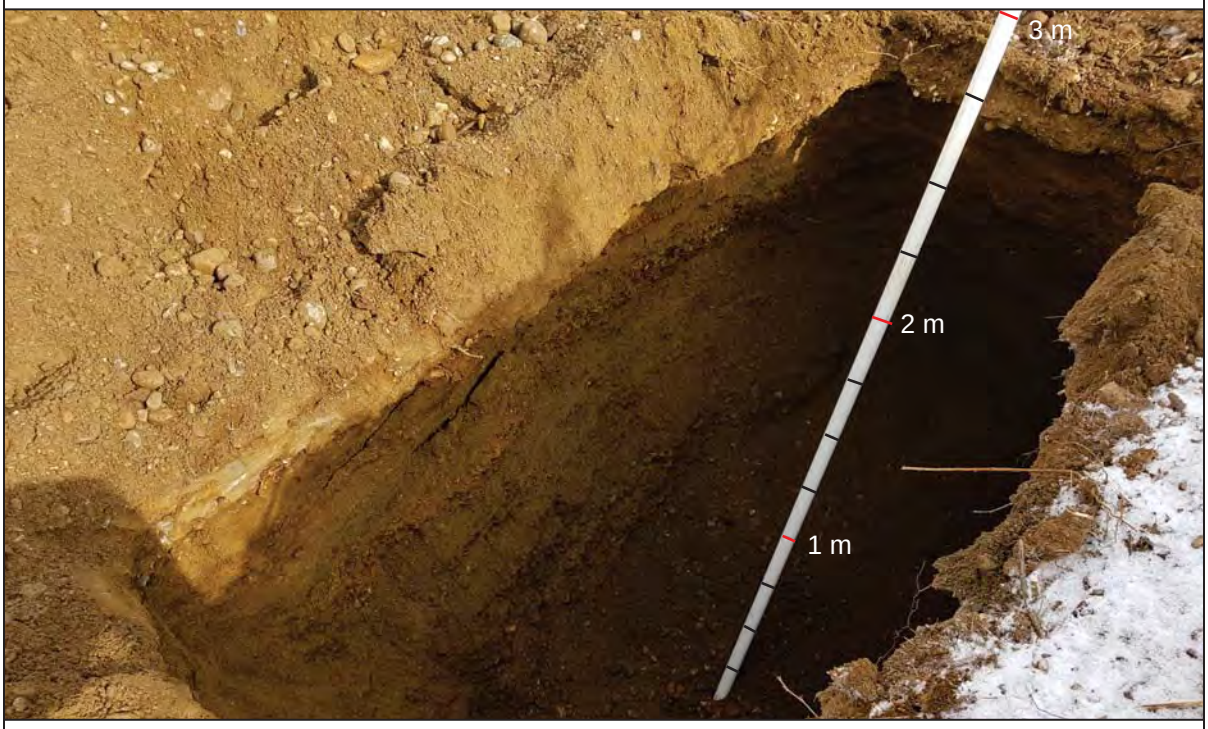


Figure A10 Test pit P3-3 scale, depth and sides of test pit. Note the coarse gravel layer near the bottom of the pit.

Figure A11 Test pit P3-4 scale for pit depth and view of layers.

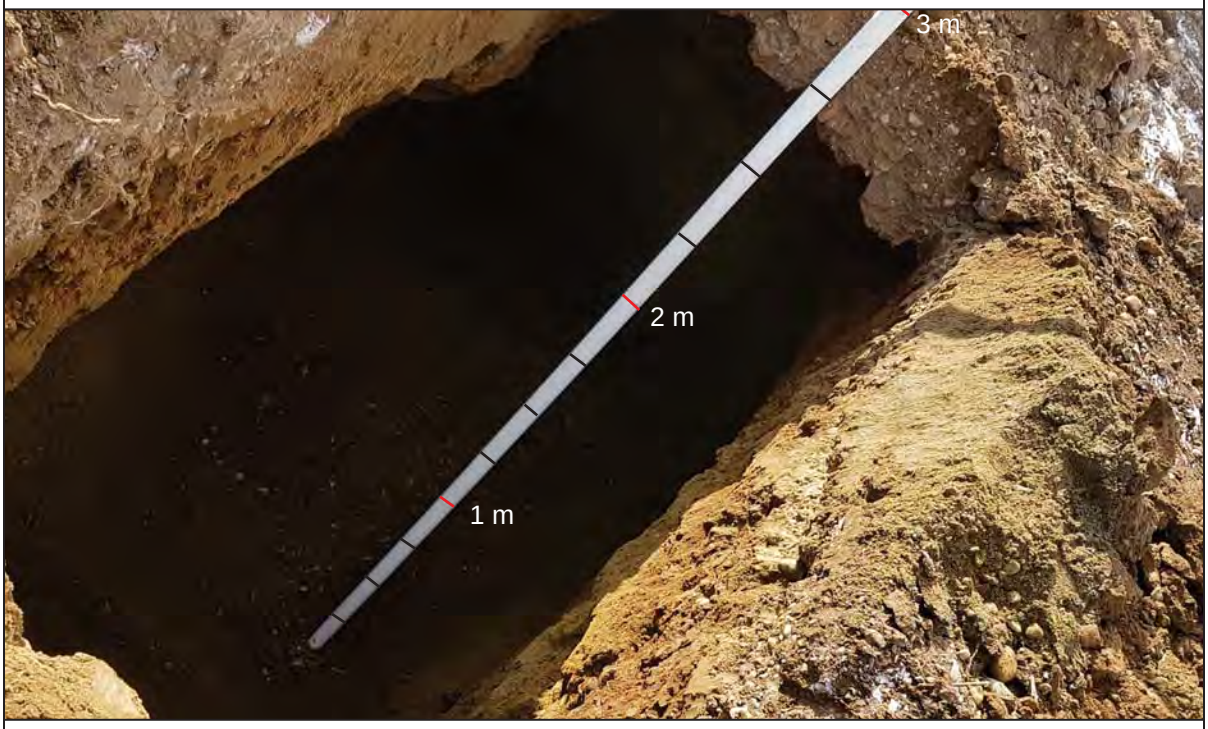


Figure A12 Test pit P3-5 scale, depth and sides of pit.

Figure A13 Test pit P4-1 Scale for pit depth and view of layers. The pit wall shows minor caving.

Figure A14 Test pit P4-2 scale, depth and sides of pit.

Figure A15 Test pit P4-3 scale for pit depth and view of layers.

Figure A16 Test pit P4-4 scale, depth and sides of pit.

APPENDIX B

Laboratory Data for Test Pits

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

CLIENT NAME: FRACFLOW CONSULTANTS
154 MAJOR'S PATH
ST. JOHN'S PATH, NL A1A5A1
(709) 739-7270

ATTENTION TO: John Gale

PROJECT: 3113 - Stephenville, NL

AGAT WORK ORDER: 18K310811

SOIL ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

WATER ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

DATE REPORTED: Feb 21, 2018

PAGES (INCLUDING COVER): 18

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Available Metals in Soil

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

SAMPLE DESCRIPTION:				3113-P1-3-SS1	3113-P2-2-SS1	3113-P3-2-SS1
SAMPLE TYPE:				Soil	Soil	Soil
DATE SAMPLED:				2018-02-07	2018-02-07	2018-02-07
Parameter	Unit	G / S	RDL	9063732	9063734	9063738
Aluminum	mg/kg		10	6520	4990	6440
Antimony	mg/kg		1	<1	<1	<1
Arsenic	mg/kg		1	4	3	4
Barium	mg/kg		5	20	20	38
Beryllium	mg/kg		2	<2	<2	<2
Boron	mg/kg		2	<2	<2	<2
Cadmium	mg/kg		0.3	<0.3	<0.3	<0.3
Chromium	mg/kg		2	23	17	21
Cobalt	mg/kg		1	7	6	8
Copper	mg/kg		2	18	23	39
Iron	mg/kg		50	13500	12700	13500
Lead	mg/kg		0.5	3.7	5.2	13.4
Lithium	mg/kg		5	7	7	8
Manganese	mg/kg		2	183	211	218
Molybdenum	mg/kg		2	<2	<2	<2
Nickel	mg/kg		2	18	22	26
Selenium	mg/kg		1	<1	<1	<1
Silver	mg/kg		0.5	<0.5	<0.5	<0.5
Strontium	mg/kg		5	7	6	6
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	3	3	3
Uranium	mg/kg		0.1	0.3	0.4	0.4
Vanadium	mg/kg		2	31	23	31
Zinc	mg/kg		5	22	27	28

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9063732-9063738 Results are based on the dry weight of the sample.

Certified By:

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

						SAMPLE DESCRIPTION:	3113-P0-1-SS1	3113-P1-1-SS1	3113-P1-2-SS1	3113-P1-3-SS1	3113-P2-1-SS1	3113-P2-2-SS1
						SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
						DATE SAMPLED:	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07
Parameter	Unit	G / S: A	G / S: B	G / S: C	RDL		9063729	9063730	9063731	9063732	9063733	9063734
Benzene	mg/kg	2.5	2.5	2.5	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Toluene	mg/kg	10000	10000	10000	0.04		<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]
Ethylbenzene	mg/kg	10000	10000	10000	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Xylene (Total)	mg/kg	110	110	110	0.05		<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]
C6-C10 (less BTEX)	mg/kg				3		<3	<3	<3	108	158	<3
>C10-C16 Hydrocarbons	mg/kg				15		<15	<15	<15	67	<15	<15
>C16-C21 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15	<15
Modified TPH (Tier 1)	mg/kg	4000	870	10000	20		<20[<B]	<20[<B]	<20[<B]	175[<B]	158[<B]	<20[<B]
Resemblance Comment							NR	NR	NR	GF+FOF	GF	NR
Return to Baseline at C32							Y	Y	Y	Y	Y	Y
Surrogate	Unit	Acceptable Limits										
Isobutylbenzene - EPH	%	60-140					99	100	102	99	102	102
Isobutylbenzene - VPH	%	60-140					93	91	91	94	96	96
n-Dotriacontane - EPH	%	60-140					100	102	103	100	103	105

Certified By:

AGAT Laboratories

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http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

						SAMPLE DESCRIPTION:	3113-P2-3-SS1	3113-P2-4-SS1	3113-P3-1-SS1	3113-P3-2-SS1	3113-P3-3-SS1	3113-P3-4-SS1
						SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
						DATE SAMPLED:	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07
Parameter	Unit	G / S: A	G / S: B	G / S: C	RDL		9063735	9063736	9063737	9063738	9063739	9063740
Benzene	mg/kg	2.5	2.5	2.5	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Toluene	mg/kg	10000	10000	10000	0.04		<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]
Ethylbenzene	mg/kg	10000	10000	10000	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Xylene (Total)	mg/kg	110	110	110	0.05		<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]
C6-C10 (less BTEX)	mg/kg				3		<3	<3	<3	680	<3	449
>C10-C16 Hydrocarbons	mg/kg				15		<15	<15	<15	193	<15	106
>C16-C21 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg				15		<15	<15	<15	393	<15	<15
Modified TPH (Tier 1)	mg/kg	4000	870	10000	20		<20[<B]	<20[<B]	<20[<B]	1270[B-A]	<20[<B]	555[<B]
Resemblance Comment							NR	NR	NR	GF+FOF+LOF	NR	GF+FOF
Return to Baseline at C32							Y	Y	Y	Y	Y	Y
Surrogate	Unit	Acceptable Limits										
Isobutylbenzene - EPH	%	60-140					99	102	99	130	96	109
Isobutylbenzene - VPH	%	60-140					91	90	93	101	95	101
n-Dotriacontane - EPH	%	60-140					102	106	104	101	97	113

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

						SAMPLE DESCRIPTION:	3113-P3-5-SS1	3113-P4-1-SS1	3113-P4-2-SS1	3113-P4-3-SS1	3113-P4-4-SS1
						SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil
						DATE SAMPLED:	2018-02-07	2018-02-07	2018-02-07	2018-02-07	2018-02-07
Parameter	Unit	G / S: A	G / S: B	G / S: C	RDL		9063741	9063742	9063743	9063744	9063745
Benzene	mg/kg	2.5	2.5	2.5	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Toluene	mg/kg	10000	10000	10000	0.04		<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]	<0.04[<A]
Ethylbenzene	mg/kg	10000	10000	10000	0.03		<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]	<0.03[<A]
Xylene (Total)	mg/kg	110	110	110	0.05		<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]	<0.05[<A]
C6-C10 (less BTEX)	mg/kg				3		<3	<3	1610	344	<3
>C10-C16 Hydrocarbons	mg/kg				15		<15	<15	38	59	<15
>C16-C21 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg				15		<15	<15	<15	<15	<15
Modified TPH (Tier 1)	mg/kg	4000	870	10000	20		<20[<B]	<20[<B]	1650[B-A]	403[<B]	<20[<B]
Resemblance Comment							NR	NR	GF+WFOF	GF+FOF	NR
Return to Baseline at C32							Y	Y	Y	Y	Y
Surrogate	Unit		Acceptable Limits								
Isobutylbenzene - EPH	%		60-140				100	99	100	105	96
Isobutylbenzene - VPH	%		60-140				97	94	101	100	98
n-Dotriacontane - EPH	%		60-140				105	104	104	107	103

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: A Refers to PIRI Tier 1 Soil Commercial Non-potable Coarse Jan 2015, B Refers to PIRI Tier 1 Soil Commercial Non-potable Coarse Jan 2015, C Refers to PIRI Tier 1 Soil Commercial Non-potable Coarse Jan 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

9063729-9063745 Results are based on the dry weight of the soil.

Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Water (Version 3.0)

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

				3113-FHM1-1.	3113-FHM1-1.	3113-FMH2-2.	3113-FHM3-2.	3113-FHM4-1.	3113-FHM5-2.	3113-FHM7-2-	3113-FHM9-2.
SAMPLE DESCRIPTION:				0-WS1	25-WS1	0-WS1	0-WS1	25-WS1	0-WS1	2.0-WS1	0-WS1
SAMPLE TYPE:				Water	Water	Water	Water	Water	Water	Water	Water
DATE SAMPLED:				2018-02-04	2018-02-04	2018-02-05	2018-02-05	2018-02-04	2018-02-05	2018-02-06	2018-02-05
Parameter	Unit	G / S	RDL	9063713	9063716	9063717	9063718	9063719	9063720	9063721	9063722
Benzene	mg/L	20	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	20	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Ethylbenzene	mg/L	20	0.001	<0.001	<0.001	0.008	<0.001	<0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	20	0.002	<0.002	<0.002	0.015	<0.002	<0.002	<0.002	<0.002	<0.002
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01	1.93	3.62	<0.01	<0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05	0.26	0.30	<0.05	<0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
>C21-C32 Hydrocarbons	mg/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Modified TPH (Tier 1)	mg/L	20	0.1	<0.1	<0.1	2.2	3.9	<0.1	<0.1	<0.1	<0.1
Resemblance Comment				NR	NR	GF	GF	NR	NR	NR	NR
Return to Baseline at C32				Y	Y	Y	Y	Y	Y	Y	Y
Surrogate	Unit	Acceptable Limits									
Isobutylbenzene - EPH	%	70-130		111	107	99	114	113	113	99	116
Isobutylbenzene - VPH	%	70-130		81	80	80	78	77	78	77	78
n-Dotriacontane - EPH	%	70-130		118	115	111	121	120	120	106	121

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PIRI Tier 1 GW Commercial Non-potable coarse Jan 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

9063713-9063722 Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

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Certificate of Analysis

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Moisture

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-P0-1-SS1 / SAMPLE TYPE: Soil / DATE SAMPLED: 2018-02-07 / 9063729	3113-P1-1-SS1 / Soil / 2018-02-07 / 9063730	3113-P1-2-SS1 / Soil / 2018-02-07 / 9063731	3113-P1-3-SS1 / Soil / 2018-02-07 / 9063732	3113-P2-1-SS1 / Soil / 2018-02-07 / 9063733	3113-P2-2-SS1 / Soil / 2018-02-07 / 9063734	3113-P2-3-SS1 / Soil / 2018-02-07 / 9063735	3113-P2-4-SS1 / Soil / 2018-02-07 / 9063736
% Moisture	%			19	11	13	18	15	11	9	15

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-P3-1-SS1 / SAMPLE TYPE: Soil / DATE SAMPLED: 2018-02-07 / 9063737	3113-P3-2-SS1 / Soil / 2018-02-07 / 9063738	3113-P3-3-SS1 / Soil / 2018-02-07 / 9063739	3113-P3-4-SS1 / Soil / 2018-02-07 / 9063740	3113-P3-5-SS1 / Soil / 2018-02-07 / 9063741	3113-P4-1-SS1 / Soil / 2018-02-07 / 9063742	3113-P4-2-SS1 / Soil / 2018-02-07 / 9063743	3113-P4-3-SS1 / Soil / 2018-02-07 / 9063744
% Moisture	%			16	12	12	16	9	11	12	15

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-P4-4-SS1 / SAMPLE TYPE: Soil / DATE SAMPLED: 2018-02-07 / 9063745
% Moisture	%			14

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

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AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Dissolved Metals

DATE RECEIVED: 2018-02-13

DATE REPORTED: 2018-02-21

Parameter	Unit	G / S	RDL	3113-FHM1-1. 0-WS1 Water 2018-02-04 9063713	3113-FHM1-1. 25-WS1 Water 2018-02-04 9063716	3113-FMH2-2. 0-WS1 Water 2018-02-05 9063717	3113-FHM3-2. 0-WS1 Water 2018-02-05 9063718	3113-FHM4-1. 25-WS1 Water 2018-02-04 9063719	3113-FHM7-2-2.0-WS1 Water 2018-02-06 9063721	3113-FHM9-2. 0-WS1 Water 2018-02-05 9063722
SAMPLE DESCRIPTION:										
SAMPLE TYPE:										
DATE SAMPLED:										
Dissolved Aluminum	ug/L		5	16	8	5	23	8	7	12
Dissolved Antimony	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Arsenic	ug/L		2	<2	<2	5	8	<2	<2	<2
Dissolved Barium	ug/L		5	19	36	47	47	43	16	16
Dissolved Beryllium	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Bismuth	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Boron	ug/L		5	10	9	8	7	12	8	6
Dissolved Cadmium	ug/L		0.017	0.020	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Dissolved Chromium	ug/L		1	2	3	3	3	7	3	3
Dissolved Cobalt	ug/L		1	<1	<1	1	1	<1	4	<1
Dissolved Copper	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Iron	ug/L		50	<50	<50	1880	4490	<50	127	<50
Dissolved Lead	ug/L		0.5	<0.5	<0.5	3.2	2.8	<0.5	<0.5	<0.5
Dissolved Manganese	ug/L		2	171	47	506	713	10	1060	84
Dissolved Molybdenum	ug/L		2	2	4	<2	<2	<2	<2	<2
Dissolved Nickel	ug/L		2	7	<2	<2	3	4	5	3
Dissolved Selenium	ug/L		1	<1	<1	<1	<1	<1	<1	<1
Dissolved Silver	ug/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Strontium	ug/L		5	89	72	58	50	148	55	57
Dissolved Thallium	ug/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Tin	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Titanium	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Uranium	ug/L		0.1	0.8	0.2	0.2	0.2	1.3	<0.1	0.2
Dissolved Vanadium	ug/L		2	<2	<2	<2	<2	<2	<2	<2
Dissolved Zinc	ug/L		5	<5	<5	<5	<5	<5	10	7

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9063713-9063722 Analysis completed on a filtered sample.

Certified By:

AGAT Laboratories

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Guideline Violation

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
9063738	3113-P3-2-SS1	NS-PIRI-ComCNPSoilG	Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved	Modified TPH (Tier 1)	mg/kg	870	1270
9063743	3113-P4-2-SS1	NS-PIRI-ComCNPSoilG	Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved	Modified TPH (Tier 1)	mg/kg	870	1650

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Soil Analysis

RPT Date: Feb 21, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Available Metals in Soil															
Aluminum	9052260		6920	7740	11.2%	< 10	99%	80%	120%	105%	80%	120%	84%	70%	130%
Antimony	9052260		<1	<1	NA	< 1	91%	80%	120%	111%	80%	120%	70%	70%	130%
Arsenic	9052260		11	9	NA	< 1	97%	80%	120%	105%	80%	120%	103%	70%	130%
Barium	9052260		22	25	NA	< 5	103%	80%	120%	115%	80%	120%	75%	70%	130%
Beryllium	9052260		<2	<2	NA	< 2	108%	80%	120%	116%	80%	120%	85%	70%	130%
Boron	9052260		<2	<2	NA	< 2	103%	80%	120%	111%	80%	120%	84%	70%	130%
Cadmium	9052260		<0.3	<0.3	NA	< 0.3	97%	80%	120%	106%	80%	120%	83%	70%	130%
Chromium	9052260		13	14	4.9%	< 2	93%	80%	120%	105%	80%	120%	85%	70%	130%
Cobalt	9052260		6	6	1.4%	< 1	98%	80%	120%	105%	80%	120%	81%	70%	130%
Copper	9052260		30	23	NA	< 2	98%	80%	120%	104%	80%	120%	91%	70%	130%
Iron	9052260		32700	28100	15.1%	< 50	95%	80%	120%	111%	80%	120%	74%	70%	130%
Lead	9052260		28.3	26.9	4.8%	< 0.5	97%	80%	120%	108%	80%	120%	70%	70%	130%
Lithium	9052260		24	34	NA	< 5	112%	70%	130%	125%	70%	130%	83%	70%	130%
Manganese	9052260		255	258	1.1%	< 2	98%	80%	120%	106%	80%	120%	87%	70%	130%
Molybdenum	9052260		3	3	NA	< 2	84%	80%	120%	97%	80%	120%	70%	70%	130%
Nickel	9052260		13	12	8.1%	< 2	100%	80%	120%	110%	80%	120%	83%	70%	130%
Selenium	9052260		<1	<1	NA	< 1	95%	80%	120%	102%	80%	120%	70%	70%	130%
Silver	9052260		<0.5	<0.5	NA	< 0.5	82%	80%	120%	87%	80%	120%	70%	70%	130%
Strontium	9052260		<5	<5	NA	< 5	88%	80%	120%	95%	80%	120%	94%	70%	130%
Thallium	9052260		<0.1	<0.1	NA	< 0.1	99%	80%	120%	113%	80%	120%	NA	70%	130%
Tin	9052260		3	3	NA	< 2	96%	80%	120%	108%	80%	120%	81%	70%	130%
Uranium	9052260		0.9	0.8	5.0%	< 0.1	96%	80%	120%	105%	80%	120%	74%	70%	130%
Vanadium	9052260		15	18	15.9%	< 2	94%	80%	120%	105%	80%	120%	77%	70%	130%
Zinc	9052260		49	55	12.1%	< 5	87%	80%	120%	96%	80%	120%	80%	70%	130%

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Trace Organics Analysis

RPT Date: Feb 21, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbons in Water (Version 3.0)															
Benzene	1	9063713	< 0.001	< 0.001	NA	< 0.001	84%	70%	130%	81%	70%	130%	NA		
Toluene	1	9063713	< 0.001	< 0.001	NA	< 0.001	86%	70%	130%	81%	70%	130%	NA		
Ethylbenzene	1	9063713	< 0.001	< 0.001	NA	< 0.001	89%	70%	130%	83%	70%	130%	NA		
Xylene (Total)	1	9063713	< 0.002	< 0.002	NA	< 0.002	91%	70%	130%	87%	70%	130%	NA		
C6-C10 (less BTEX)	1	9063713	< 0.01	< 0.01	NA	< 0.01	101%	70%	130%	100%	70%	130%	92%	70%	130%
>C10-C16 Hydrocarbons	1	9063721	< 0.05	< 0.05	NA	< 0.05	98%	70%	130%	107%	70%	130%	110%	70%	130%
>C16-C21 Hydrocarbons	1	9063721	< 0.10	< 0.10	NA	< 0.10	98%	70%	130%	107%	70%	130%	110%	70%	130%
>C21-C32 Hydrocarbons	1	9063721	<0.1	<0.1	NA	< 0.1	104%	70%	130%	107%	70%	130%	110%	70%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved															
Benzene	1	9063729	< 0.03	< 0.03	NA	< 0.03	83%	60%	140%	79%	60%	140%	NA		
Toluene	1	9063729	< 0.04	< 0.04	NA	< 0.04	88%	60%	140%	76%	60%	140%	NA		
Ethylbenzene	1	9063729	< 0.03	< 0.03	NA	< 0.03	89%	60%	140%	76%	60%	140%	NA		
Xylene (Total)	1	9063729	< 0.05	< 0.05	NA	< 0.05	92%	60%	140%	80%	60%	140%	NA		
C6-C10 (less BTEX)	1	9063729	< 3	< 3	NA	< 3	93%	60%	140%	87%	60%	140%	83%	30%	130%
>C10-C16 Hydrocarbons	1	9063867	< 15	< 15	NA	< 15	100%	60%	140%	108%	60%	140%	121%	30%	130%
>C16-C21 Hydrocarbons	1	9063867	< 15	< 15	NA	< 15	99%	60%	140%	108%	60%	140%	121%	30%	130%
>C21-C32 Hydrocarbons	1	9063867	< 15	< 15	NA	< 15	106%	60%	140%	108%	60%	140%	121%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Water Analysis

RPT Date: Feb 21, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Dissolved Metals															
Dissolved Aluminum	9063722	9063722	12	13	NA	< 5	111%	80%	120%	107%	80%	120%	87%	70%	130%
Dissolved Antimony	9063722	9063722	<2	<2	NA	< 2	102%	80%	120%	111%	80%	120%	111%	70%	130%
Dissolved Arsenic	9063722	9063722	<2	<2	NA	< 2	102%	80%	120%	102%	80%	120%	109%	70%	130%
Dissolved Barium	9063722	9063722	16	16	NA	< 5	101%	80%	120%	101%	80%	120%	111%	70%	130%
Dissolved Beryllium	9063722	9063722	<2	<2	NA	< 2	113%	80%	120%	111%	80%	120%	119%	70%	130%
Dissolved Bismuth	9063722	9063722	<2	<2	NA	< 2	108%	80%	120%	115%	80%	120%	NA	70%	130%
Dissolved Boron	9063722	9063722	6	6	NA	< 5	113%	80%	120%	111%	80%	120%	112%	70%	130%
Dissolved Cadmium	9063722	9063722	<0.017	<0.017	NA	< 0.017	100%	80%	120%	102%	80%	120%	105%	70%	130%
Dissolved Chromium	9063722	9063722	3	3	NA	< 1	102%	80%	120%	103%	80%	120%	101%	70%	130%
Dissolved Cobalt	9063722	9063722	<1	<1	NA	< 1	103%	80%	120%	102%	80%	120%	100%	70%	130%
Dissolved Copper	9063722	9063722	<2	<2	NA	< 2	105%	80%	120%	106%	80%	120%	100%	70%	130%
Dissolved Iron	9063722	9063722	<50	<50	NA	< 50	106%	80%	120%	111%	80%	120%	98%	70%	130%
Dissolved Lead	9063722	9063722	<0.5	<0.5	NA	< 0.5	106%	80%	120%	105%	80%	120%	101%	70%	130%
Dissolved Manganese	9063722	9063722	84	85	1.8%	< 2	104%	80%	120%	107%	80%	120%	NA	70%	130%
Dissolved Molybdenum	9063722	9063722	<2	<2	NA	< 2	99%	80%	120%	105%	80%	120%	85%	70%	130%
Dissolved Nickel	9063722	9063722	3	3	NA	< 2	105%	80%	120%	109%	80%	120%	106%	70%	130%
Dissolved Selenium	9063722	9063722	<1	<1	NA	< 1	101%	80%	120%	99%	80%	120%	108%	70%	130%
Dissolved Silver	9063722	9063722	<0.1	<0.1	NA	< 0.1	105%	80%	120%	103%	80%	120%	85%	70%	130%
Dissolved Strontium	9063722	9063722	57	59	2.9%	< 5	103%	80%	120%	104%	80%	120%	NA	70%	130%
Dissolved Thallium	9063722	9063722	<0.1	<0.1	NA	< 0.1	106%	80%	120%	112%	80%	120%	108%	70%	130%
Dissolved Tin	9063722	9063722	<2	<2	NA	< 2	98%	80%	120%	103%	80%	120%	97%	70%	130%
Dissolved Titanium	9063722	9063722	<2	<2	NA	< 2	109%	80%	120%	111%	80%	120%	95%	70%	130%
Dissolved Uranium	9063722	9063722	0.2	0.2	NA	< 0.1	104%	80%	120%	104%	80%	120%	103%	70%	130%
Dissolved Vanadium	9063722	9063722	<2	<2	NA	< 2	100%	80%	120%	102%	80%	120%	103%	70%	130%
Dissolved Zinc	9063722	9063722	7	8	NA	< 5	100%	80%	120%	101%	80%	120%	107%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Modified TPH (Tier 1)	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
% Moisture		Calculation	GRAVIMETRIC

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K310811

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	SM 3125	ICP-MS

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 4.3
Hold Time:
AGAT Job Number: 18K310811
Notes: metals for soil

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☐ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3868

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☑ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☐ Total ☑ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P205)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
3113-FHM1-1.0-WS1	February 4, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservatives			✓								✓												
3113-FHM1-1.25-WS1	February 4, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservatives			✓								✓												

Samples Relinquished By (Print Name):	Date/Time	Samples Received By (Print Name):	Date/Time
David Gale	Feb. 13/18	Emma Penney	Feb. 13/18
Samples Relinquished By (Sign):	Date/Time	Samples Received By (Sign):	Date/Time
		Emma Penney	10:46pm

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White Copy- AGAT

Document ID: DM-133-1501.002
Date revised: January 2016

AGAT Laboratories

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Dartmouth, NS
B3B 1M2
webearth.agatlabs.com • www.agatlabs.com
P: 902.468.8718 • F: 902.468.8924

Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 4.3
Hold Time:
AGAT Job Number: 18K310811
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3868

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☑ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☐ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☐ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☐ Total ☑ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P205)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
3113-FHM2-2.0-WS1	February 5, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-FHM3-2.0-WS1	February 5, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-FHM4-1.25-WS1	February 4, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-FHM5-2.0-WS1	February 5, 2018	Water	3x40, 2x250 mL	All bottles with preservative											✔													
3113-FHM7-2-2.0-WS1	February 6, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-FHM9-2.0-WS1	February 5, 2018	Water	3x40, 1x100, 2x250 mL	All bottles with preservative			✔								✔													
3113-P0-1-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P1-1-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P1-2-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P1-3-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative			✔								✔													
3113-P2-1-SS1	February 7, 2018	Soil	2x40, 1x250mL	2 of 40 mL vial with preservative											✔													
3113-P2-2-SS1	February 7, 2018	Soil	2x40. 1x250 mL	2 of 40 mL vial with preservative			✔								✔													

Samples Relinquished By (Print Name):	Date/Time	Samples Received By (Print Name):	Date/Time
David Gale	Feb. 13/18	Emma Penney	Feb. 13/18
Samples Relinquished By (Sign):	Date/Time	Samples Received By (Sign):	Date/Time
		Emma Penney	10:40am

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N°: FFC-3113-COC-06

Document ID: UG-133-1501.002
Date revised: January 2016

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 4.3
Hold Time:
AGAT Job Number: 18K310811
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To
Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3868

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☑ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube

☐ CCME
☐ Industrial
☐ Commercial
☐ Res/Park
☐ Agricultural
☐ FWAL
☐ Sediment

☐ CDWQ
☐ NSEQS-Cont Sites
☐ HRM 101
☐ Storm Water
☐ Waste Water
☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☐ Total ☑ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P205)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
3113-P2-3-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P2-4-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P3-1-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P3-2-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative			✔								✔													
3113-P3-3-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P3-4-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P3-5-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P4-1-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P4-2-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P4-3-SS1	February 7, 2018	Soil	2x40, 1x250 mL	2 of 40 mL vial with preservative											✔													
3113-P4-4-SS1	February 7, 2018	Soil	2x40, 1x250mL	2 of 40 mL vial with preservative											✔													

Samples Relinquished By (Print Name):	Date/Time	Samples Received By (Print Name):	Date/Time
David Gale	Feb. 13/18	Emma Penney	Feb-13/18
Samples Relinquished By (Sign):	**Date/Time**	**Samples Received By (Sign):**	**Date/Time**
		Emma Penney	10:46 am

Pink Copy - Client
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White Copy- AGAT

N°: FFC-3113-COC-06

Document ID: DIV-133-1501.002
Date revised: January 2016

APPENDIX C

Technical Memorandum FFC-NL-3113-007

Assessment of the Groundwater Supply Potential from the Overburden Aquifer – Field Data and 3-D Model Simulations, Stephenville, NL

Assessment of the Groundwater Supply Potential from the Overburden Aquifer – Field Data and 3D Model Simulations Stephenville, NL

Prepared by:

Fracflow Consultants Inc.
154 Majors Path
St. John's, NL
A1A 5A1

Submitted to:

Marine Harvest Atlantic Canada
#124 - 1334 Island Highway
Campbell River, BC
V9W 8H9

PROVINCE OF NEWFOUNDLAND
PERMIT HOLDER
CLASS "A"
This Permit Allows
FRACFLOW CONSULTANTS INC.
To practice Professional Engineering
in Newfoundland and Labrador.
Permit No. as issued by APEGN D0169
which is valid for the year 2018.

REGISTERED PROFESSIONAL ENGINEER
JOHN E. GALE
SIGNATURE
May 9, 2018
DATE
PROVINCE OF NEWFOUNDLAND

File 3113

April 30, 2018

Executive Summary

In 2009, Fracflow conducted an initial hydrogeological assessment of an area adjacent to the Port of Stephenville (Port Harmon) to determine the potential for developing a water supply for a proposed fish hatchery (Northern Harvest Sea Farm – now Northern Harvest Smolt Limited - NHSL) which was subsequently constructed. This investigation included constructing several monitoring wells and a 150 mm diameter test well. The water supply for Northern Harvest Smolt Limited was developed in the area of the NHSL test well by constructing two (2) new 200 mm diameter production wells and by converting the 150 mm diameter test well to a production well to provide additional water as needed. These production wells have been operating for a number of years at combined flowrates that range from 2,000 Lpm to 4,000 Lpm.

As part of the overall groundwater assessment that is required to determine if sufficient groundwater exists to meet the needs of a potential fish hatchery expansion, additional monitoring wells were constructed to map the water table gradient in the area of interest and to construct a 3D groundwater flow and transport model of the groundwater flow system. In addition, a 200 mm diameter test well to 80 m of depth was constructed at the location of a future production well to determine potential well yields and water chemistry in that part of the aquifer. The 3D model was constructed and used to simulate the groundwater flow system as a basis for assessing the long-term groundwater yield for this area with reference to the known areas of environmental impact from the US air force activities and the linerboard mill, in the form of old landfills and oil spills.

Water level measurements in the new monitoring wells show that there is a water table gradient of approximately 0.004 to 0.0065, oriented NNE to SSW with the main recharge area located north of the main bog/marsh area. Laboratory analysis of groundwater samples collected from the three (3) new monitoring wells and from the two (2) main water supply wells for the existing fish hatchery operation did not detect the presence of any contaminants from any of the known potential contaminant sources in the immediate area.

The 3D numerical flow and transport model was constructed, using the FEFLOW software, of the area that is expected to contribute recharge to the existing well field and to any new wells that may be constructed as part of the fish hatchery expansion. This 3D model was used to simulate the withdrawals from the existing production wells and identify the location of and simulate groundwater withdrawal from new production wells to establish a reasonable estimate of the long term well yields for the aquifer system in the fish hatchery area. A simplified conceptual hydrogeological model of the aquifer and well field capture area plus the adjacent hydrogeological buffer areas was developed for use in modeling the groundwater flow and the potential impacts of changes and variations in recharge on the groundwater withdrawals. Recharge estimates were determined by completing a water budget analysis using historical climatic data and assumptions related to the water budget components. The hydro-stratigraphy in the model was developed from the existing test well and monitoring well database and by making assumptions with respect to the underlying bedrock topography. The hydraulic

conductivity and porosity values that were assigned to the model were obtained from the aquifer data on the test and production wells and grain size analysis of soil samples collected during well drilling.

Determining the sustainable long-term supply of groundwater for an area requires that the annual production rate (output) not exceed the rate of recharge (input) from precipitation within the catchment area of interest. Based on the analysis of the climatic data, we have estimated that the recharge through the marsh covered areas of the granular aquifer can be assigned at a maximum rate of 368 mm per year and that other areas that are not predominantly covered by marsh have a maximum recharge rate of 294 mm per year. The 3D model was used to assess and adjust those recharge estimates by calibration against the measured hydraulic heads and aquifer test data. The final recharge values and hydraulic conductivity values were used in the 3D model to compute the response of the aquifer to the expected withdrawal rates that would be required for the fish hatchery expansion.

The model simulations demonstrated that most of the surface water bodies are perched and are not connected directly to the aquifer water table. The proposed fish hatchery expansion well field, consisting of three (3) production wells each producing at a rate of 1,820 Lpm, was simulated. The drawdown and capture areas for this simulated withdrawal rate of 5,460 Lpm is superimposed on the aquifer response to the withdrawal rates, of approximately 3,600 Lpm, from the two (2) existing fish hatchery production wells. The effects of extracting this volume of groundwater is to lower the hydraulic heads over a broad area if no constant head recharge boundaries are encountered such as ponds and streams that are directly connected to the granular aquifer. Even with the five (5) wells operating at full capacity, the steady state drawdown of 1.0 m is contained within the drainage basin boundaries. Equally important, the 3D model computed pathways and travel times for water arriving at the well field, based on a porosity of 25%, indicates that the ground water from the water supply wells is being recharged in the upper part of the drainage basin, along with the water that is being recharged directly over the immediate well field area. The travel times indicate that groundwater will move approximately 1 km in four (4) years under the influence of these combined aquifer withdrawals. Also the particle track simulations show that none of the known contaminant sources are contributing groundwater to the well field under the drawdown conditions that were simulated. The steady state 3D model simulations indicate that the projected demand withdrawals of 9,060 Lpm, or 4.7 million cubic metres of water per year, will not produce excessive drawdowns in the aquifer.

In addition to the 3D model simulations, water availability from the granular aquifer can be assessed using simple ball-park calculations based on Darcy's Law, using measured values of the hydraulic gradient and hydraulic conductivity and assumed values for the thickness and extent of the aquifer in the area that is not overlain by the marsh. This calculation gives a flux of 2.8 to 5.7 million cubic metres per year towards that part of the granular aquifer in which the well fields are or will be located. Groundwater recharge over the up-gradient part of the drainage basin, where this water is recharged, with a recharge estimated at 294 mm per year, would be 3.56 million cubic metres per year, not accounting for any contribution from the underlying

bedrock. Using an estimated recharge rate of 368 mm per year, the volume of water that is recharged through the larger section of marsh that immediately overlies the granular aquifer in which the well field is located would be approximately 1.386 million cubic metres of water per year. For reference, a production well that is producing 2,000 Lpm will extract approximately 1.05 million cubic metres of groundwater per year. Based on these ball-park calculations, the aquifer is estimated to have a sustained yield in the range of 4.2 to 7.0 million cubic metres of water per year.

Also, for comparison purposes, if the granular aquifer is assumed to be 50 m thick with porosity that ranges from 25% to 30%, the groundwater that is stored in the granular aquifer under the immediate marsh area is estimated at 48 to 58 million cubic metres. Again, potential contributions from the bedrock aquifer that is assumed to underlie the granular aquifer have not been considered. Additional work is underway to evaluate how the precipitation infiltrates and moves through the marsh areas to provide support to the estimated recharge rates. In addition, nested piezometers will be constructed into the bedrock to assess the role that the bedrock aquifer system may play in recharging the granular aquifer. These data will be used to construct a 3D transient model that incorporates the full well field production history of the existing well field to compare the simulated and measured aquifer response to the well field operation. This 3D model will be used to design a real-time monitoring system for the well fields that will supply existing and any future expansion of the water supply system.

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1.0 BACKGROUND

In 2009, Fracflow conducted an initial hydrogeological assessment of an area (**Figures 1** and **2**) adjacent to the Port of Stephenville (Port Harmon) to determine the potential for developing a water supply for a proposed fish hatchery (Northern Harvest Sea Farm – now Northern Harvest Smolt Limited - NHSL) which was subsequently constructed. The 2009 assessment consisted of augering three (3) boreholes and constructing three (3) monitoring wells and drilling a 150 mm diameter, screened, test water well to determine the approximate groundwater yield from the aquifer. The aquifer was found to consist of sands and gravels to some unknown depth, greater than 60 m, and to have a high permeability. However, the vertical overburden column included a low permeability paleosurface surface, locally, at approximately 5 m to 6 m below ground surface which impedes local groundwater recharge and creates a perched water table. The actual water table is approximately 20 m below the ground surface. The continuity of the paleosurface is unknown.

The water supply for Northern Harvest Smolt Limited was developed in the area of the NHSL test well by constructing two (2) new 200 mm diameter production wells and by converting the 150 mm diameter test well to a production well to provide additional water as needed. These production wells have been operating for a number of years at combined flowrates that range between 2,000 Lpm to 4,000 Lpm. The source and recharge areas for the NHSL well field has never been fully defined. As part of the overall groundwater assessment that is required to determine if sufficient groundwater exists to meet the needs of a new fish hatchery, Marine Harvest Atlantic Canada (MHAC) engaged Fracflow Consultants to construct additional monitoring wells to map the water table gradient in the area of interest and to construct a 3D groundwater flow and transport model (**Figures 3, 4** and **5**) of the groundwater flow system. In addition, MHAC engaged Fracflow to construct and test a full size test well at the location (**Figure 5**) of a future production well to determine potential well yields and water chemistry. The details of this test well construction, which was drilled to 80 m below ground surface, and aquifer test data are provided in a separate Technical Memo (**FFC-NL-3113-006**). The 3D model was constructed and used to simulate the groundwater flow system as a basis for assessing the long-term groundwater yield for this area with reference to the known areas of environmental impact from the US air force activities and the linerboard mill, in the form of old landfills and oil spills as defined by Fracflow's 2006 and 2009 Phase 1 and Phase 2 work for Abitibi in this area.