Figure 5 FEFLOW mesh (plan view) in the area of production wells (existing and proposed) with features incorporated in the 3D flow model.

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2.0 AQUIFER WIDE WATER TABLE VARIATIONS

The first step in assessing the local groundwater potential was to determine the nature of the recharge to the aquifer by determining the water table gradient. Given the lack of water table elevation data, three (3) new monitoring wells were constructed (BH1, BH2 and BH3 in **Figure 2**). The logs for these three (3) boreholes are provided in **Appendix A**. The depth to water in BH1 was 19.17 m bgs, 19.51 m bgs in BH2 and 11.95 m in BH3. The water table elevation, below the perched water table, was 12.275 m in BH1, 12.277 m in BH2 and 16.186 m in BH3. An additional 11 existing monitoring wells were surveyed by Enos Fudge Surveys and the water table elevations were measured in those wells (**Figure 2**). These water table measurements 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 area. However, it is expected that while the bog and ponds constitute a perched water table system, there is significant recharge from this perched water table to the deeper groundwater system.

The new MHAC Test Well was constructed within 100 m of the BH2 monitoring well. The generalized well log for this Test Well is also included in **Appendix A**.

3.0 GROUNDWATER CHEMISTRY - NHSL PRODUCTION WELLS, NEW MONITORING WELLS AND MHAC TEST WELL

Groundwater samples were collected from the three (3) new monitoring wells and from the two (2) main water supply wells for the existing fish hatchery. The water was analyzed for general chemistry, total and dissolved metals and low level BTEX/TPH. Water samples were also collected from the MHAC Test Well during the 72-hour aquifer test. The laboratory data for all three (3) sets of water samples are presented in Appendix B.

The groundwater samples showed consistent water chemistry, typical TDS, fluid conductivity and pH values for the groundwater in this immediate area. The total iron levels in BH2 and BH3 are elevated which is consistent with the higher turbidity levels in these two (2) monitoring wells. The dissolved iron levels are not elevated. It is expected that when a water supply well is fully developed the turbidity level will decrease and the total metals iron level will also decrease to an acceptable level. The five (5) different water samples that were collected from the MHAC Test Well during the 72-hour aquifer test (**Appendix B**) show a consistent pattern of stable to decreasing metal levels. Note that approximately eight million litres of water was pumped from the aquifer during this 72-hour aquifer test. The first water sample from the Test Well had elevated zinc levels but the zinc levels dropped below guideline values in the remaining four (4) water samples from the 72-hour aquifer test.

Each sample was analyzed for BTEX/TPH using a low-level detection approach and no detectable BTEX/TPH was reported in any of the water samples. BH1 showed a Fluoride concentration that was 0.16 mg/L versus the Fresh Water Aquatic Guidelines of 0.12 mg/L. Since the laboratory measured value is very close to the detection level, this monitoring well will be resampled to see if one can determine if the Fluoride is still present in the groundwater and if so the source of the Fluoride. However, there are no current plans to develop a production well that would draw significant volumes of water from the area of MW1.

4.0 AQUIFER PROPERTIES ESTIMATED FROM GRAIN SIZE DISTRIBUTIONS AND AQUIFER TEST

Each monitoring well borehole was completed using hollow stem augers and split spoon samples were collected at regular intervals. The aquifer material in those samples consists of fine sand, some silt or clay particles, gravel with some cobbles and occasional boulders. The split spoon samples that were collected from below the water table were analyzed and the grain size distribution determined. In addition, during the drilling of the MHAC Test Well, composite samples were collected at 1.5 m intervals and grain size distributions were determined for selected drill cutting samples from the borehole section in which the well screen was placed for this MHAC Test Well. The grain size data are included in **Appendix C** and show that nearly all of overburden samples that were collected from below the water table had grain sizes such that 50% of the grain diameters were greater than 0.5 mm. The grain size data were used to determine the slot size for screened wells since the general approach is to allow for 50% of the aquifer particles to pass through the well screen during well development in order to develop a natural gravel pack around the well screen. Based on these grain size distributions, a slot 20 well screen was selected as a suitable slot size for a well screen where a natural gravel pack will be developed. If an artificial gravel pack is installed, using a #2 sand, then a slot 40 well screen can be utilized.

The grain size data were used to compute the hydraulic conductivity values for the split-spoon samples that were collected below the water table using the Hazen method (Fetter, 2001) as,

$$K = C(d_{10})^2$$

where K is hydraulic conductivity (cm/s), d_{10} is the effective grain size (cm), and C is a coefficient with a range as shown in **Table 1**. The method is generally applicable for sand with the effective grain size ranged from 0.01 cm to 0.3 cm. The effective grain size from the eleven (11) analyzed samples ranged from 0.007 cm to 0.012 cm and the computed hydraulic conductivity values ranged from 4.41E-03 to 1.44E-02 cm/s (**Table 1**). An additional eleven (11) drill cutting samples from the Test Well (**Table 2)** were analyzed and effective grain size ranged from 0.0087 cm to 0.027 cm and the computed hydraulic conductivity values ranged from 6.06 E-03 to 7.29 E-02 cm/s for the selected Hazen coefficients.

The grain size data from the different depth levels are consistent. However, it should be noted that the procedure used to capture drill cuttings is biased towards the larger grain sizes.

Table 1 Hydraulic conductivities calculated from the grain size distribution data from the monitoring wells using the Hazen method.

Sample ID	d_{10}		d_{60}	$C^{(1)}$	K		C_{min}	C_{max}	K_{min}	K_{max}
	mm	*cm*	*mm*	--	*cm/s*	*m/s*	--	--	*cm/s*	*cm/s*
BH1-SS14	0.089	0.0089	0.6	90	7.13E-03	7.13E-05	80	120	6.34E-03	9.51E-03
BH1-SS15	0.094	0.0094	2	90	7.95E-03	7.95E-05	80	120	7.07E-03	1.06E-02
BH1-SS17	0.07	0.007	0.6	90	4.41E-03	4.41E-05	80	120	3.92E-03	5.88E-03
BH2-SS17	0.113	0.0113	0.675	100	1.28E-02	1.28E-04	80	120	1.02E-02	1.53E-02
BH2-SS18	0.088	0.0088	0.7	110	8.52E-03	8.52E-05	80	120	6.20E-03	9.29E-03
BH2-SS19	0.092	0.0092	0.95	90	7.62E-03	7.62E-05	80	120	6.77E-03	1.02E-02
BH2-SS20	0.105	0.0105	0.85	100	1.10E-02	1.10E-04	80	120	8.82E-03	1.32E-02
BH3-SS13	0.097	0.0097	0.35	90	8.47E-03	8.47E-05	80	120	7.53E-03	1.13E-02
BH3-SS15	0.12	0.012	0.63	100	1.44E-02	1.44E-04	80	120	1.15E-02	1.73E-02
BH3-SS18	0.092	0.0092	0.565	100	8.46E-03	8.46E-05	80	120	6.77E-03	1.02E-02
BH3-SS20	0.09	0.009	0.685	110	8.91E-03	8.91E-05	80	120	6.48E-03	9.72E-03

Table 2 Hydraulic conductivities calculated from the grain size distribution data from the MHAC Test Well using the Hazen method.

Sample ID	d_{10}		$C^{(1)}$	K		C_{min}	C_{max}	K_{min}	K_{max}
	mm	*cm*	--	*cm/s*	*m/s*	--	--	*cm/s*	*cm/s*
MHPW1-160-165	0.16	0.016	80	2.05E-02	2.05E-04	70	90	1.79E-02	2.30E-02
MHPW1-165-170	0.16	0.016	80	2.05E-02	2.05E-04	70	90	1.79E-02	2.30E-02
MHPW1-170-175	0.17	0.017	90	2.60E-02	2.60E-04	80	100	2.31E-02	2.89E-02
MHPW1-175-180	0.16	0.016	90	2.30E-02	2.30E-04	80	100	2.05E-02	2.56E-02
MHPW1-180-185	0.1	0.01	80	8.00E-03	8.00E-05	70	90	7.00E-03	9.00E-03
MHPW1-185-190	0.095	0.0095	80	7.22E-03	7.22E-05	70	90	6.32E-03	8.12E-03
MHPW1-190-195	0.087	0.0087	80	6.06E-03	6.06E-05	70	90	5.30E-03	6.81E-03
MHPW1-195-200	0.12	0.012	90	1.30E-02	1.30E-04	80	100	1.15E-02	1.44E-02
MHPW1-200-205	0.265	0.0265	100	7.02E-02	7.02E-04	90	110	6.32E-02	7.72E-02
MHPW1-205-210	0.27	0.027	100	7.29E-02	7.29E-04	90	110	6.56E-02	8.02E-02
MHPW1-210-215	0.26	0.026	100	6.76E-02	6.76E-04	90	110	6.08E-02	7.44E-02

Note: (1) Table for coefficient ***C*** by *Hazen* (1911).

40 - 80	Very fine sand, poorly sorted
40 - 80	Fine sand with appreciable fines
80 - 120	Medium sand, well sorted
80 - 120	Coarse sand, poorly sorted
120 - 150	Coarse sand, well sorted, clean

Slug tests (falling head test) were conducted in the three (3) boreholes, BH1, BH2 and BH3 on November 27, 2017. The hydraulic conductivities were calculated using the Hvorslev method (Fetter, 2001) as,

$$K = \frac{r^2 \, ln(L_e/R)}{2 \, L_e \, T_0}$$

where K is hydraulic conductivity (L/T; m/s), r is the radius of the well casing (L; m), R is the radius of the well screen (L; m), L_e is the length of the well screen (L; m), and T_o is the time it takes for the water level to rise or fall to 37 percent of the initial change (T; sec). The above formula applies when the length of the piezometer/well screen is more than eight (8) times the radius of the well screen ($L_e/R > 8$) and the ratio was greater than 300 for the three (3) boreholes, BH1, BH2 and BH3. The time to fall to 37 percent (T_o) of the initial change ranged from 5 to 10 seconds for the three (3) slug tests, and the computed hydraulic conductivities ranged from 1.16E-02 cm/s to 2.10E-02 cm/s (**Table 3**).

Table 3 Hydraulic conductivities calculated from the slug tests using the Hvorslev method.

Borehole ID	***Hydraulic Conductivity (K)***	
	cm/s	***m/s***
BH1	2.10E-02	2.10E-04
BH2	1.49E-02	1.49E-04
BH3	1.16E-02	1.16E-04

Hydraulic conductivity (K) values that were calculated from the 72-hour aquifer test data (**FFC-NL-3113-006)** using the later time drawdown data and the Neuman unconfined aquifer type curves (Fetter, 2001) produced a K-value of 5.52×10^{-5} m/s for an assumed aquifer thickness of 50 m. Fitting the early time data to the Neuman type curves produced a K-value of 1.63×10^{-5} m/s. For comparison purposes, the pumping well data were also analyzed using the Cooper-Jacob semi-log or time drawdown data, which is used to analyze observation well data in a confined aquifer, with the analysis based on the later time data produced a K-value of $8.51 \times 10\text{-}^{4}$ m/s. Also, the drawdown data from monitoring well BH2 were analyzed using the Cooper-Jacob time drawdown procedure (generally referred to as the straight-line procedure) which produced a K-value of 7.11×10^{-4} m/s and a storativity of 0.0948 - which is consistent with the storativity values that are expected for either an unconfined aquifer or a very leaky semi-confined aquifer.

5.0 3D FLOW AND TRANSPORT MODEL BOUNDARIES

A 3D model that was constructed in 1999 for the Town of Stephenville was based on MODFLOW, a finite difference code and did not include the area of the existing fish hatchery well field or the potential sites of water supply wells for a new fish hatchery. For the purposes of conducting a groundwater assessment of the aquifer that is expected to supply water to both fish hatcheries, the new model boundaries (Figures 1 and 3) were selected to include most of the drainage basin in which the well fields for the Town of Kippens and the Town of Stephenville are located as well as the key areas of the drainage basin in which the overburden aquifer is located. In addition, the model area in the new model has been extended to a broader area to capture the more extensive watershed boundaries and to enable the assessment of how the different proposed well field locations and withdrawal rates may impact the yield from existing well fields or wells and the long-term yield from other water supply areas. Development of the larger aerial model allowed the historical well field performance data from the existing well fields to be used to calibrate the model and to confirm whether or not the individual well fields interact and, by doing so, provide an assessment of the overall groundwater capacity for the general area. Based on the calibrated flow model under the current condition of the groundwater extraction by the existing well field, the impact of any potential contaminates such as the leachate from the abandoned and active landfills can be assessed by computing travel times and pathways.

This new model will allow the stakeholders to address any questions that might be raised relative to the interference between well fields or competing water supplies. In addition, this extensive, but detailed, groundwater flow model will enable the stakeholders to refine the watershed boundaries, and provide a basis for developing a well field protection plan for both the existing and new well fields. This model will also permit the simulation of different operational scenarios for the existing pumping wells, identify the location of and simulate the 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. The boundaries of this new model were extended to the east to capture the area around Mine Pond and the old Abitibi landfills and part of their up-gradient drainage basins.

The modelling simulations were performed using FEFLOW (Finite Element subsurface Flow System). FEFLOW (Diersch, H. -J. G., 2005) is an advanced, finite element code that is used to model groundwater flow and transport in both porous media and fractured-bedrock systems. The transport portion of the FEFLOW code allows the user to track the movement of particles, or tracers, along discrete flow lines to map the direction of movement and travel time of water and conservative as well as non-conservative ions between points of interest. Unlike the finite difference code, the finite element approach is more suited to simulate multiple production and observation wells because the mesh around the production wells can be refined locally resulting in a significantly smaller number of number of grid points and simulation time than the finite difference code.

A simplified conceptual hydrogeological model of the aquifer and well field capture area plus adjacent hydrogeological buffer areas was developed for use in modelling the groundwater flow and the potential impacts of changes and variations in recharge on the groundwater withdrawals. The conceptual hydrogeological model was constructed based on a combination of the available hydrogeological data and informed judgement. Every attempt was made to incorporate field measurements collected at the site during this study and previous studies. However, assumptions were still required in most locations since the data coverage is sparse in some areas.

6.0 MODEL CONSTRUCTION AND BOUNDARY CONDITIONS

The overall study area or model domain selected for the groundwater flow system simulation covers approximately 166.4 km^2 (**Figure 3**). The study area was divided into a number of discrete nodes and triangle elements for which all of the hydrogeological parameters were assigned. The nodal points define the corners of a series of polygonal elements that have been specified across the surface of the study area, at strategic locations, creating what is referred to as the surface mesh (**Figures 3, 4** and **5**). The surface mesh was constructed using 79,981 nodal points and 158,298 elements. The surface width of the elements in the far-field areas away from the production wells and monitoring wells varies between 50 m and 100 m. The elements in the near-field area around those wells varied between 10 m to 25 m to permit more detailed discretization of the hydrogeological conditions around the wells (**Figure 5**). The grid was also smoothed to remove any obtuse angles within each element. Without grid smoothing, abrupt changes in grid spacing could have caused non-convergence of the numerical solution. The elements around each production well location were refined (subdivided) further to accommodate the actual well size (**Figure 5**). The smallest element at each well centre was 0.6 m in length. In the vertical direction, the domain was divided into 12 layers (13 slices) with a combined thickness of 250 m. This produced a 3D model with 1,039,753 nodes and 1,899,576 elements. **Figure 6** is a cross-section of the model which illustrates the 3D model geometry, with a cut-out showing the distribution of hydraulic conductivity within the model.

For locations where the surface water could not be used to define boundary conditions, the perimeters of the drainage basins or hydraulic boundaries were defined by assuming that groundwater divides coincide with topographic divides. The streams/brooks located in the interior of the drainage basin were specified as constant head boundaries where this condition was supported by the water table elevations. The values of the constant head cells that were assigned along the brooks corresponded to an elevation that was slightly lower than the ground surface elevation for each cell that was used to define the brooks. The constant-head boundaries were only specified for the top slice of the model layer. For most cases, it was implicitly assumed that the streams/brooks were no deeper than the top layer (i.e., 10 m) of the model. Considering that streams/brooks in this area are generally not deeply incised features, this was considered a reasonable assumption. A constant hydraulic head of 1 m above sea level was assigned to the ocean boundary along the outer shoreline and to the Port Stephenville to reflect average tide conditions. This boundary condition was applied to all layers of the model along the outer shoreline except the bottom layer. In coastal environments, groundwater flow is generally directed upwards as the sea boundary is approached and the model boundary is assigned a no-flow boundary condition. This assignment is based on the expected response to the density contrast between seawater and the overlying fresh water. In this situation the seawater effectively acts as an impermeable boundary to flow unless the horizontal hydraulic conductivities are much higher than the vertical hydraulic conductivities. However, for this site the layered nature of the granular aquifer results in significant flow of ground water into the ocean from each layer.

The surface/ground elevation for the modeling domain was constructed based on a digital elevation model (DEM) data set derived from a set of ortho-rectified images (Department of Fisheries and Land Resources). The surface elevation for each surface node in the model was assigned using one of the FEFLOW's interpolation routines (i.e., inverse distance-squared method).

The stratigraphy used in the model was based in part on the borehole data base from the government files and Fracflow's internal data files but is based primarily on the detailed overburden sampling to depths of up to 80 m that was completed by Fracflow Consultants Inc. for Marine Harvest Atlantic Canada in the immediate area of the proposed well field. The model stratigraphy consisted of an upper bog and sand layer, sand layer with thin sporadic/scattered silt/clay layer, thick sand layer, and underlying bedrock. The bottom layer is assumed to be bedrock. However, the depth to the bedrock has not been confirmed in the existing production wells and the monitoring wells at the immediate well field area. In the new MHAC Test Well, a resistant layer was encountered at approximately 70 m of depth with the drill cuttings indicating the penetration of either a coarse-grained conglomerate or a coarse gravel in a clay matrix. The thickness assigned to each of the various model layers was estimated based on the available borehole information.

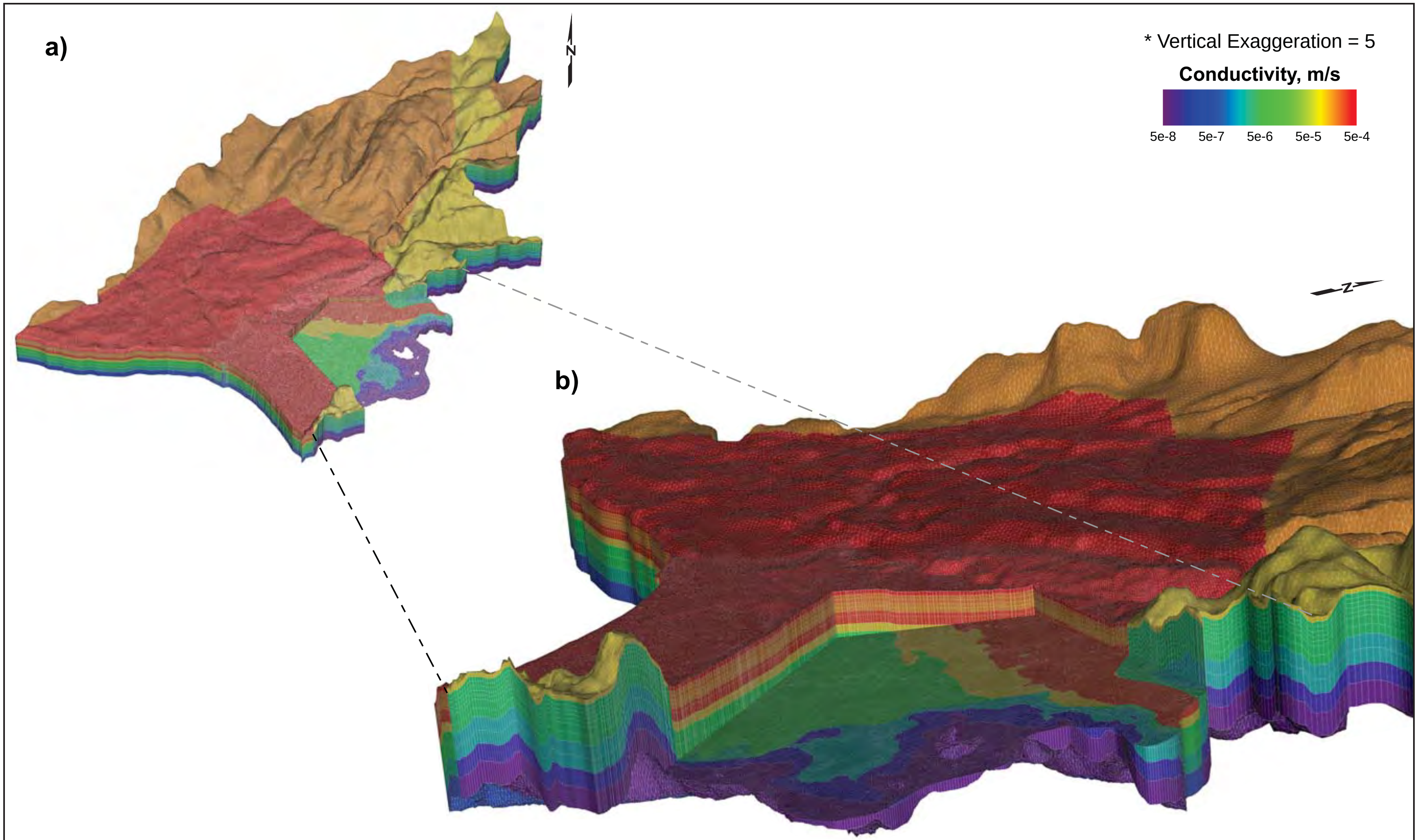

Figure 6 Plan view (a) and cross-section (b) of the 3D numerical model showing the assigned hydraulic conductivity values of the layers.

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7.0 WATER BUDGET AND WATER AVAILABILITY

The area from which the Marine Harvest Atlantic Canada fish hatchery would draw its groundwater supply is located partly within the drainage basin that drains into and includes Noel's Pond and Muddy Pond which is linked by a constructed/culverted channel to Noel's Pond. For the purposes of this discussion, Muddy Pond on which the pump house is located that has been used to pump water to Mine Pond to support the industrial facilities, now decommissioned, at what was then known as Port Harmon, will be considered to be part of Noel's Pond. The overall watershed is estimated to be approximately 54.6 km^2 (Acres 1994). However, the area that is of interest in terms of estimating groundwater recharge for the potential production wells for a new fish hatchery is much smaller and it includes the area through which Warm Creek (sometimes referred to as Noel's Pond Brook), passes as it flows through the small community of Noel's Pond on the Hansen Highway and into the impounded waters of Noel's Pond itself. The recharge area for the future water supply wells is also assumed to extend back to Long Pond. The Mine Pond (Gull Pond) drainage basin to the east side of the main drainage basin drains into Mine Pond which is also impounded. The overflow from the Mine Pond berm or dam drains as a perched water system along the eastern edge of the valley or marsh area and this surface perched stream flows into Port Harmon/Port of Stephenville following a small stream or brook that flows along the eastern edge of the old Abitibi mill site and a similar stream that flows along the west side of the old Abitibi mill site. There is no obvious surface drainage from the main marsh area and what surface drainage does take place is perched above the deeper water table.

The size and extent of the main granular aquifer is unknown. However, the granular aquifer is bounded to the east by a ridge of granitic rock that trends approximately north-south. On the west side, the granular aquifer is assumed to extend under the eastern side of the airport and part or all of Noel's Pond. The granular aquifer is also assumed to extend south to the harbour and out to the shoreline and north to the upland areas above the Hansen Highway. The existence of and the extent of a bedrock aquifer below the granular aquifer is assumed and its hydrogeological properties are assumed and have not been measured. Bedrock was assumed to have been intersected at approximately 70 m of depth in the MHAC Test Well. Both the Town of Stephenville and the Town of Kippens have constructed high yielding bedrock wells. This bedrock aquifer is assumed to extend under the granular aquifer and may contribute recharge from below to the granular aquifer.

For the purposes of this discussion, five (5) sub-Areas (**Figure 7**) or zones within the Noel's Pond or Warm Creek drainage basin have been identified as potential areas that recharge the groundwater aquifer system in this area. These areas include Zones 1 and 3 which are primarily marsh covered. Zone 2 which is covered by surface water, forested areas with ponds and streams and minor areas of pavement that are underlain by thick granular deposits, and Zone 4 that is covered by forest and small ponds but underlain by thin overburden over fractured granitic bedrock. In Zones 1 and 3, the near surface water table is perched with the actual water table from which the wells would draw their water being located some 10 to 20 m or more below the ground surface. In Zone 2, the water table is also some depth below the ground surface. In Zone 4, the water table is relatively shallow and this groundwater then recharges the area that is underlain by the marsh and the forest covered areas.

Areas/Zones 1 and 3 have a combined area of and 5.17 km^2, with 0.756 km^2 or 15% surface water bodies. Those surface water bodies or ponds are perched in that the elevation of the water level in those surface water bodies is above the elevation of the water table in the underlying granular aquifer.

Area 2 is 8.231 km^2 with 1.154 km^2 of surface water. Area 4 is 2.58 km^2 with 0.196 km^2 of surface water and Zone/Area 5, which represents the Mine Pond drainage basin is 5.198 km^2 with 0.882 km^2 of surface water. The existing Northern Harvest Smolt Limited well field and the Marine Harvest Test Well and proposed production wells are all located in the lower section of this marsh covered granular aquifer which has an area of 3.869 km^2 and surface water bodies of 0.49 km^2.

The recharge to Area 5 is assumed to discharge to Mine Pond and to the perched water table and surface water bodies below Mine Pond and then follow a perched stream that runs along the eastern boundary of the granular aquifer and discharges to the waters of the Port of Stephenville. This water is considered to contribute little to no recharge to the granular aquifer.

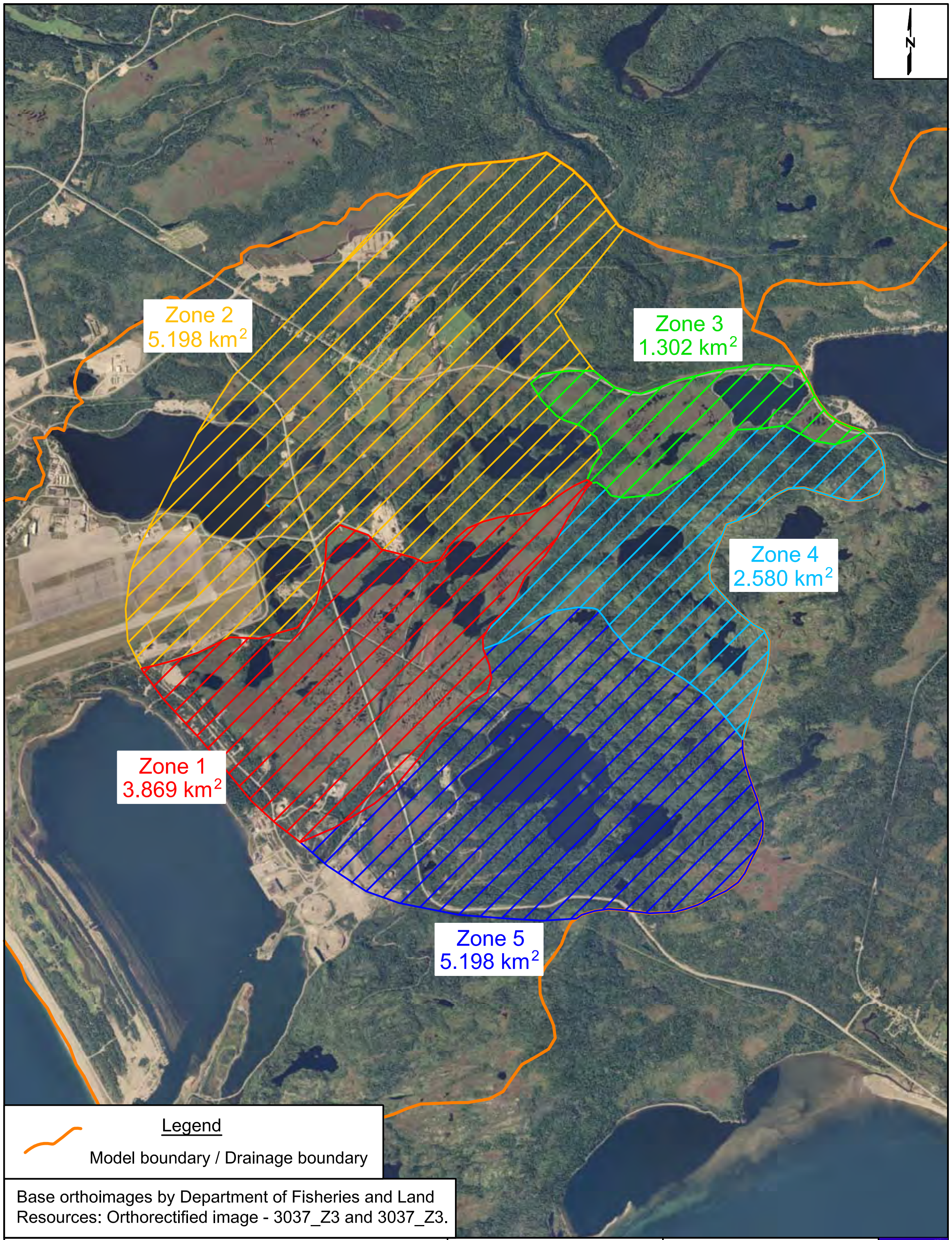
Area 4 is assumed to contribute recharge to the up-gradient side of the granular aquifer. Likewise Area 2 and 3 both contribute recharge to the up-gradient side of the granular aquifer.

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. Therefore, an assessment of the water balance (**Appendix D**) within the drainage basin in which Noel’s Pond/Warm Creek and the existing and proposed well fields are and may be located was carried out with adjustments made to the normal procedure for calculating recharge to reflect the conditions that exist in each of the five (5) sub-Areas as defined above.

Based on the analysis and climatic data provided in **Appendix D**, we have assumed that the recharge through the marsh covered areas of the granular aquifer can be assigned at a rate of 368 mm per year. Areas (Areas 2, 4 and 5) that are not predominantly covered by marsh have been assigned a recharge rate of 294 mm per year. The 3D model has been used to assess these recharge estimates.

Water availability can also be assessed using simple ball-park calculations. For example, since monitoring wells were installed across the aquifer with BH3 located up-gradient from the marsh covered area of the granular aquifer, the gradient on the water table aquifer in this area is known to range from 0.004 to 0.0065 m/m. Using a reference cross-section of 1,500 m, an assumed aquifer thickness of 50 m, a gradient or I of 0.006 m/m and a hydraulic conductivity (K) of 0.0002 to 0.0004 m/s, Darcy's Law, Q=KIA, gives a flux of 2.8 to 5.7 million cubic metres per year towards that part of the granular aquifer that is covered by marsh. By comparison, the up-gradient and trans-gradient areas have a combined area of more than 12 km^2. With a recharge estimated at 294 mm for part of this area, the total annual recharge would be 3.56 million cubic metres, 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 marsh layer into the underlying granular aquifer, in Area 1, is approximately 1.386 million cubic metres of water per year. For reference, a production well that is producing 2,000 litres per minute will extract approximately 1.05 million cubic metres of groundwater per year. Production wells that produce 5,000 litres per minute will extract approximately 2.5 million cubic metres of water per year from the aquifer.

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 marsh in Area 1, is estimated at 48 to 58 million cubic metres of groundwater. Again, potential contributions from the bedrock aquifer that is assumed to underlie the granular aquifer have not been considered.



Base orthoimages by Department of Fisheries and Land Resources: Orthorectified image - 3037_Z3 and 3037_Z3.

Figure 7 Sub-areas of recharge within the Noel's Pond or Warm Creek drainage basin.

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8.0 MODEL INPUT PARAMETERS AND MODEL CALIBRATION

The numerical flow model is controlled by a number of different input parameters which are assigned to simulate the hydrogeologic features of the model domain. These parameters include the assignment of the transmissive properties of the underlying materials (i.e., hydraulic conductivity), the assignment of points of known hydraulic head (discussed above) and the amount of infiltration or recharge. The model also includes the location, flow-rate and hydraulic head for any known groundwater sources or sinks.

The hydraulic conductivity (K) values were calculated and/or estimated based on the data collected from the new boreholes using falling-head tests in the wells, grain size analysis of the soil samples and the aquifer test data from the MHAC Test Well. In addition, data from Fracflow's in-house records were also reviewed to provide hydraulic conductivity (K) values for the layers. **Table 4** shows the thickness of each individual layer at the MHAC Test Well location, a brief description of each unit and the field measured or estimated K-values. The initial K-values were adjusted during the model calibration to ensure reasonable transmissivity values where the thickness of the unit varied, and the final assignments of both the horizontal hydraulic conductivities (K_h) and the vertical hydraulic conductivities (K_v) are shown in **Table 4**. Note that the vertical hydraulic conductivities are set equal to one fifth or one tenth of the horizontal hydraulic conductivities and that we assume that the K-values are isotropic in the horizontal plane.

Table 4 The hydraulic conductivity values assigned to the model layers for the three main areas of the model domain.

				Area, A1		***Area, A2***		***Surficial Area, A3***	
Layer (m)	Thick (m)	Depth (m)	Type	Kh (m/s)	Kv (m/s)	Kh (m/s)	Kv (m/s)	Kh (m/s)	Kv (m/s)
1	10	10	Till	2.00E-04	2.00E-04	1.00E-04	1.00E-04	5.00E-04	5.00E-04
2	10	20	Sand	2.00E-05	1.00E-05	5.00E-06	1.00E-06	2.50E-04	1.50E-04
3	10	30						2.50E-04	1.50E-04
4	10	40						2.00E-04	1.50E-04
5	10	50	Upper BR	1.00E-05	8.00E-06			2.00E-04	1.50E-04
6	10	60						4.00E-04	2.50E-04
7	20	80	SS Aquifer					4.00E-04	2.50E-04
8	20	100						1.00E-04	5.00E-05
9	30	130	Basal BR	5.00E-06	1.00E-06	2.00E-06	1.00E-06	1.00E-05	8.00E-06
10	30	160		5.00E-06	1.00E-06	2.00E-06	1.00E-06	1.00E-05	8.00E-06
11	40	200		5.00E-07	1.00E-07	2.00E-07	1.00E-07	3.00E-06	1.50E-06
12	50	250		1.00E-07	8.00E-08	8.00E-08	5.00E-08	5.00E-07	1.00E-07

The remaining input parameter required for the model was groundwater recharge. The amount of recharge expected for the study area was estimated based on assumptions regarding evapotranspiration, runoff and snowmelt losses (**Appendix D**). Porosity is assigned for transport or travel time simulations.

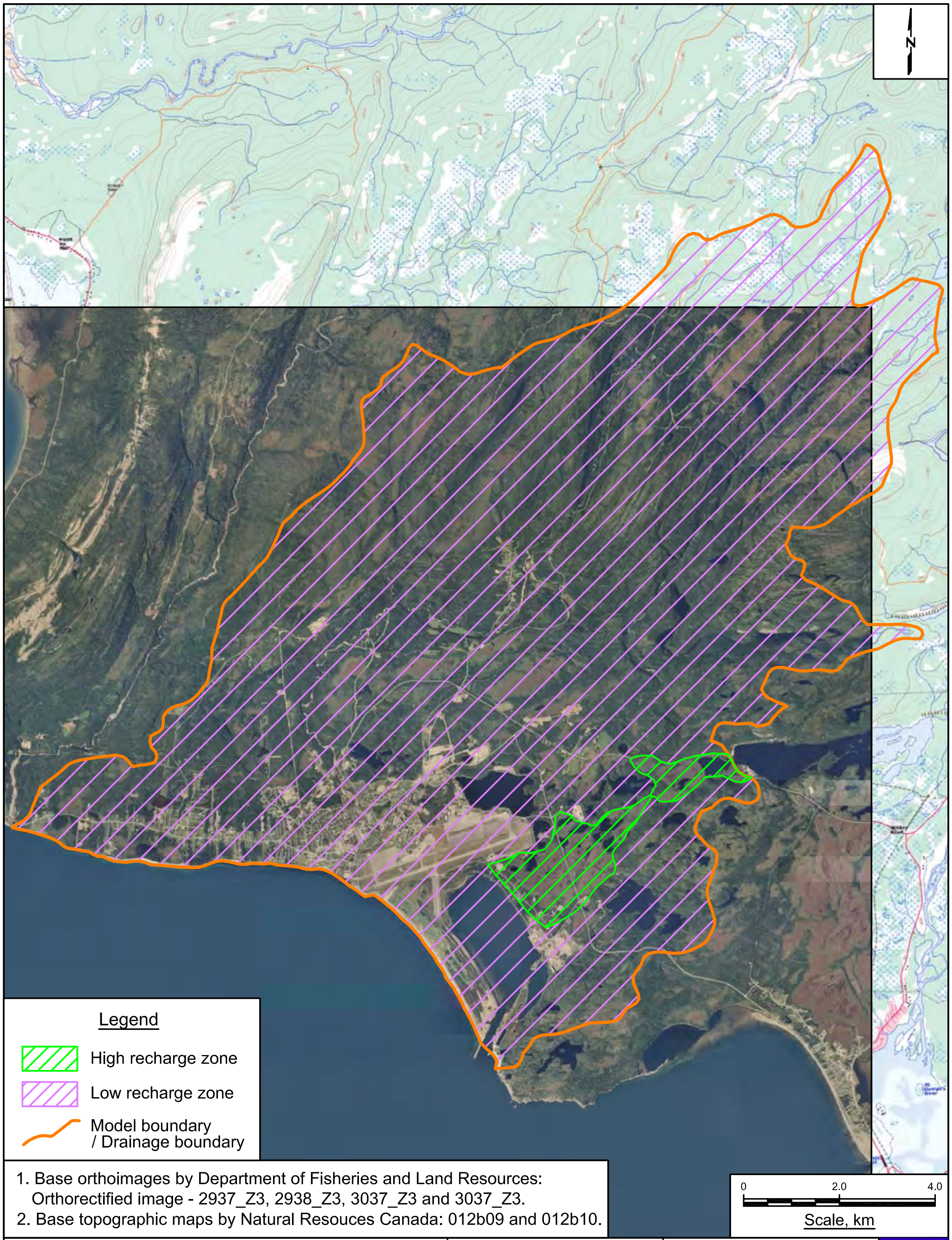
The model calibration simulations demonstrated that most of the surface water bodies are not connected directly to the aquifer water table. As such, they cannot be simulated as areas of constant head but have to be simulated as either drain cells or zones of enhanced recharge or recharge that is similar to the overall marsh or bog area. For each pond, there is a zone of unsaturated aquifer material that is assumed to underlie the bottom of each body of surface water. The bog and the ponds act as large sponges that hold the rain and snow meltwater and gradually release the water to the underlying aquifer through the unsaturated zone. **Figure 8** shows the pattern of recharge that was assigned to this model for calibration purpose. **Figure 9** is a plot of measured hydraulic heads in selected monitoring wells versus the hydraulic heads that were computed by the 3D model at the same locations. For a perfect match between measured and computed hydraulic heads, the data points would plot on a 45-degree line – the solid line in **Figure 9**. The dashed lines on either side of the solid line indicate a +/- difference of 1.0 m between the measured and computed values. For data points that plot below the solid line, the measured values are higher than the computed values. For data points that plot above the solid line, the model heads are higher than the measured heads. The R^2 term indicates the degree of fit between the measured and computed heads. Based on the high degree of agreement ($R^2 = 0.99$) between the measured and computed hydraulic heads, the model was considered to be calibrated and was then used for this series of flow system and aquifer simulations.

The model was first used to evaluate selected local boundary conditions and recharge estimates. **Figure 10** shows the difference between assigning a constant head of 0.0 m (equal to LNT) versus assigning a constant hydraulic head of 1.0 m (equal to the average tide changes). This simulation clearly shows that the tide levels affect the hydraulic heads in the monitoring wells that are close to the harbour. For transient simulations, the full tide cycle for a given measurement period can be assigned to the model.

Figures 11 and **12** show how variations in the recharge that is assigned to the different areas affect the model calibration. This simulation indicates that a lower recharge than that provided in **Appendix D** may be applicable to the model.

Figures 13 and **14** show how the measured versus computed head values are affected by changes in the vertical hydraulic conductivity. Essentially there is very little change in the degree of fit between measured and computed values for steady state simulations, suggesting that as expected in the long term the vertical hydraulic conductivity has very little to no impact on the drawdown. However, in the short-term there will be a delayed response for hydraulic head response in monitoring wells that are completed above the producing zone of the aquifer as noted during the aquifer test on the MHAC Test well.

Steady state simulations were used to compare the drawdowns that were measured in the monitoring well, BH2, to the hydraulic head changes at the same elevation as the monitoring well screen. The drawdown in the monitoring well was 0.12 m after 72 hours of pumping. However, while the water levels in the pumping well were still decreasing slowly, the monitoring well was continuing to drawdown at a more rapid rate. The steady state model predicted that after a long period of pumping, when steady state was achieved, the drawdown in the monitoring well would be 0.13 m. This demonstrates a very good match between the model and the actual aquifer response to this short term pumping.



1. Base orthoimages by Department of Fisheries and Land Resources:
   Orthorectified image - 2937_Z3, 2938_Z3, 3037_Z3 and 3037_Z3.
2. Base topographic maps by Natural Resouces Canada: 012b09 and 012b10.

Figure 8 The pattern of recharge assigned to the 3D model for model calibration.

Project No.
3113

Document Reference
FFC-NL-3113-007

Location
Stephenville, NL

Date
April 2018

FFC

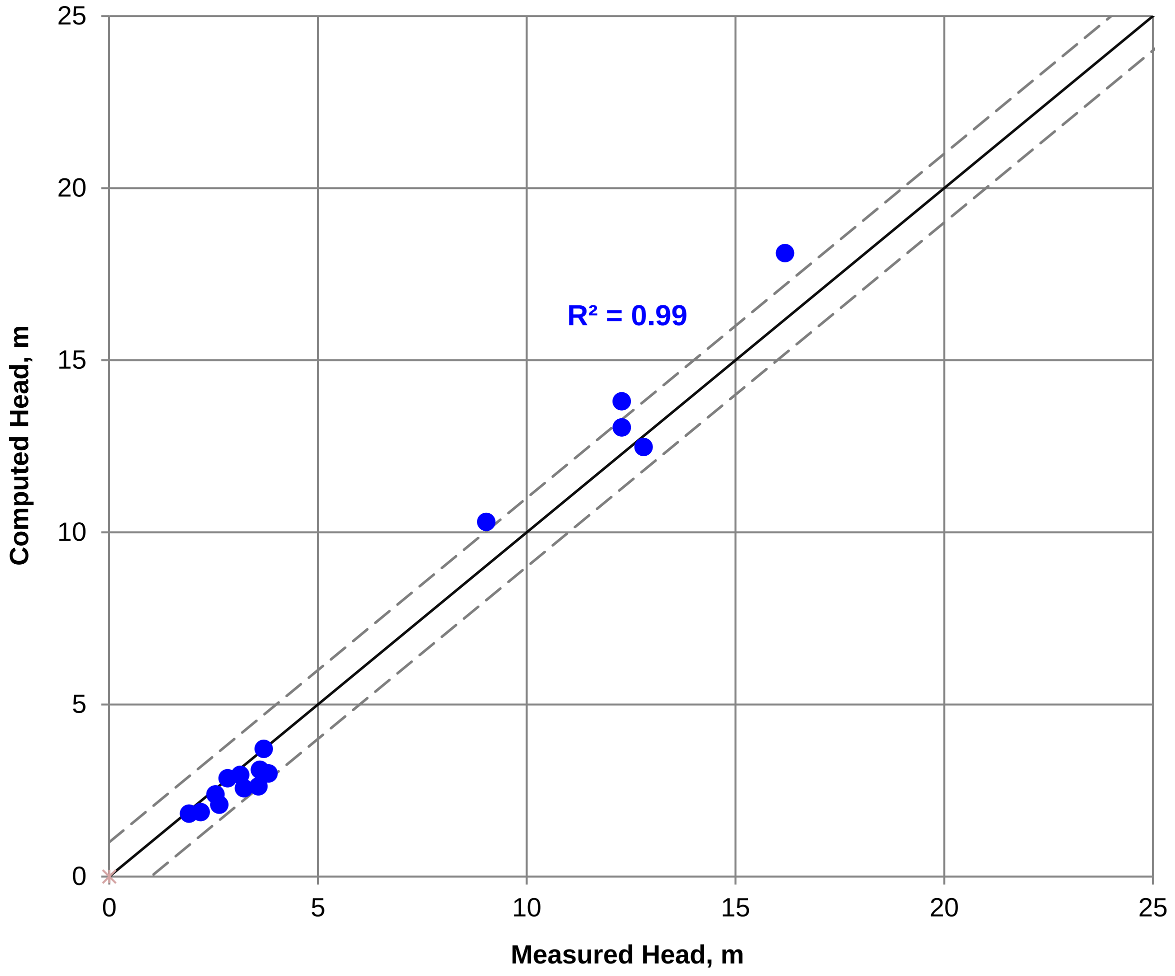


Figure 9 Plot of measured versus the hydraulic heads that were computed by the 3D model at the available locations.

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

FFC

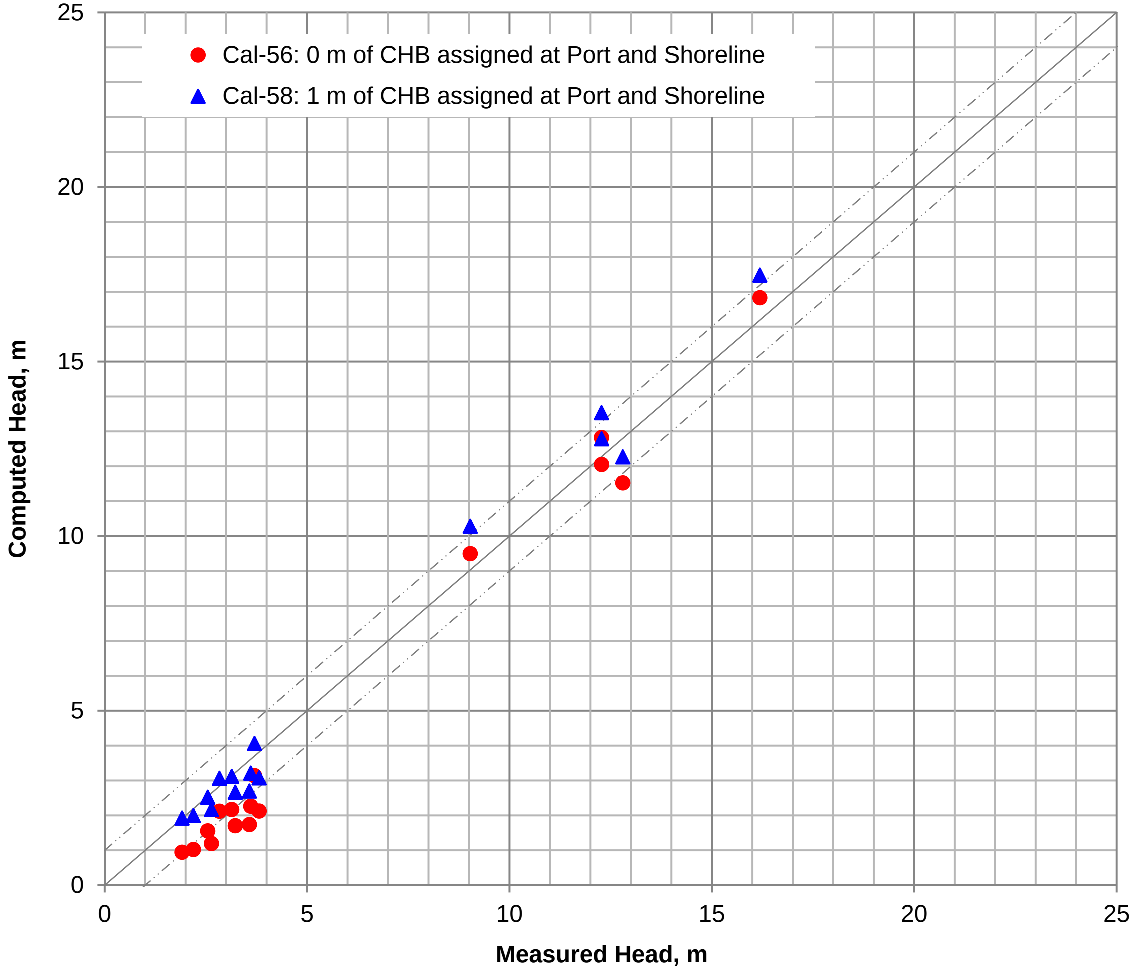


Figure 10 Plot of computed heads versus measured heads with the Constant Head Boundary (CHB) condition for the Port of Stephenville and the coastal boundary as a variable.

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

FFC

Cal-60

Zone	Sub-Zone	Recharge (mm/year)
A1	--	250
A2	--	150
A3	--	315

Cal-62

Zone	Sub-Zone	Recharge (mm/year)
A1	--	294
A2	--	294
A3	1 & 3	368
A3	2, 4 & 5	294

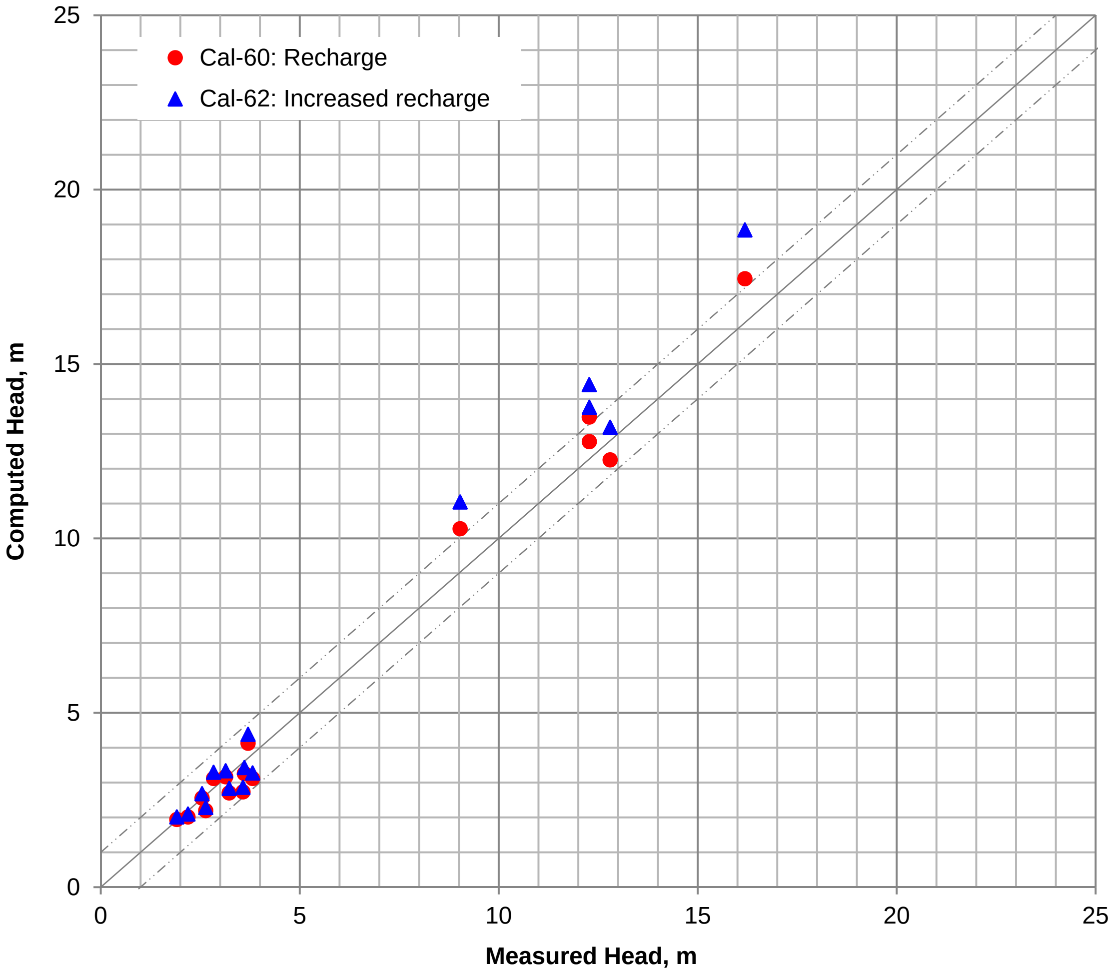


Figure 11 Plot of computed heads versus measured heads with the recharge as a variable.

Project No.	Document Reference
3113	FFC-NL-3113-007
Location	**Date**
Stephenville, NL	April 2018

FFC

Cal-77

Zone	Recharge (mm/year)	
A1	--	294
A2	--	294
A3	1 & 3	368
A3	2, 4 & 5	294

Cal-78

Zone	Sub-Zone	Recharge (mm/year)
A1	--	270
A2	--	270
A3	1 & 3	330
A3	2, 4 & 5	270

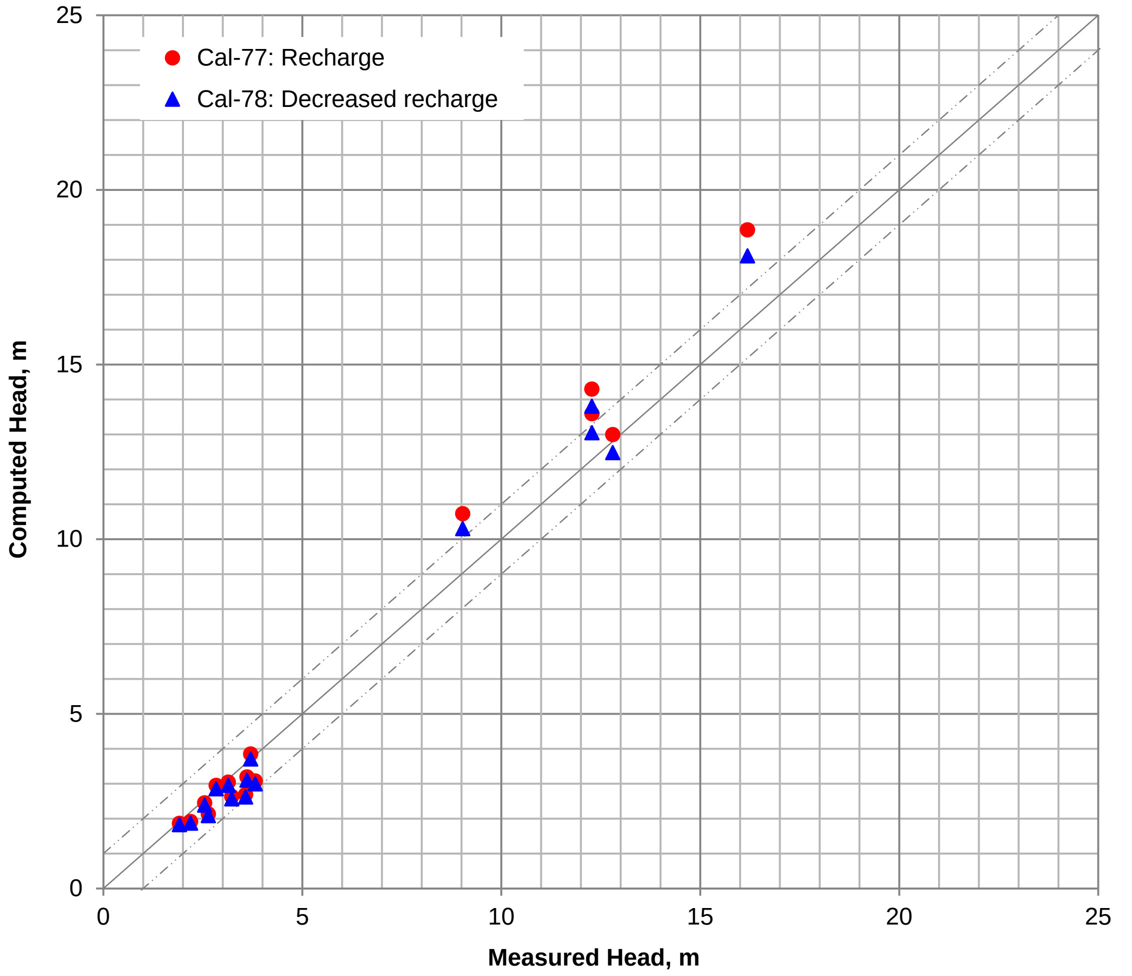


Figure 12 Plot of computed heads versus measured heads with the recharge as a variable.

Project No.	Document Reference
3113	FFC-NL-3113-007
Location	**Date**
Stephenville, NL	April 2018

Cal-58

Layer	Kv (x e-4)		
	Zone1	Zone2	Zone3
1	2	1	5
2	0.2	0.05	1
3	0.2	0.05	2
4	0.2	0.05	2
5	0.1	0.05	2
6	0.1	0.05	5
7	0.1	0.05	5
8	0.1	0.05	1
9	0.05	0.02	0.08
10	0.05	0.02	0.08
11	0.005	0.002	0.02
12	0.001	0.0008	0.005

Cal-60

Layer	Kv (x e-4)		
	Zone1	Zone2	Zone3
1	2	1	5
2	0.1	0.01	1
3	0.1	0.01	2
4	0.1	0.01	1
5	0.08	0.01	1
6	0.08	0.01	2
7	0.08	0.01	2
8	0.08	0.01	0.5
9	0.01	0.01	0.05
10	0.01	0.01	0.05
11	0.001	0.001	0.01
12	0.0008	0.0005	0.001

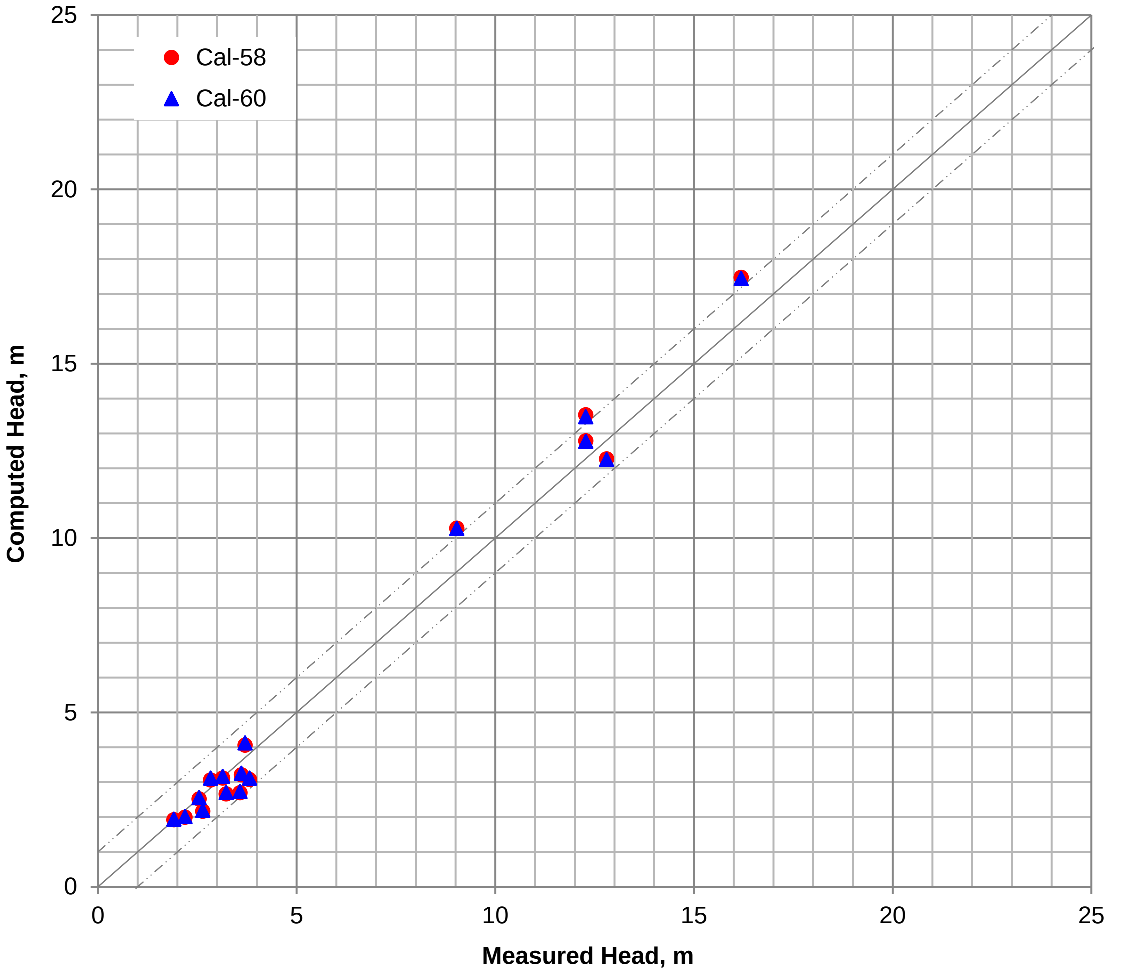


Figure 13 Plot of computed heads versus measured heads for various vertical conductivity values.

Project No.	Document Reference
3113	FFC-NL-3113-007
Location	Date
Stephenville, NL	April 2018

FFC

Cal-73

	Zone 3 (x e-4)	
Layer	Kh	Kv
1	5	5
2	3	1.5
3	3	1.5
4	2	1.5
5	2.5	2
6	5.5	2.5
7	5.5	2.5
8	1	0.5
9	0.1	0.08
10	0.1	0.08
11	0.03	0.015
12	0.005	0.001

Cal-76

	Zone 3 (x e-4)	
Layer	Kh	Kv
1	5	5
2	2	1.5
3	2	1.5
4	1.5	1
5	1.5	1
6	3	2.5
7	3	2.5
8	0.8	0.5
9	0.1	0.08
10	0.1	0.08
11	0.03	0.015
12	0.005	0.001

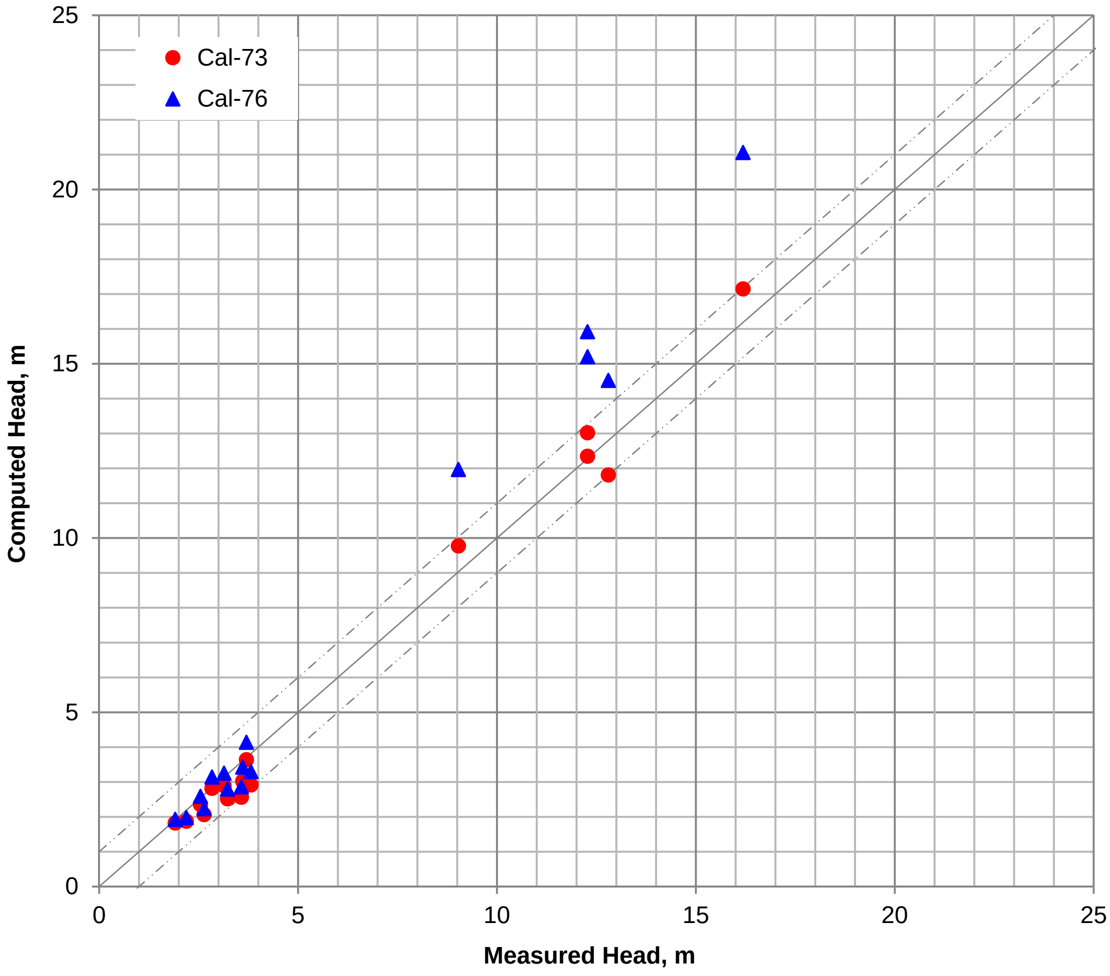


Figure 14 Plot of computed heads versus measured heads for two different sets of horizontal and vertical conductivity values in Zone 3.

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

9.0 WELL FIELD CAPTURE AREA

The proposed MHAC well field consisting of three production wells, each producing at a rate of 1,820 litres per minute were simulated. The recharge rates that were used in this simulation are shown as Cal-78, Calibration simulation number 78, in **Figure 12** and the Hydraulic conductivity value for each layer in the three (3) main areas of the model tabulated in **Table 4**. During each one of those calibration and simulation runs, the Northern Harvest production wells were simulated with a combined flow rate 3,604 litres per minute. **Figure 15** shows the steady state drawdown for the MHAC Test Well, pumping at 1,820 litres per minute. The extended drawdown cone, under steady state conditions, reflects the lower recharge that was assigned to the model for the areas outside of the immediate lower part of the Noel's Pond-Warm Creek drainage basin. Note that the actual drawdown at the well is not shown on the drawdown figures.

Figure 16 shows the steady state drawdowns that are produced by pumping three (3) MHAC production wells at the combined rate of 5,460 litres per minute, with the Northern Harvest existing production wells operating as specified above. 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 limit of 1.0 m is contained within the drainage basin boundaries.

Figure 17 shows the computed pathways and travel times for water arriving at the MHAC Test well based on a porosity of 25%. This simulation indicates that it is the water that 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 that is arriving at the well field. Note that the simulation indicates that it will take approximately four (4) years for water from the area of BH3 to arrive at the Test Well location. Likewise, if all three (3) of the proposed MHAC production wells are operating the pathways and travel times are only changed slightly (**Figure 18**).

Figure 15 Capture area predicted by the model for a scenario of pumping the Test Well, MHPW1, at 1,820 Lpm, steady-state.

Project No.
3113

Document Reference
FFC-NL-3113-007

Location
Stephenville, NL

Date
April 2018

FFC

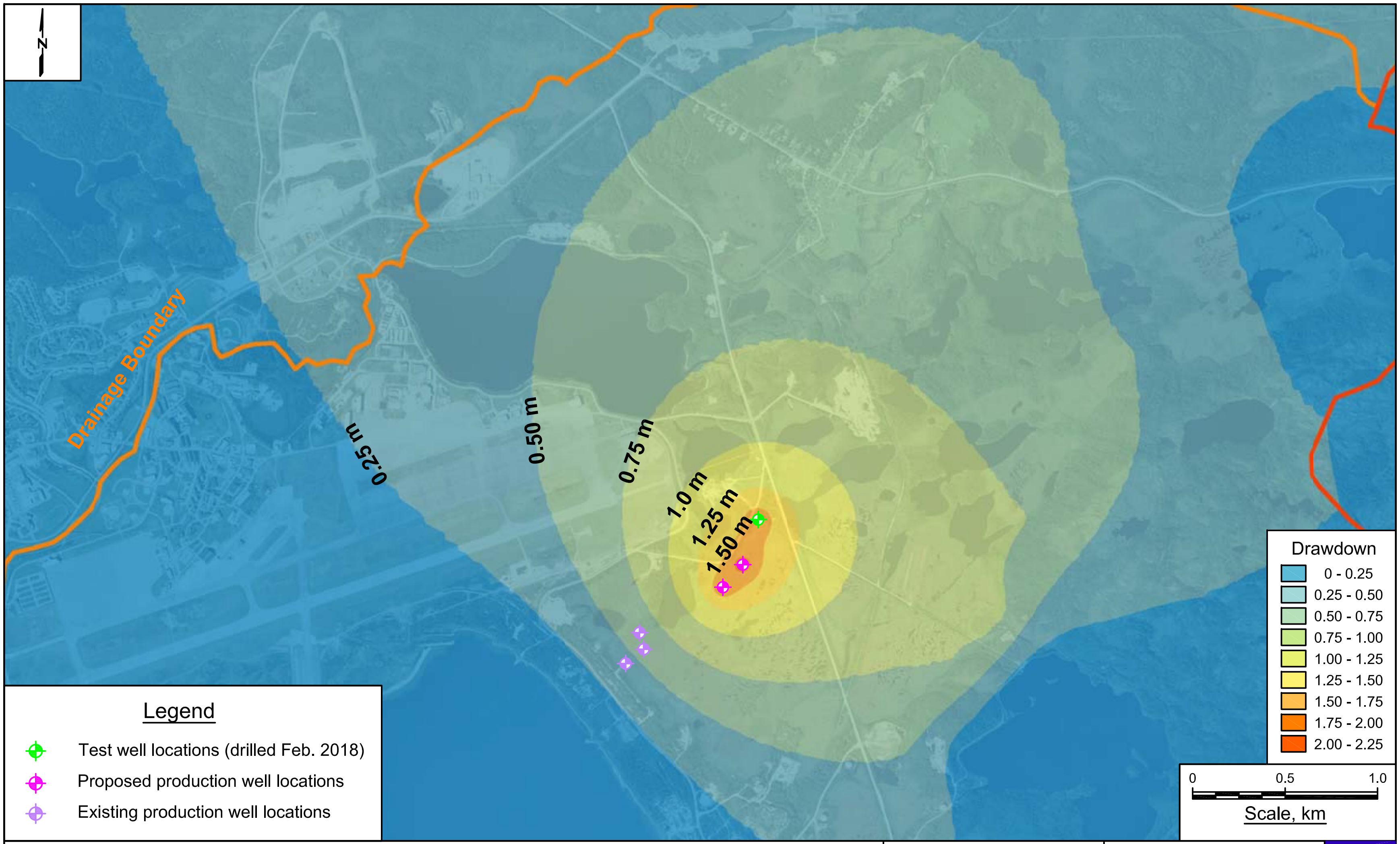


Figure 16 Capture area predicted by the steady state model for pumping the Test Well, MHPW1 and the other two proposed Test Wells, at 1,820 Lpm, each.

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

FFC

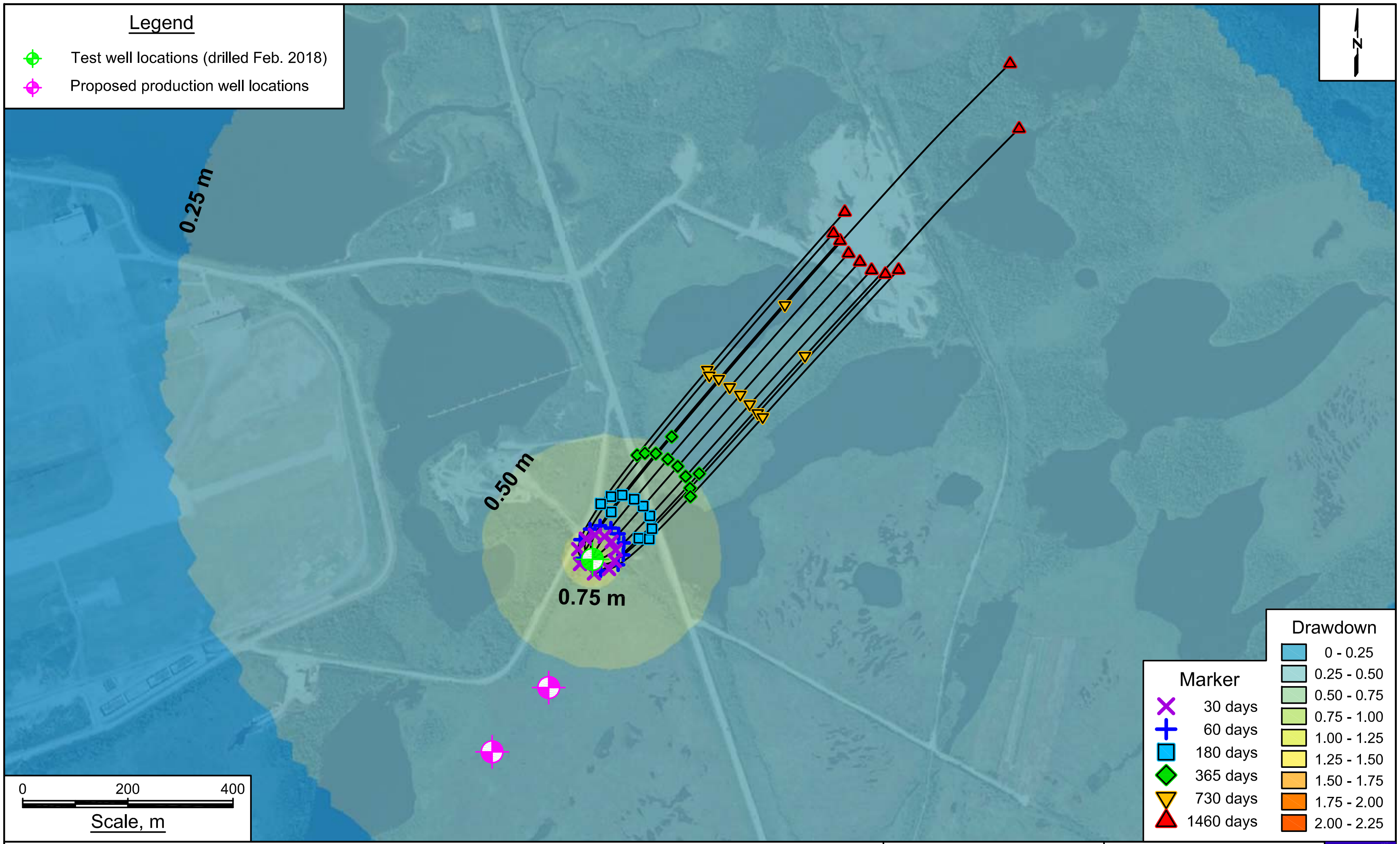


Figure 17 Reverse particle tracks showing selected pathways for distances travelled between 30 days and 1460 days (4 years) with pumping of the Test Well, MHPW1, at 1820 Lpm - steady state.

Project No.
3113

Document Reference
FFC-NL-3113-007

Location
Stephenville, NL

Date
April 2018

FFC

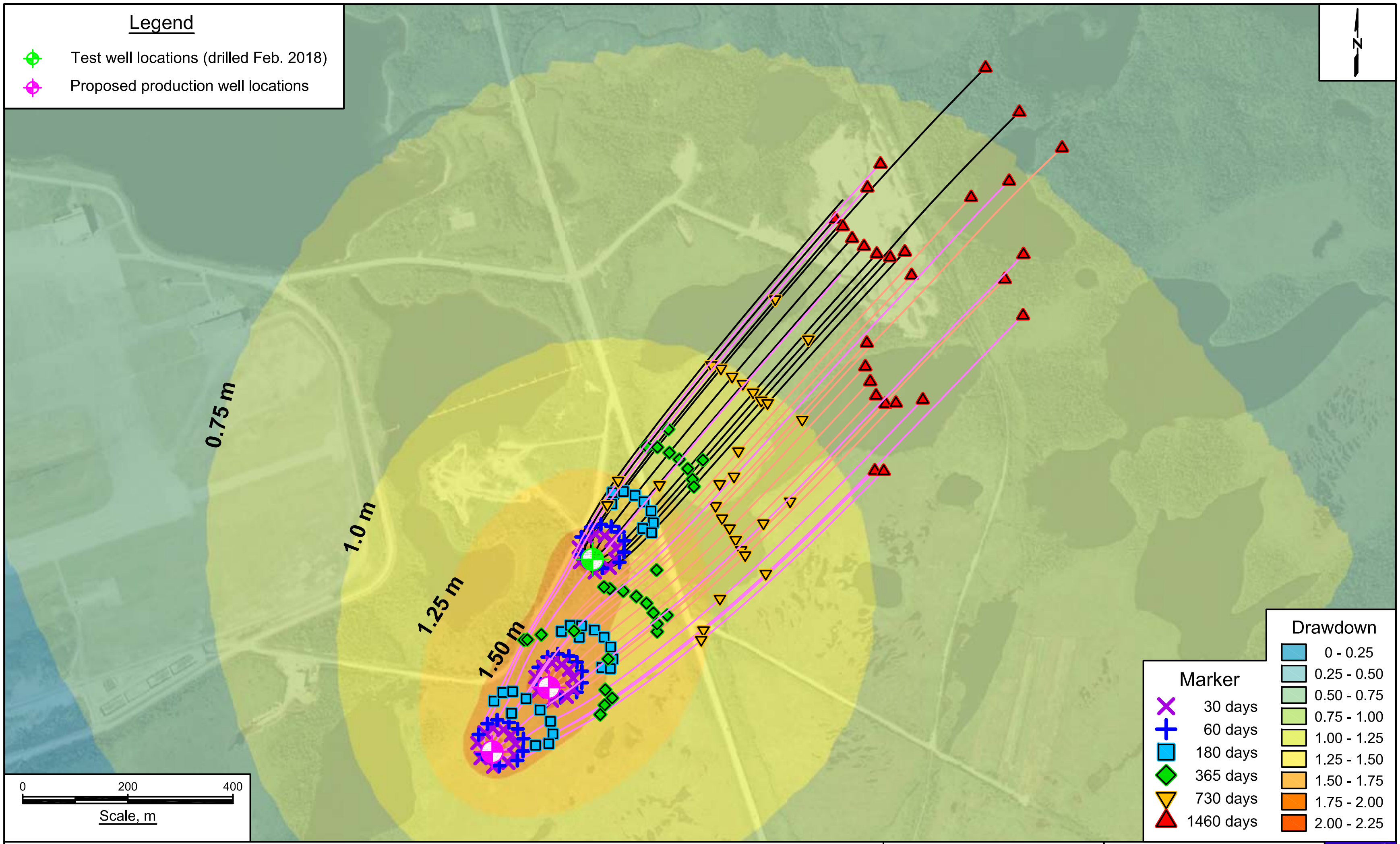


Figure 18 Reverse particle tracks showing selected pathways for distances travelled between 30 days and 1460 days (4 years) with pumping of the Test Well, MHPW1 and the other two proposed Test Wells at 1820 Lpm each.

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

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10.0 SUMMARY AND CONCLUSIONS

We have assessed the water availability from the granular aquifer using both simple ball-park calculations and by using a 3D model to compare the measured versus computed hydraulic heads for a range of measured K-values and for a range of estimated recharge values for expected well production rates and proposed well locations and depths. For example, since monitoring wells were installed across the aquifer with BH3 located up-gradient from the marsh covered area of the granular aquifer, the gradient on the water table aquifer in this area is known to range from 0.004 to 0.0065 m/m. Using a reference cross-section of 1,500 m, an assumed aquifer thickness of 50 m, a gradient or I of 0.006 m/m and a hydraulic conductivity (K) of 0.0002 to 0.0004 m/s, Darcy's Law, Q=KIA, gives a flux of 2.8 to 5.7 million cubic metres per year towards that part of the granular aquifer that is covered by marsh. By comparison, the up-gradient and trans-gradient areas have a combined area of more than 12 km^2. With a recharge estimated at 294 mm for part of this area, the total annual recharge would be 3.56 million cubic metres, 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 marsh layer into the underlying granular aquifer, in Sub-Area 1, is approximately 1.386 million cubic metres of water per year. For reference, a production well that is producing 2,000 litres per minute will extract approximately 1.05 million cubic metres of groundwater per year. Production wells that produce 5,000 litres per minute will extract approximately 2.5 million cubic metres of water per year from the aquifer.

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 marsh in Area 1, is estimated at 48 to 58 million cubic metres of groundwater. Again, potential contributions from the bedrock aquifer that is assumed to underlie the granular aquifer have not been considered.

The 3D model steady state simulations indicate that the production wells will draw water from a zone that extends up towards the top part of the Noel's Pond-Warm Creek drainage basin and that the water levels in the aquifer will be reduced over a broad area. Clearly, if the drawdowns increase in the production wells and the upper part of the aquifer dewaters, the capture areas will change. However, the travel times will not change significantly. Based on the available data, the 3D model simulations supported by the measured hydraulic heads and the available aquifer test data, three (3) proposed MHAC production wells are expected to produce the required 5,000 litres per minute. Note that steady state simulations are generally more conservative than transient simulations and do not reflect the local changes in hydraulic head over time that are induced by changes in aquifer properties.

The database for this 3D model simulation is somewhat sparse. The lack of real time data from the multi-year operation of the existing Northern Harvest Production wells increases uncertainty in model predictions. Also, the actual depth of the granular aquifer and the depth and nature of any high permeability zones within the bedrock system prevents one from assigning any significant contribution from the bedrock system to the long term well yields or determine if there will be any changes in water quality due to up-welling groundwater.

Reducing uncertainty requires;

1. Construction of two (2) sets of mini-piezometers in an area of the marsh where the bog or peat layers are thick (up to 4 m thick). These mini-piezometers, four (4) per set or per location, can be installed by hand using a jack-hammer. The mini-piezometers would be equipped with short screened sections or well points and used to measure the hydraulic conductivity of the marsh layers and the hydraulic head variations with depth. These measurements would allow one to quantify the recharge rates through the marsh areas.

2. Construction of two (2) deep monitoring well nests into the bedrock or some depth below the producing zones of the existing and proposed production wells. These wells would have to be drilled to approximately 100 m of depth using a 150 mm diameter casing with four 50 mm monitoring wells installed at four (4) different levels as the casing is retracted. The well would be sampled at 1.5 m intervals as the casing is being driven or drilled out. These two (2) deep multi-level monitoring well nests would allow one to obtain water samples from very specific depths, measure the hydraulic conductivity at the screened depths, and measure the hydraulic gradients to determine both vertical and horizontal response of the water levels to changes in production well withdrawals.

3. Reconstruct the history of the water level changes that are associated with production from the Northern Harvest water supply wells to determine if the existing well drawdowns during pumping are related to changes in well performance or aquifer dewatering.

4. Using this additional data, conduct a five-year transient, unconfined, aquifer simulation using monthly variations in recharge rates to determine if the aquifer will dewater under the combined pumping that is being considered for both fish hatcheries and if the seasonal pattern of measured water level changes are consistent with the model simulations.

11.0 REFERENCES

Acres, 1994. Water Resources Study of the Southwestern Newfoundland Region: Volume 1. Report prepared by Acres International Limited.

Diersch, H. -J. G., 2005. FEFLOW 5.3 Finite Element - Subsurface Flow and Transport Simulation System. WASY GnbH, Institute for Water Resources Planning and Systems Research, Berlin, Germany.

Fetter, C.W., 2001, *Applied Hydrogeology*. Fourth Edition, Prentice Hall.

FFC-NL-3113-006, Construction and Aquifer Testing – Test Well MHPW1 – 2018; Technical Memorandum – Progress Report, April 19, 2018, Fracflow Consultants Inc.

APPENDIX A

Borehole Logs

Project: Geotechnical Investigation

Log of Borehole: BH1

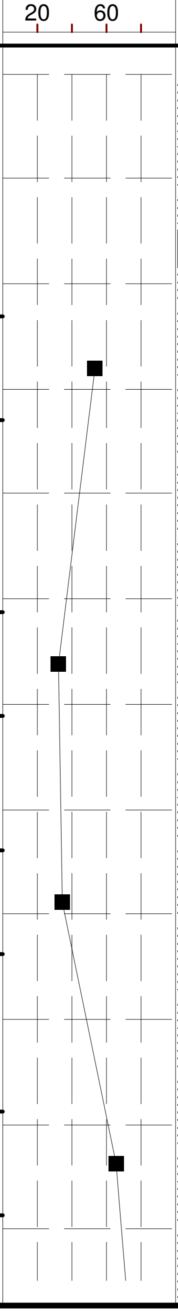
Client: Marine Harvest Atlantic Canada

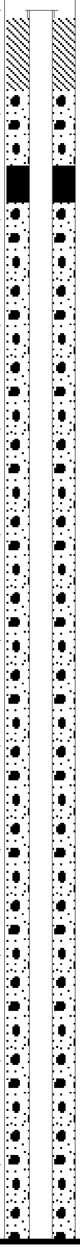
Project No: 3113

Location: Stephenville, NL

Date: November 16 - 19, 2017

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	Well Data	Well Description
0		Ground Surface (GS)	31.4								Well head protection installed Cement packing from 0.05 m to 0.46 m Native sand packing from 0.46 m to 0.91 m Bentonite packing from 0.91 m to 1.12 m
		Auger	30								
		SPT: 4 / 18 / 36 / 36 Wet, brown, medium sand	29.4	SS	1	54	31				
		Auger	28.3								0.05 m dia. riser from 0 m to 16.68 m
		SPT: 7 / 12 / 21 / 22 Damp, brown, medium sand with red and black particles	27.7	SS	2	33	52				
		Auger	26.9								
		SPT: 13 / 16 / 19 /14 Damp,brown, medium sand	26.3	SS	3	35	25				Native sand packing from 1.12 m to 26.48 m
		Auger	25.4								
		SPT: 10 / 39 / 27 / 16 No recovery	24.8	SS	4	66	0				
23		Auger									





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
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 1 of 5

Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

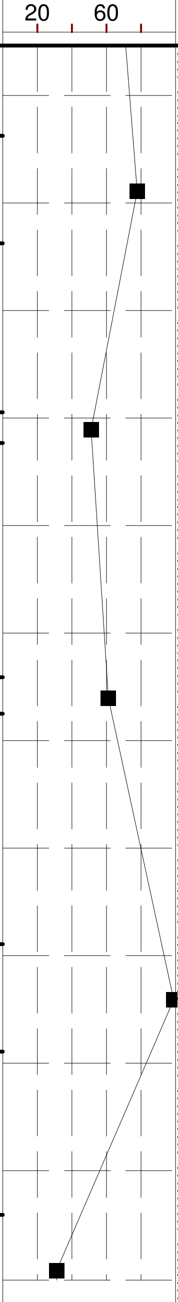
Log of Borehole: BH1

Project No: 3113

Date: November 16 - 19, 2017

SUBSURFACE PROFILE			SAMPLE						
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
23 24			23.9						
25 26 8		SPT: 7 / 25 / 53 / 53 Dry, brown, fine to medium sand with some rock fragments	23.3	SS	5	78	20		
27 28 29 9		Auger	22.4						
30		SPT: 43 / 52 for 0.03 m (Refusal) Brown and tan, fine sand with some rock fragments	22.2	SS	6	52	36		0.05 m dia. riser from 0 m to 16.68 m
31 32 33 10 34		Auger	20.9						
35		SPT: 44 / 62 for 0.06 m (Refusal) Dry, grey and brown, fine sand with some rock fragments	20.6	SS	7	62	97		
36 11 37 38 39 12		Auger	19.3						Native sand packing from 1.12 m to 26.48 m
40 41		SPT: 17 / 52 / 66 / 42 Dry, light grey to dark brown, fine sand with some coarse sand	18.7	SS	8	118	62		
42 13 43 44		Auger	17.8						
45 46 14		SPT: 9 / 15 / 17 / 20 Dry, grey and some brown, fine sand with some rock fragments					41		

Standard Penetration Test "N" Value per 300 mm



Well Data

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL A1A 5A1
Phone: (709) 739-7270
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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 2 of 5

Project: Geotechnical Investigation

Log of Borehole: BH1

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 16 - 19, 2017

SUBSURFACE PROFILE | SAMPLE

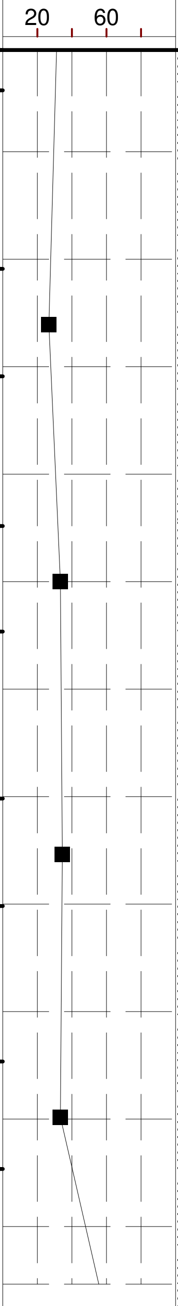
Depth

46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69

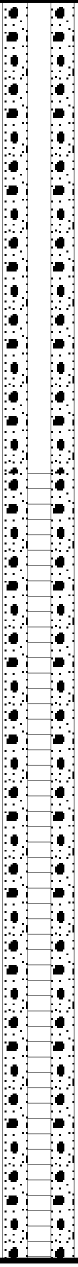
15 16 17 18 19 20 21

Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
		17.2	SS	9	32	41	
	Auger	16.2					
	SPT: 10 / 12 / 15 / 13 Brown and grey, fine sand with some rock fragments	15.6	SS	10	27	54	
	Auger	14.7					
	SPT: 9 / 17 / 17 / 16 Damp, brown, fine sand	14.1	SS	11	34	67	
	Auger	13.2					
	SPT: 10 / 18 / 17 / 15 Dry, grey and brown, fine sand	12.6	SS	12	35	58	
	Auger	11.7					
	SPT: 9 / 15 / 19 / 19 Wet, grey, very fine sand	11.1	SS	13	34	46	
	Auger						

Standard Penetration Test "N" Value per 300 mm



Well Data



Well Description

Native sand packing from 1.12 m to 26.48 m

0.05 m dia. screen from 16.68 m to 25.82 m

▼ 19.17 m BGS (Nov. 27, 2017)

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 3 of 5

Project: Geotechnical Investigation

Log of Borehole: BH1

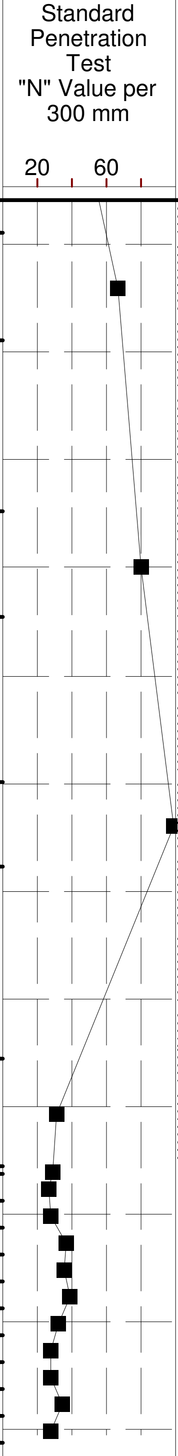
Client: Marine Harvest Atlantic Canada

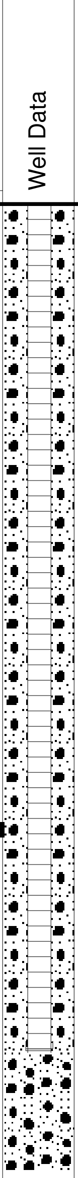
Project No: 3113

Location: Stephenville, NL

Date: November 16 - 19, 2017

SUBSURFACE PROFILE			SAMPLE						
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
69			10.3						
70 71		SPT: 12 / 28 / 39 / 18 CFEM: Sand, trace Gravel, trace Silt/Clay	9.65	SS	14	67	37		
72 – 22 73 74		Auger	8.68						0.05 m dia. screen from 16.68 m to 25.82 m
75 – 23 76		SPT: 32 / 49 / 32 / 34 CFEM: Gravelly Sand, trace Silt/Clay	8.07	SS	15	81	33		
77 78 79 – 24		Auger	7.14						Native sand packing from 1.12 m to 26.48 m
80 81		SPT: 29 / 54 / 67 / 52 for 0.03 m (Refusal) No recovery	6.66	SS	16	121	0		
82 – 25 83 84		Auger	5.57						
85 – 26 86		SPT: 14 / 13 / 19 / 23 CFEM: Sand, some Silt/Clay, trace Gravel	4.97	SS	17	32	27		Screw-on cap
87 88 89 – 27 90 91 92 – 28		DCPT (Blow counts per 150 mm)		PC PC PC PC PC PC PC PC PC PC PC	-- -- -- -- -- -- -- -- -- -- --	29 27 28 37 36 39 33 28 28 35 28			





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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 4 of 5

Project: Geotechnical Investigation

Log of Borehole: BH1

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

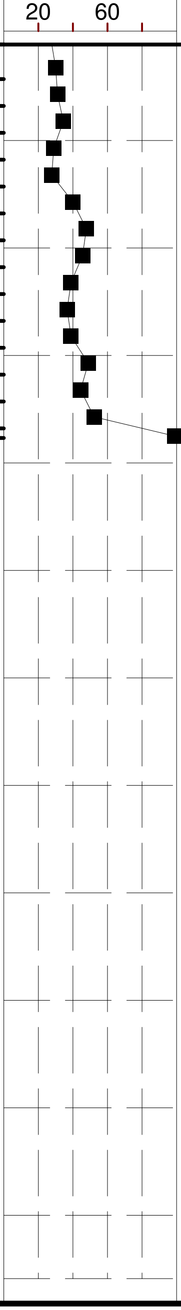
Date: November 16 - 19, 2017

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	Well Data	Well Description
		DCPT (Blow counts per 150 mm)		PC	--	31					
				PC	--	32					
				PC	--	35					
				PC	--	29					
				PC	--	28					
				PC	--	41					
				PC	--	48					
				PC	--	46					
				PC	--	40					
				PC	--	37					
				PC	--	39					
				PC	--	49					
				PC	--	45					
			1.2	PC	--	53					
				PC	--	104					
		End of Borehole									

Depth scale (ft / m):

92, 93, 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15

29, 30, 31, 32, 33, 34, 35



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 5 of 5

Project: Geotechnical Investigation

Log of Borehole: BH2

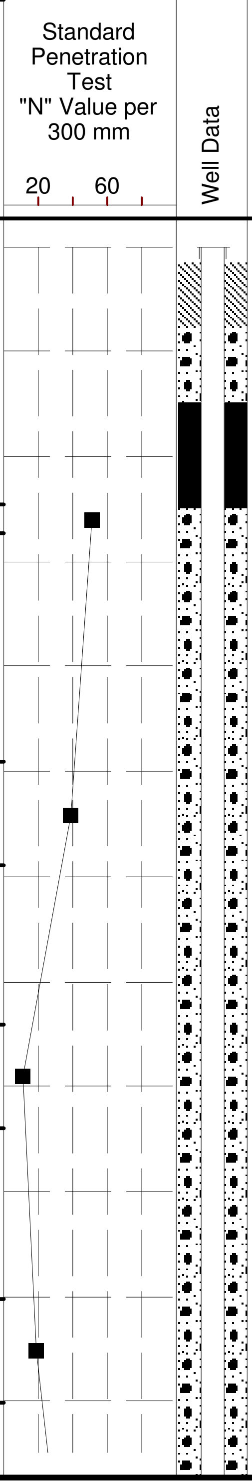
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017

SUBSURFACE PROFILE	SAMPLE					
Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
Ground Surface (GS)	31.8					
Auger	30.3					
SPT: 4 / 52 for 0.03 m (Refusal) Wet, dark brown coarse sand	30.1	SS	1	52	100	
Auger	28.8					
SPT: 4 / 20 / 19 / 6 0 m - 0.31 m: damp, brown gravel with coarse sand with red and black particles 0.31 m - 0.56 m: wet, silt/clay	28.2	SS	2	39	92	
Auger	27.3					
SPT: 5 / 6 / 6 / 5 Wet, brown 0 m - 0.15 m: medium sand 0.15 m - 0.25 m: silt/clay	26.7	SS	3	12	42	
Auger	25.7					
SPT: 10 / 11 / 8 / 6 Wet, dark brown, medium sand with gravel	25.1	SS	4	19	23	



Depth: ft 0–23; m 0–6

Well Description

Flush mount installed

Cement packing from 0.1 m to 0.46 m

Native sand packing from 0.46 m to 0.91 m

Bentonite packing from 0.91 m to 1.52 m

0.05 m dia. riser from 0 m to 15.76 m

Native sand packing from 1.52 m to 31.00 m

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Sheet: 1 of 6

Project: Geotechnical Investigation

Log of Borehole: BH2

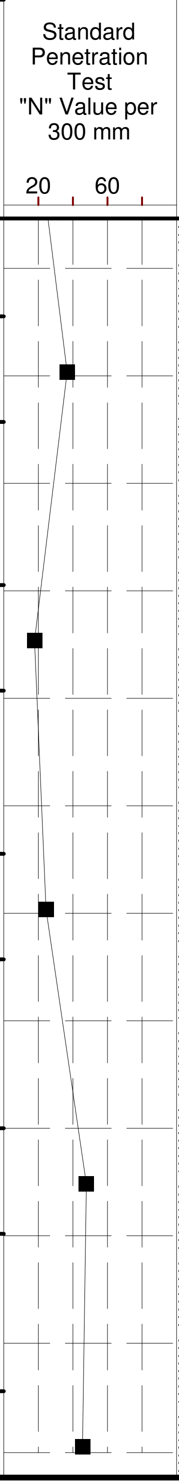
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017

SUBSURFACE PROFILE			SAMPLE					
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
23 24		Auger	24.2					
25 26 8		SPT: 11 / 18 / 19 / 10 Damp, light brown, medium sand	23.6	SS	5	37	8	
27 28 29 9		Auger	22.7					
30 31		SPT: 10 / 9 / 9 / 21 Damp, brown 0 m - 0.07 m: fine sand 0.07 m - 0.15 m: gravel with coarse sand	22.1	SS	6	18	25	
32 33 34 10		Auger	21.2					
35 36 11		SPT: 9 / 12 / 13 / 14 Damp, light brown, medium sand with red and black particles	20.6	SS	7	25	42	
37 38 39 12		Auger	19.6					
40 41		SPT: 12 / 25 / 23 / 29 Damp, light brown, fine sand with gravel with red and black particles	19	SS	8	48	44	
42 43 44 13		Auger	18.1					
45 46 14		SPT: 8 / 23 / 23 / 20 Dry, light brown, medium sand with red and black particles					56	



Well Data

Well Description

0.05 m dia. riser
from 0 m to 15.76 m

Native sand packing
from 1.52 m
to 31.00 m

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Sheet: 2 of 6

Project: Geotechnical Investigation

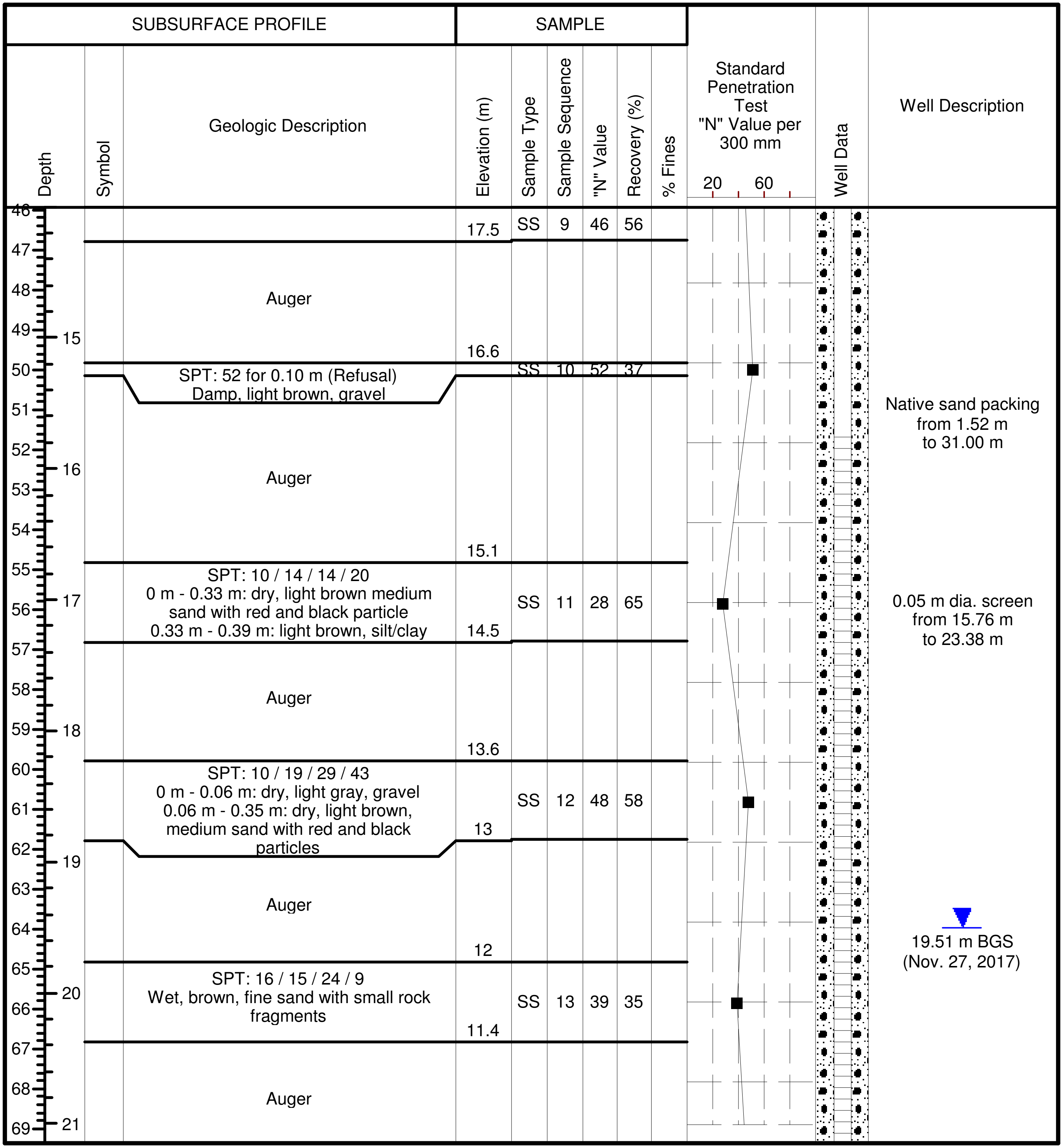
Log of Borehole: BH2

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017



Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
	17.5	SS	9	46	56	
Auger	16.6					
SPT: 52 for 0.10 m (Refusal) Damp, light brown, gravel		SS	10	52	37	
Auger	15.1					
SPT: 10 / 14 / 14 / 20 0 m - 0.33 m: dry, light brown medium sand with red and black particle 0.33 m - 0.39 m: light brown, silt/clay	14.5	SS	11	28	65	
Auger	13.6					
SPT: 10 / 19 / 29 / 43 0 m - 0.06 m: dry, light gray, gravel 0.06 m - 0.35 m: dry, light brown, medium sand with red and black particles	13	SS	12	48	58	
Auger	12					
SPT: 16 / 15 / 24 / 9 Wet, brown, fine sand with small rock fragments	11.4	SS	13	39	35	
Auger						

Well Description

Native sand packing
from 1.52 m
to 31.00 m

0.05 m dia. screen
from 15.76 m
to 23.38 m

19.51 m BGS
(Nov. 27, 2017)

Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Project: Geotechnical Investigation

Log of Borehole: BH2

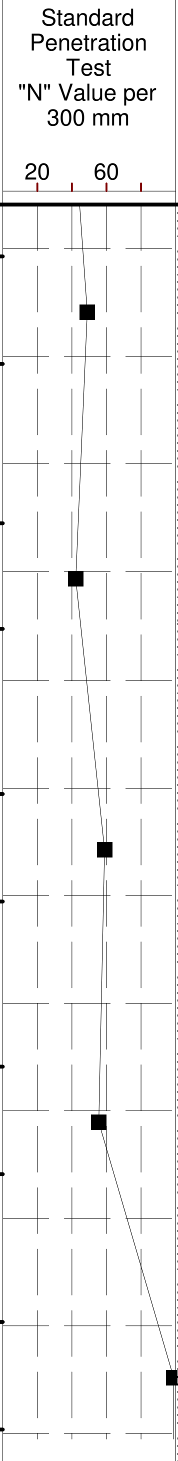
Client: Marine Harvest Atlantic Canada

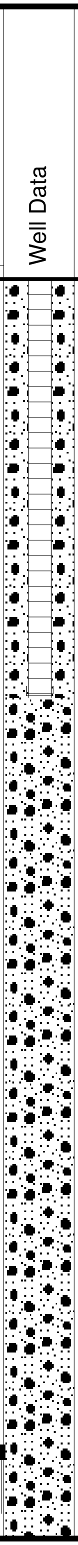
Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017

SUBSURFACE PROFILE			SAMPLE						
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
69			10.5						
70 71 72		SPT: 19 / 23 / 26 / 29 Wet, brown, fine sand with small rock fragments	9.87	SS	14	49	29		0.05 m dia. screen from 15.76 m to 23.38 m
22 73 74		Auger	8.98						
75 23 76		SPT: 31 / 19 / 24 / 33 Wet, brown, fine to medium sand	8.37	SS	15	43	46		Screw-on cap
77 78 24 79		Auger	7.44						
80 81		SPT: 15 / 20 / 39 / 50 Wet, brown, fine to medium sand with red and black particles	6.83	SS	16	59	42		
82 25 83 84		Auger	5.89						Native sand packing from 1.52 m to 31.00 m
85 26 86		SPT: 14 / 21 / 35 / 36 CFEM: Sand, trace Gravel, trace Silt/Clay	5.28	SS	17	56	42		
87 88 27 89		Auger	4.44						
90 91		SPT: 18 / 78 / 36 / 45 CFEM: Sand, trace Silt/Clay	3.84	SS	18	114	29		
92 28									





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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Sheet: 4 of 6

Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Borehole: BH2

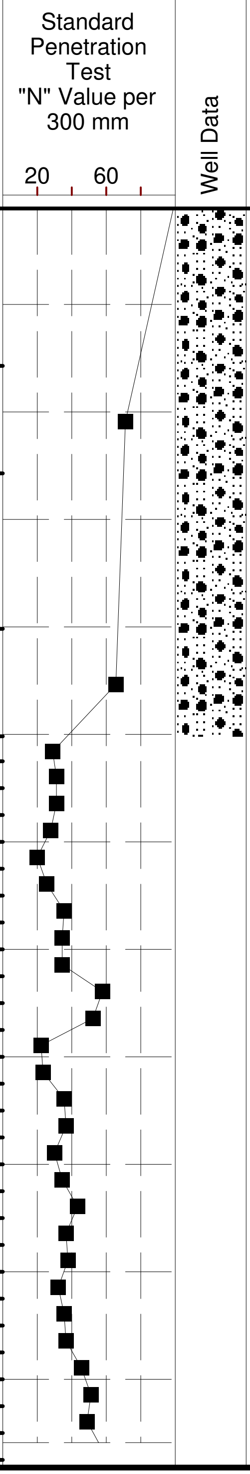
Project No: 3113

Date: November 19 - 22, 2017

SUBSURFACE PROFILE / SAMPLE

Depth: 92, 93, 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15 / 29, 30, 31, 32, 33, 34, 35

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
		Auger	2.9					
29		SPT: 35 / 38 / 34 / 27 CFEM: Sand, some Gravel, trace Silt/Clay	2.28	SS	19	72	23	
30		Auger	1.4					
		SPT: 18 / 32 / 34 / 41 CFEM: Sand, trace Gravel, trace Silt/Clay	0.787	SS	20	66	46	
31		DCPT (Blow counts per 150 mm)		PC	--	30		
				PC	--	32		
				PC	--	32		
				PC	--	28		
				PC	--	21		
				PC	--	26		
32				PC	--	36		
				PC	--	35		
				PC	--	35		
				PC	--	58		
				PC	--	53		
				PC	--	23		
33				PC	--	24		
				PC	--	36		
				PC	--	37		
				PC	--	31		
				PC	--	35		
				PC	--	44		
				PC	--	37		
34				PC	--	38		
				PC	--	33		
				PC	--	36		
				PC	--	37		
				PC	--	46		
				PC	--	52		
				PC	--	50		
35				PC	--	58		



Well Description

Native sand packing from 1.52 m to 31.00 m

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Sheet: 5 of 6

Project: Geotechnical Investigation

Log of Borehole: BH2

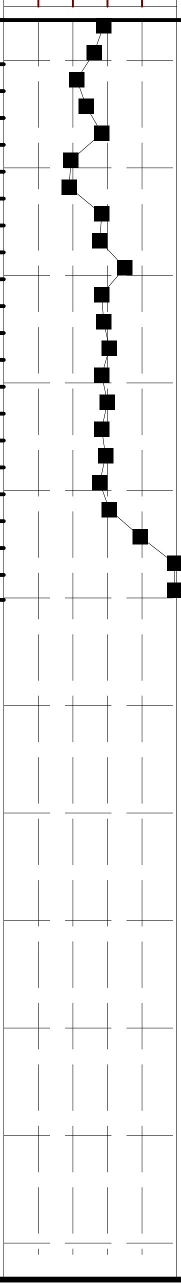
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017

SUBSURFACE PROFILE | SAMPLE



Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Data	Well Description
15		DCPT (Blow counts per 150 mm)		PC	--	58				
				PC	--	53				
16				PC	--	43				
				PC	--	48				
17				PC	--	57				
				PC	--	40				
18 36				PC	--	38				
				PC	--	57				
19				PC	--	56				
				PC	--	71				
20				PC	--	57				
				PC	--	58				
21				PC	--	62				
37				PC	--	57				
22				PC	--	61				
				PC	--	57				
23				PC	--	60				
				PC	--	56				
24				PC	--	62				
				PC	--	79				
25 38				PC	--	103				
			-6.52	PC	--	119				
26		End of Borehole								
27										
28 39										
29										
30										
31 40										
32										
33										
34 41										
35										
36										
37										
42										

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Project: Geotechnical Investigation

Log of Borehole: BH3

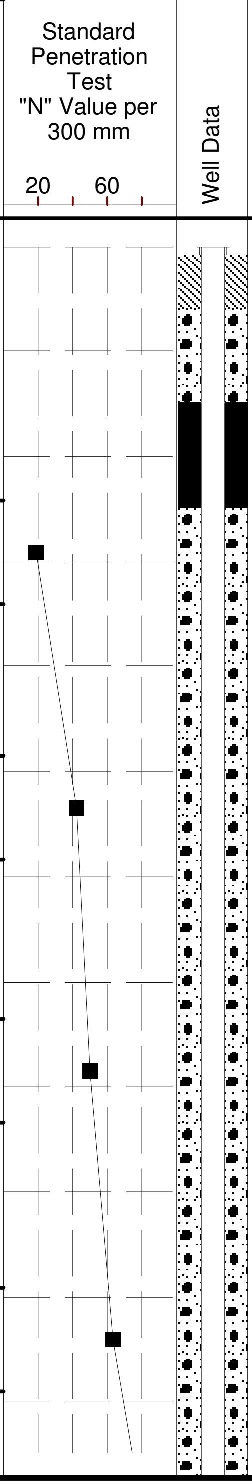
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

SUBSURFACE PROFILE			SAMPLE					
Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
0 / 0		Ground Surface (GS)	28.1					
		Auger	26.7					
		SPT: 6 / 9 / 10 / 11 Dry, brown,coarse sand	26	SS	1	19	21	
		Auger	25.2					
		SPT: 17 / 31 / 12 / 20 Medium to coarse sand with small rock fragments	24.6	SS	2	43	29	
		Auger	23.6					
		SPT: 5 / 21 / 30 / 21 Dry, light brown gravel with coarse sand with red and black particles	23	SS	3	51	29	
		Auger	22.1					
		SPT: 10 / 27 / 37 / 30 Dry, light brown, gravel with coarse sand	21.5	SS	4	64	27	



Well Description

Well head protection Installed

Cement packing from 0.05 m to 0.36 m

Native sand packing from 0.36 m to 0.91 m

Bentonite packing from 0.91 m to 1.52 m

0.05 m dia. riser from 0 m to 12.21 m

Native sand packing from 1.52 m to 32.71 m

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 1 of 6

Log of Borehole: BH3

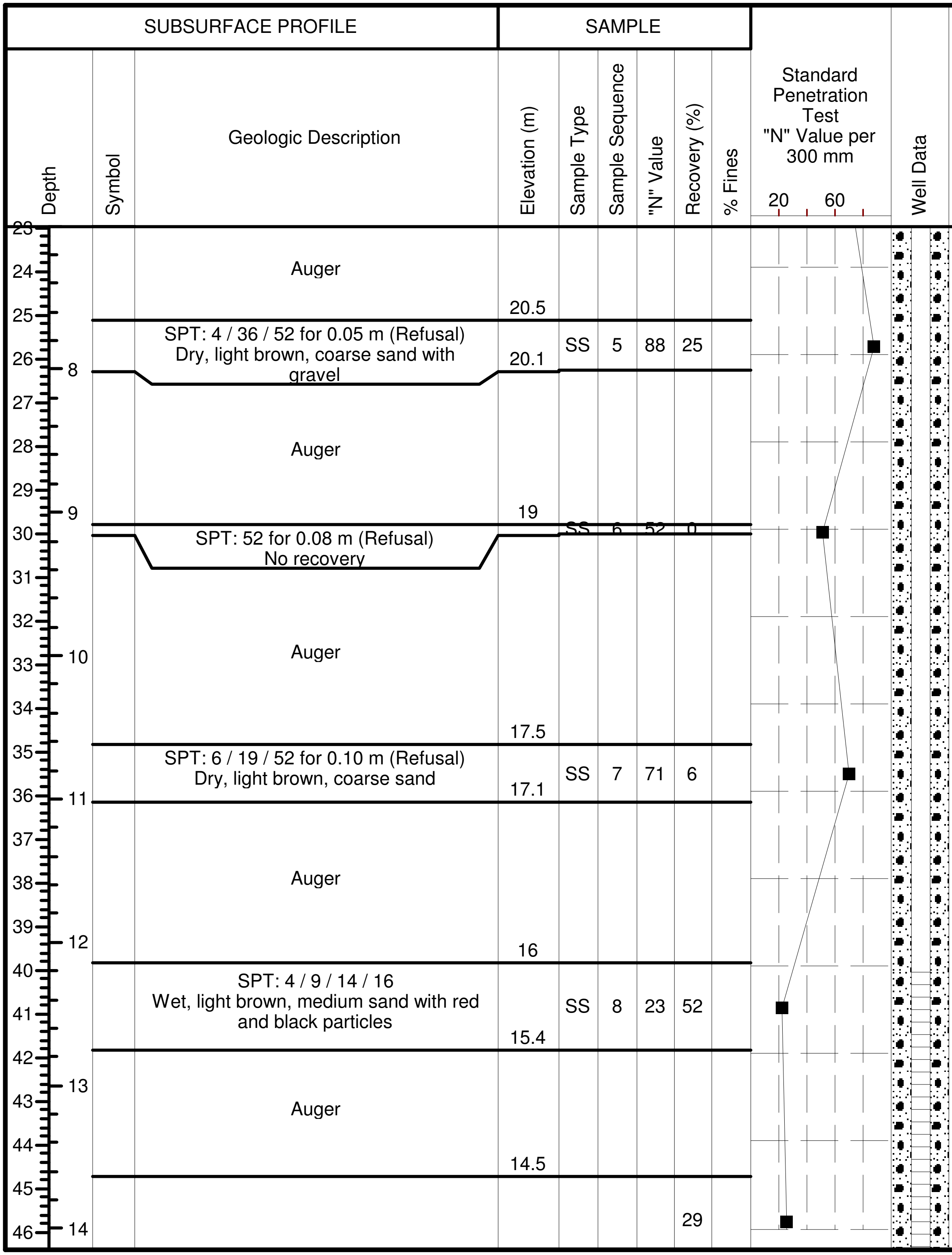
Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Project No: 3113

Date: November 23 - 26, 2017



SUBSURFACE PROFILE	SAMPLE					
Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
Auger	20.5					
SPT: 4 / 36 / 52 for 0.05 m (Refusal) Dry, light brown, coarse sand with gravel	20.1	SS	5	88	25	
Auger	19					
SPT: 52 for 0.08 m (Refusal) No recovery		SS	6	52	0	
Auger	17.5					
SPT: 6 / 19 / 52 for 0.10 m (Refusal) Dry, light brown, coarse sand	17.1	SS	7	71	6	
Auger	16					
SPT: 4 / 9 / 14 / 16 Wet, light brown, medium sand with red and black particles	15.4	SS	8	23	52	
Auger	14.5					
					29	

Well Description

Native sand packing
from 1.52 m
to 32.71 m

11.95 m BGS
(Nov. 27, 2017)

0.05 m dia. screen
from 12.21 m
to 21.36 m

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 2 of 6

Project: Geotechnical Investigation

Log of Borehole: BH3

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

SUBSURFACE PROFILE	SAMPLE							
Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Data	Well Description
SPT: 3 / 10 / 16 / 17 Wet, light brown with red and black particles 0 m - 0.05 m: fine to medium sand 0.05 m - 0.18 m: medium sand	13.9	SS	9	26	29			
Auger	12.9							
SPT: 8 / 17 / 19 / 19 Wet, light brown with red and black particles 0 m - 0.18 m: fine sand 0.18 m - 0.23 m: medium sand	12.3	SS	10	36	37			Native sand packing from 1.52 m to 32.71 m
Auger	11.5							
SPT: 8 / 16 / 24 / 29 Wet, light brown, fine sand with red and black particles	10.8	SS	11	40	30			
Auger	9.84							
SPT: 20 / 22 / 28 / 25 Wet, light brown, fine to medium sand with red and black particles	9.23	SS	12	50	67			0.05 m dia. screen from 12.21 m to 21.36 m
Auger	8.46							
SPT: 7 / 15 / 21 / 16 CFEM: Sand, trace Silt/Clay	7.85	SS	13	36	54			
Auger								

Depth
46
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59 18
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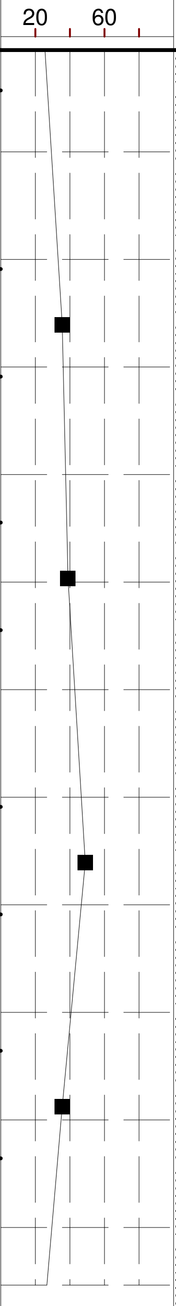
66 20
67
68
69 21

Symbol

Standard Penetration Test "N" Value per 300 mm



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 3 of 6

Project: Geotechnical Investigation

Log of Borehole: BH3

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

SUBSURFACE PROFILE	SAMPLE						
Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
	6.88						
SPT: 3 / 10 / 13 / 17 Wet, light brown, fine to medium sand with red and white particles	6.27	SS	14	23	37		Screw-on cap
Auger	5.44						
SPT: 6 / 12 / 18 / 25 CFEM: Sand, trace Silt/Clay	4.83	SS	15	30	33		
Auger	3.84						
SPT: 2 / 8 / 13 / 14 Wet, brown, fine sand	3.23	SS	16	21	1		Native sand packing from 1.52 m to 32.71 m
Auger	2.3						
SPT: 2 / 9 / 13 / 17 Brown, fine to medium sand with red and white particles	1.69	SS	17	22	29		
Auger	0.809						
SPT: 15 / 15 / 20 / 27 CFEM: Sand, trace Silt/Clay, trace Gravel	0.199	SS	18	35	21		

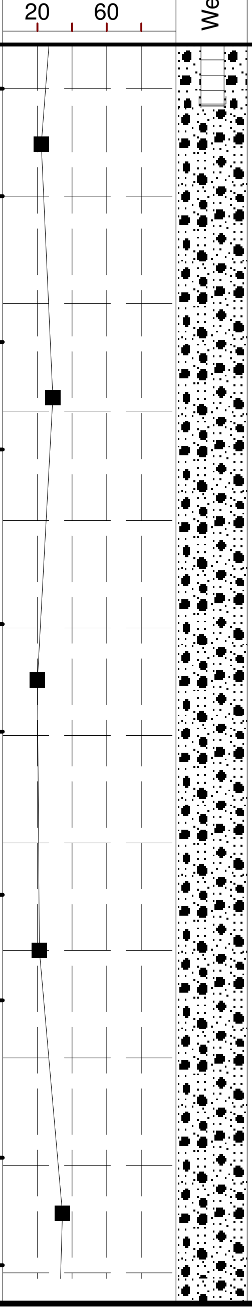
Depth

69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92

22 23 24 25 26 27 28

Symbol

Standard Penetration Test "N" Value per 300 mm



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 4 of 6

Project: Geotechnical Investigation

Log of Borehole: BH3

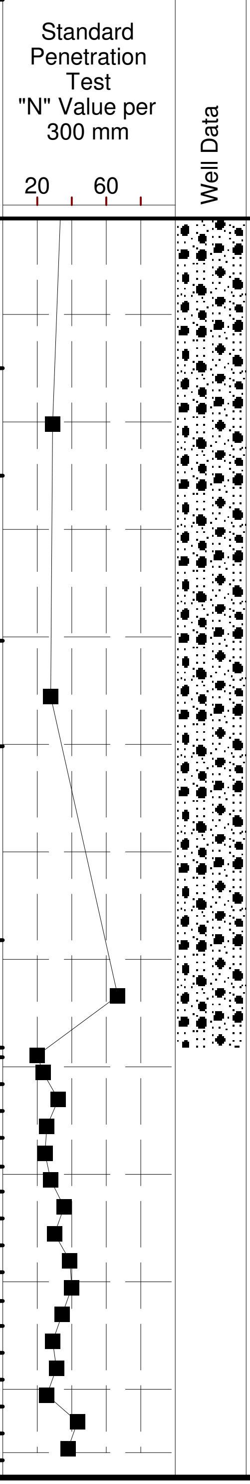
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

SUBSURFACE PROFILE			SAMPLE						
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
92 93 94		Auger	-0.721						Native sand packing from 1.52 m to 32.71 m
95 29 96		SPT: 1 / 9 / 21 / 27 Wet, grey fine to medium sand with red and white particles	-1.33	SS	19	30	21		
97 98 30 99		Auger	-2.27						
00 01		SPT: 3 / 11 / 17 / 26 CFEM: Sand, trace Silt/Clay	-2.88	SS	20	28	21		
31 02 03 04		Auger	-3.74						
05 32		Sampler sank 0.23 m under own weight	-3.97						
06 07		SPT: 22 / 31 / 36 / 53 Wet, brown, fine to medium sand with silt/clay Rock chip at the tip of sampler	-4.58	SS	21	67	10		
08 33 09 10 11 34 12 13 14 35 15		DCPT (Blow counts per 150 mm)		PC	--	21			
				PC	--	24			
				PC	--	33			
				PC	--	26			
				PC	--	25			
				PC	--	28			
				PC	--	36			
				PC	--	31			
				PC	--	40			
				PC	--	41			
				PC	--	35			
				PC	--	29			
				PC	--	32			
				PC	--	26			
				PC	--	44			
				PC	--	38			



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical Investigation

Log of Borehole: BH3

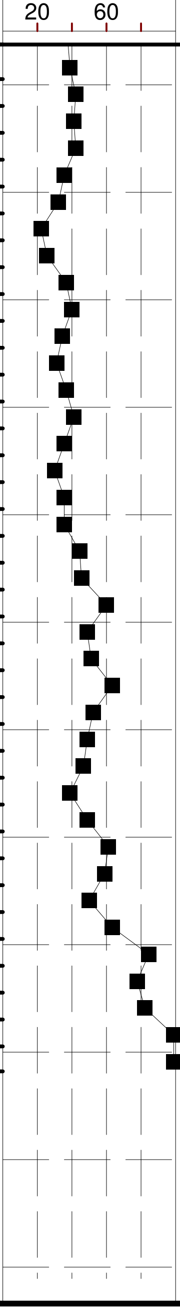
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

SUBSURFACE PROFILE			SAMPLE						Standard Penetration Test "N" Value per 300 mm	Well Data	Well Description
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	20 60		
15		DCPT (Blow counts per 150 mm)		PC	--	39					
				PC	--	43					
16				PC	--	42					
				PC	--	43					
17				PC	--	36					
				PC	--	33					
18				PC	--	23					
				PC	--	26					
19				PC	--	37					
				PC	--	41					
20				PC	--	35					
				PC	--	32					
21				PC	--	37					
				PC	--	42					
22				PC	--	36					
				PC	--	31					
23				PC	--	36					
				PC	--	36					
24				PC	--	45					
				PC	--	46					
25				PC	--	61					
				PC	--	50					
26				PC	--	52					
				PC	--	64					
27				PC	--	53					
				PC	--	49					
28				PC	--	47					
				PC	--	40					
29				PC	--	50					
				PC	--	62					
30				PC	--	59					
				PC	--	51					
31				PC	--	64					
				PC	--	85					
32				PC	--	78					
				PC	--	83					
33				PC	--	127					
			-12.7	PC	--	153					
34		End of Borehole									
35											
36											
37											



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
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

APPENDIX B

Laboratory Analytical Reports of Chemical and Bacteriological Analysis

Run Date: 22/03/18
Run Time: 0916

Western Health Care Corp. - LAB **LIVE**
Corner Brook, NL
Department Of Laboratory

Page: 1

** LIVE **

RECEIVED MAR 28 2018

NAME: PW, SEOK EUNJEONG

Report for: GOV.SERV.CENTRE-STEPHEN

SPEC #: 18:WA0000885R
OLL: 19/03/18-1835
RECD: 20/03/18-1522
COLLECTED BY: ES
SOURCE: WATER

COMMENTS: NAME:EUNJEONG SEOK FRACFLOW CONSULTANTS INC ADDRESS:154 MAJORS PATH ST JOHNS A1A 5A1 TELEPHONE:739-7270 BARCODE NUMBER:44516 SPECIMEN TYPE:DRILLED WELL

Procedure	Result	Verified	Site
***** MICROBIOLOGY *****			
> **BACTERIOLOGICAL WATER ANALYSIS**	Final	21/03/18-1538	
TOTAL COLIFORMS	ABSENT / 100ML		
FECAL COLIFORM (E. COLI)	ABSENT / 100ML		

GOVERNMENT SERVICE CENTRE

Stephenville Office
643-8650

INTERPRETATION OF WATER TEST RESULTS:

☑ Satisfactory
☐ Unsatisfactory
☐ Sub-standard
☐ Unable to Interpret

Comments: ____________________

Mar. 23/18
Date

Melanie
Environmental Health Officer III

NAME: PW,THOMPSON SHAWN

Report for: GOV.SERV.CENTRE-STEPHEN

SPEC #: 18:WA0000927R
OLL: 21/03/18-0832
RECD: 22/03/18-1104
COLLECTED BY: ST
SOURCE: WATER

COMMENTS: NAME:SHAWN THOMPSON ADDRESS:154 MAJORS PATH ST JOHNS A1A 5A1 TELEPHONE:239-2270 BARCODE NUMBER:44515 SPECIMEN TYPE:DRILLED WELL FRACFLOW CONSULTANTS INC

Procedure	Result	Verified	Site
	***** MICROBIOLOGY *****		
> **BACTERIOLOGICAL WATER ANALYSIS**	Final	23/03/18-1144	
TOTAL COLIFORMS	ABSENT / 100ML		
FECAL COLIFORM (E. COLI)	ABSENT / 100ML		

GOVERNMENT SERVICE CENTRE
Stephenville Office
643-8650

INTERPRETATION OF WATER TEST RESULTS:

☑ Satisfactory
☐ Unsatisfactory
☐ Sub-standard
☐ Unable to Interpret

Comments:

Mar 26, 2018
Date

Environmental Health Officer III

NAME: PW,THOMPSON SHAWN

Report for: GOV.SERV.CENTRE-STEPHEN

SPEC #: 18:WA0000928R **OLL:** 21/03/18-1412 **COLLECTED BY:** ST
RECD: 22/03/18-1106 **SOURCE:** WATER

COMMENTS: NAME:SHAWN THOMPSON ADDRESS:154 MAJORS PATH ST JOHNS A1A 5A1 TELEPHONE:739-7270 BARCODE NUMBER:50769 SPECIMEN TYPE:DRILLED WELL FRACFLOW CONSULTANTS INC

Procedure	Result	Verified	Site
*** MICROBIOLOGY ***			
> **BACTERIOLOGICAL WATER ANALYSIS**	Final	23/03/18-1144	
TOTAL COLIFORMS	ABSENT / 100ML		
FECAL COLIFORM (E. COLI)	ABSENT / 100ML		

GOVERNMENT SERVICE CENTRE
Stephenville Office
643-8650

INTERPRETATION OF WATER TEST RESULTS:
☑ Satisfactory ☐ Sub-standard
☐ Unsatisfactory ☐ Unable to Interpret
Comments:

Mar 26, 2018
Date

David
Environmental Health Officer III

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: 18K322806

WATER ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

DATE REPORTED: Apr 03, 2018

PAGES (INCLUDING COVER): 14

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 RDL for Hg. Issued April 3, 2018.

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

Certificate of Analysis

AGAT WORK ORDER: 18K322806
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
SAMPLING SITE:

ATTENTION TO: John Gale
SAMPLED BY:

Dissolved Metals

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

			SAMPLE DESCRIPTION:	3113-MHPW1-WS1
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-19
Parameter	Unit	G / S	RDL	9144903
Dissolved Aluminum	ug/L	Variable	5	<5
Dissolved Antimony	ug/L		2	<2
Dissolved Arsenic	ug/L	5	2	<2
Dissolved Barium	ug/L		5	41
Dissolved Beryllium	ug/L		2	<2
Dissolved Bismuth	ug/L		2	<2
Dissolved Boron	ug/L	29000,	5	21
Dissolved Cadmium	ug/L	1.0, 0.09	0.017	<0.017
Dissolved Chromium	ug/L		1	2
Dissolved Cobalt	ug/L		1	<1
Dissolved Copper	ug/L	Equation	2	4
Dissolved Iron	ug/L	300	50	<50
Dissolved Lead	ug/L	Equation	0.5	0.8
Dissolved Manganese	ug/L		2	3
Dissolved Molybdenum	ug/L	73	2	<2
Dissolved Nickel	ug/L	Equation	2	<2
Dissolved Selenium	ug/L	1.0	1	<1
Dissolved Silver	ug/L	0.25	0.1	<0.1
Dissolved Strontium	ug/L		5	84
Dissolved Thallium	ug/L	0.8	0.1	<0.1
Dissolved Tin	ug/L		2	<2
Dissolved Titanium	ug/L		2	<2
Dissolved Uranium	ug/L	33, 15	0.1	0.4
Dissolved Vanadium	ug/L		2	<2
Dissolved Zinc	ug/L	30	5	81

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

9144903 Analysis completed on a filtered sample.

Certified By: Jason Coughtrey

Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

		SAMPLE DESCRIPTION:		3113-MHPW1-WS1	3113-MHPW1-WS2
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2018-03-19	2018-03-20
Parameter	Unit	G / S	RDL	9144903	9144904
pH		6.5-9.0		8.11	8.11
Reactive Silica as SiO2	mg/L		0.5	10.9	7.4
Chloride	mg/L	640, 120	1	13	12
Fluoride	mg/L	0.12	0.12	<0.12	<0.12
Sulphate	mg/L		2	5	4
Alkalinity	mg/L		5	142	142
True Color	TCU	Narrative	5	13	14
Turbidity	NTU	Narrative	0.1	0.8	1.1
Electrical Conductivity	umho/cm		1	310	313
Nitrate + Nitrite as N	mg/L		0.05	0.43	0.37
Nitrate as N	mg/L	550, 13	0.05	0.43	0.37
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.03	0.05
Total Organic Carbon	mg/L		0.5	<0.5	<0.5
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01
Total Sodium	mg/L		0.1	8.2	8.1
Total Potassium	mg/L		0.1	1.0	0.9
Total Calcium	mg/L		0.1	50.3	47.0
Total Magnesium	mg/L		0.1	6.9	6.9
Bicarb. Alkalinity (as CaCO3)	mg/L		5	142	142
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	172	166
Hardness	mg/L			154	146
Langelier Index (@20C)	NA			0.35	0.33
Langelier Index (@ 4C)	NA			0.03	0.01
Saturation pH (@ 20C)	NA			7.76	7.78
Saturation pH (@ 4C)	NA			8.08	8.10
Anion Sum	me/L			3.34	3.29

Certified By: Jason Coughtrey

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

			SAMPLE DESCRIPTION:	3113-MHPW1-WS1	3113-MHPW1-WS2
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2018-03-19	2018-03-20
Parameter	Unit	G / S	RDL	9144903	9144904
Cation sum	me/L			3.47	3.30
% Difference/ Ion Balance (NS)	%			1.9	0.2
Total Aluminum	ug/L	Variable	5	8	7
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L	5	2	<2	<2
Total Barium	ug/L		5	39	39
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L	29000,	5	12	6
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L	Equation	1	44	13
Total Iron	ug/L	300	50	89	65
Total Lead	ug/L	Equation	0.5	4.5	1.8
Total Manganese	ug/L		2	4	3
Total Molybdenum	ug/L	73	2	<2	<2
Total Nickel	ug/L	Equation	2	2	<2
Total Phosphorous	mg/L	Fact Sheet	0.02	0.03	0.03
Total Selenium	ug/L	1	1	<1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1
Total Strontium	ug/L		5	84	86
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	<2	<2
Total Uranium	ug/L	33, 15	0.1	0.4	0.4
Total Vanadium	ug/L		2	<2	<2
Total Zinc	ug/L	30	5	82	23

Certified By: Jason Coughtrey

Certificate of Analysis

AGAT WORK ORDER: 18K322806
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-23
DATE REPORTED: 2018-04-03

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

Certified By: Jason Coughtrey

Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

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

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Various Inorganics (Water)

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

			SAMPLE DESCRIPTION:	3113-MHPW1-WS1
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-19
Parameter	Unit	G / S	RDL	9144903
Dissolved Organic Carbon	mg/L		0.5	<0.5
Mercury	mg/L	0.000026	0.000026	<0.000026
Mercury Digest				y
Total Kjeldahl Nitrogen as N	mg/L		0.4	0.5
Bromide	mg/L		0.05	<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

Certified By:

Guideline Violation

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
9144903	3113-MHPW1-WS1	NS-CCME FWAL	Dissolved Metals	Dissolved Zinc	ug/L	30	81
9144903	3113-MHPW1-WS1	NS-CCME FWAL	Standard Water Analysis + Total Metals	Total Zinc	ug/L	30	82

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K322806
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis

RPT Date: Apr 03, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Standard Water Analysis + Total Metals															
pH	9144903	9144903	8.11	8.10	0.1%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1	9133260	7.0	10	35.3%	< 0.5	113%	80%	120%		80%	120%	120%	80%	120%
Chloride	9148923		(256)	(263)	2.5%	< 1	91%	80%	120%	NA	80%	120%	NA	80%	120%
Fluoride	9148923		<0.12	<0.12	NA	< 0.12	107%	80%	120%	NA	80%	120%	97%	80%	120%
Sulphate	9148923		23	23	3.4%	< 2	109%	80%	120%	NA	80%	120%	NA	80%	120%
Alkalinity	9144903	9144903	142	142	0.3%	< 5	97%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9142642		8	10	NA	< 5	120%	80%	120%	NA			NA		
Turbidity	9142642		87.2	86.8	0.5%	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	9144903	9144903	310	312	0.7%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9148923		(7.64)	(7.95)	3.9%	< 0.05	98%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrite as N	9148923		0.41	0.42	1.9%	< 0.05	103%	80%	120%	NA	80%	120%	100%	80%	120%
Ammonia as N	1	9142979	<0.03	<0.03	NA	< 0.03	95%	80%	120%		80%	120%	92%	80%	120%
Total Organic Carbon	1	9143876	8.5	8.3	2.4%	< 0.5	94%	80%	120%		80%	120%	83%	80%	120%
Ortho-Phosphate as P	1	9133260	0.14	0.16	13.3%	< 0.01	115%	80%	120%		80%	120%	113%	80%	120%
Total Sodium	9149177		39.8	41.3	3.6%	< 0.1	103%	80%	120%	100%	80%	120%	NA	70%	130%
Total Potassium	9149177		1.3	1.4	8.3%	< 0.1	101%	80%	120%	99%	80%	120%	NA	70%	130%
Total Calcium	9149177		8.2	8.6	4.8%	< 0.1	107%	80%	120%	101%	80%	120%	NA	70%	130%
Total Magnesium	9149177		0.9	1.0	7.7%	< 0.1	105%	80%	120%	101%	80%	120%	85%	80%	120%
Bicarb. Alkalinity (as CaCO3)	9144903	9144903	142	142	0.3%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9144903	9144903	<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9144903	9144903	<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9149177		101	109	7.6%	< 5	107%	80%	120%	106%	80%	120%	103%	70%	130%
Total Antimony	9149177		<2	<2	NA	< 2	98%	80%	120%	112%	80%	120%	103%	70%	130%
Total Arsenic	9149177		<2	<2	NA	< 2	97%	80%	120%	100%	80%	120%	97%	70%	130%
Total Barium	9149177		25	25	NA	< 5	98%	80%	120%	98%	80%	120%	NA	70%	130%
Total Beryllium	9149177		<2	<2	NA	< 2	100%	80%	120%	102%	80%	120%	97%	70%	130%
Total Bismuth	9149177		<2	<2	NA	< 2	108%	80%	120%	116%	80%	120%	98%	70%	130%
Total Boron	9149177		12	12	NA	< 5	100%	80%	120%	108%	80%	120%	101%	70%	130%
Total Cadmium	9149177		0.047	0.049	NA	< 0.017	98%	80%	120%	99%	80%	120%	94%	70%	130%
Total Chromium	9149177		<1	<1	NA	< 1	107%	80%	120%	108%	80%	120%	102%	70%	130%
Total Cobalt	9149177		<1	<1	NA	< 1	119%	80%	120%	120%	80%	120%	119%	70%	130%
Total Copper	9149177		96	100	3.7%	< 1	109%	80%	120%	113%	80%	120%	NA	70%	130%
Total Iron	9149177		227	239	NA	< 50	116%	80%	120%	119%	80%	120%	NA	70%	130%
Total Lead	9149177		2.4	2.4	NA	< 0.5	118%	80%	120%	119%	80%	120%	102%	70%	130%
Total Manganese	9149177		16	16	3.6%	< 2	113%	80%	120%	113%	80%	120%	NA	70%	130%
Total Molybdenum	9149177		<2	<2	NA	< 2	99%	80%	120%	103%	80%	120%	107%	70%	130%
Total Nickel	9149177		<2	<2	NA	< 2	107%	80%	120%	110%	80%	120%	103%	70%	130%
Total Phosphorous	9149177		0.02	0.02	NA	< 0.02	97%	80%	120%	87%	80%	120%	104%	70%	130%
Total Selenium	9149177		<1	<1	NA	< 1	92%	80%	120%	96%	80%	120%	87%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 18K322806
PROJECT: 3113-Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 03, 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
Total Silver	9149177		<0.1	<0.1	NA	< 0.1	107%	80%	120%	108%	80%	120%	99%	70%	130%
Total Strontium	9149177		28	28	0.0%	< 5	104%	80%	120%	103%	80%	120%	NA	70%	130%
Total Thallium	9149177		<0.1	<0.1	NA	< 0.1	110%	80%	120%	114%	80%	120%	104%	70%	130%
Total Tin	9149177		<2	<2	NA	< 2	98%	80%	120%	101%	80%	120%	101%	70%	130%
Total Titanium	9149177		<2	<2	NA	< 2	104%	80%	120%	105%	80%	120%	100%	70%	130%
Total Uranium	9149177		0.6	0.6	1.3%	< 0.1	109%	80%	120%	110%	80%	120%	107%	70%	130%
Total Vanadium	9149177		<2	<2	NA	< 2	103%	80%	120%	104%	80%	120%	106%	70%	130%
Total Zinc	9149177		11	10	NA	< 5	108%	80%	120%	109%	80%	120%	92%	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.

Dissolved Metals

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Lower	Upper	Recovery	Lower	Upper	Recovery	Lower	Upper
Dissolved Aluminum	9150500		<5	<5	NA	< 5	108%	80%	120%	106%	80%	120%	93%	70%	130%
Dissolved Antimony	9150500		<2	<2	NA	< 2	95%	80%	120%	106%	80%	120%	115%	70%	130%
Dissolved Arsenic	9150500		7	6	NA	< 2	97%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Barium	9150500		98	98	0.3%	< 5	100%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Beryllium	9150500		<2	<2	NA	< 2	102%	80%	120%	106%	80%	120%	107%	70%	130%
Dissolved Bismuth	9150500		<2	<2	NA	< 2	93%	80%	120%	105%	80%	120%	NA	70%	130%
Dissolved Boron	9150500		140	138	1.8%	< 5	104%	80%	120%	107%	80%	120%	NA	70%	130%
Dissolved Cadmium	9150500		0.026	0.025	NA	< 0.017	97%	80%	120%	99%	80%	120%	103%	70%	130%
Dissolved Chromium	9150500		2	3	NA	< 1	92%	80%	120%	97%	80%	120%	102%	70%	130%
Dissolved Cobalt	9150500		2	2	NA	< 1	103%	80%	120%	108%	80%	120%	114%	70%	130%
Dissolved Copper	9150500		<2	<2	NA	< 2	95%	80%	120%	99%	80%	120%	83%	70%	130%
Dissolved Iron	9150500		<50	<50	NA	< 50	100%	80%	120%	102%	80%	120%	98%	70%	130%
Dissolved Lead	9150500		<0.5	<0.5	NA	< 0.5	100%	80%	120%	101%	80%	120%	90%	70%	130%
Dissolved Manganese	9150500		1140	1100	3.1%	< 2	99%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Molybdenum	9150500		<2	<2	NA	< 2	93%	80%	120%	97%	80%	120%	97%	70%	130%
Dissolved Nickel	9150500		12	12	0.4%	< 2	95%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Selenium	9150500		2	2	NA	< 1	104%	80%	120%	103%	80%	120%	NA	70%	130%
Dissolved Silver	9150500		<0.1	<0.1	NA	< 0.1	95%	80%	120%	100%	80%	120%	95%	70%	130%
Dissolved Strontium	9150500		1230	1190	3.5%	< 5	103%	80%	120%	104%	80%	120%	NA	70%	130%
Dissolved Thallium	9150500		<0.1	<0.1	NA	< 0.1	99%	80%	120%	103%	80%	120%	98%	70%	130%
Dissolved Tin	9150500		<2	<2	NA	< 2	96%	80%	120%	99%	80%	120%	98%	70%	130%
Dissolved Titanium	9150500		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	94%	70%	130%
Dissolved Uranium	9150500		0.4	0.4	NA	< 0.1	95%	80%	120%	98%	80%	120%	102%	70%	130%
Dissolved Vanadium	9150500		3	3	NA	< 2	91%	80%	120%	92%	80%	120%	113%	70%	130%
Dissolved Zinc	9150500		8	8	NA	< 5	93%	80%	120%	95%	80%	120%	94%	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.

Various Inorganics (Water)

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Lower	Upper	Recovery	Lower	Upper	Recovery	Lower	Upper
Mercury	1	9143899	<0.	<0.	NA	< 0.000026	100%	80%	120%		80%	120%	99%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K322806
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 03, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Kjeldahl Nitrogen as N	1	9142487	0.5	0.5	NA	< 0.4	120%	80%	120%		80%	120%	90%	80%	120%
Bromide	9148923		0.09	0.10	NA	< 0.05	94%	80%	120%	NA	80%	120%	114%	80%	120%

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: Jason Coughtrey

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

PROJECT: 3113-Stephenville, NL

SAMPLING SITE:

AGAT WORK ORDER: 18K322806

ATTENTION TO: John Gale

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INORG-121-6028	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 18K322806
PROJECT: 3113-Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Total Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K322806
ATTENTION TO: John Gale
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Mercury	MET-121-6100 & MET-121-6107	SM 3112 B	CVAAS
Mercury Digest	MET-121-6100 & MET-121-6107	EPA 245.5	CV/AA
Total Kjeldahl Nitrogen as N	INOR-121-6020	SM 4500 NORG D	COLORIMETER
Bromide	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only

Arrival Condition: ☑ Good ☐ Poor (see notes)
Arrival Temperature: 3.8 C
Hold Time:
AGAT Job Number: 18K322806
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:

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
☐ Res/Park ☐ HRM 101
☐ Agricultural ☐ Storm Water
☑ FWAL ☐ Waste Water
☐ Sediment ☐ Other

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

Invoice To Same Yes ☑ / No ☐

Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3880

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: Diss Organic Carbon	Other: Bromide & TKN	Hazardous (Y/N)
3113-MHPW1-WS1	March 19, 2018 18:35	Water	6	Doc & Diss.Metal filtered		✓	✓	✓																		✓	✓	
3113-MHPW1-WS2	March 20, 2018 11:48	Water	4	Diss.Metal filtered		✓	✓																					

Samples Relinquished By (Print Name): Eunjeong Seok
Date/Time: March 23/18
Samples Received By (Print Name): Emma Penney
Date/Time: Mar. 23/18

Samples Relinquished By (Sign):
Date/Time: 10:07
Samples Received By (Sign): Emma Penney
Date/Time: 10:06am.

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

Page 1 of 1

Nº: FFC-3113-COC-07

Document ID: DIV-133-1501.002

Date revised: January 2016

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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: 18K323461

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

WATER ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

DATE REPORTED: Apr 19, 2018

PAGES (INCLUDING COVER): 21

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. Corrected sampling dates. Issued April 19th, 2018.

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: 18K323461
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: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS3	3113-MHPW1-WS5
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149302
Benzene	mg/L		0.001	<0.001	<0.001
Toluene	mg/L		0.001	<0.001	<0.001
Ethylbenzene	mg/L		0.001	<0.001	<0.001
Xylene (Total)	mg/L		0.001	<0.001	<0.001
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C21-C32 Hydrocarbons	mg/L		0.01	<0.01	<0.01
Modified TPH (Tier 1)	mg/L		0.1	<0.1	<0.1
Resemblance Comment				NR	NR
Return to Baseline at C32				Y	Y
Surrogate	Unit	Acceptable Limits			
Isobutylbenzene - EPH	%	70-130		111	119
Isobutylbenzene - VPH	%	70-130		89	94
n-Dotriacontane - EPH	%	70-130		112	122

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

9149300-9149302 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:

Certificate of Analysis

AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Dissolved Metals

DATE RECEIVED: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS3	3113-MHPW1-WS5
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149302
Dissolved Aluminum	ug/L		5	<5	<5
Dissolved Antimony	ug/L		2	<2	<2
Dissolved Arsenic	ug/L		2	<2	<2
Dissolved Barium	ug/L		5	40	39
Dissolved Beryllium	ug/L		2	<2	<2
Dissolved Bismuth	ug/L		2	<2	<2
Dissolved Boron	ug/L		5	7	7
Dissolved Cadmium	ug/L		0.017	<0.017	<0.017
Dissolved Chromium	ug/L		1	2	2
Dissolved Cobalt	ug/L		1	<1	<1
Dissolved Copper	ug/L		2	<2	<2
Dissolved Iron	ug/L		50	<50	<50
Dissolved Lead	ug/L		0.5	<0.5	<0.5
Dissolved Manganese	ug/L		2	2	<2
Dissolved Molybdenum	ug/L		2	<2	<2
Dissolved Nickel	ug/L		2	6	<2
Dissolved Selenium	ug/L		1	<1	<1
Dissolved Silver	ug/L		0.1	<0.1	<0.1
Dissolved Strontium	ug/L		5	83	83
Dissolved Thallium	ug/L		0.1	<0.1	<0.1
Dissolved Tin	ug/L		2	<2	<2
Dissolved Titanium	ug/L		2	<2	<2
Dissolved Uranium	ug/L		0.1	0.3	0.3
Dissolved Vanadium	ug/L		2	<2	<2
Dissolved Zinc	ug/L		5	28	29

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
9149300-9149302 Analysis completed on a filtered sample.

Certified By: Laura Baker

Certificate of Analysis

AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Mercury Analysis in Water (Total)

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS5
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL	9149302
Total Mercury	ug/L	0.026	0.026	<0.026

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

Certified By:

Certificate of Analysis

AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

57 Old Pennywell Road, Unit I
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CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS3	3113-MHPW1-WS4
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149305
pH		6.5-9.0		8.14	8.13
Reactive Silica as SiO2	mg/L		0.5	6.0	5.7
Chloride	mg/L	640, 120	1	12	12
Fluoride	mg/L	0.12	0.12	<0.12	<0.12
Sulphate	mg/L		2	4	4
Alkalinity	mg/L		5	143	143
True Color	TCU	Narrative	5	<5	<5
Turbidity	NTU	Narrative	0.1	0.5	0.9
Electrical Conductivity	umho/cm		1	321	323
Nitrate + Nitrite as N	mg/L		0.05	0.36	0.39
Nitrate as N	mg/L	550, 13	0.05	0.36	0.39
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.04	0.04
Total Organic Carbon	mg/L		0.5	<0.5	0.7
Ortho-Phosphate as P	mg/L		0.01	0.08	0.07
Total Sodium	mg/L		0.1	8.2	8.3
Total Potassium	mg/L		0.1	0.9	0.9
Total Calcium	mg/L		0.1	50.0	47.3
Total Magnesium	mg/L		0.1	7.2	7.1
Bicarb. Alkalinity (as CaCO3)	mg/L		5	143	143
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	170	167
Hardness	mg/L			154	147
Langelier Index (@20C)	NA			0.38	0.35
Langelier Index (@ 4C)	NA			0.06	0.03
Saturation pH (@ 20C)	NA			7.76	7.78
Saturation pH (@ 4C)	NA			8.08	8.10
Anion Sum	me/L			3.31	3.31

Certified By: Laura Baker

Certificate of Analysis

AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
SAMPLING SITE:

ATTENTION TO: John Gale
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

		SAMPLE DESCRIPTION:		3113-MHPW1-WS3	3113-MHPW1-WS4
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149305
Cation sum	me/L			3.48	3.34
% Difference/ Ion Balance (NS)	%			2.5	0.4
Total Aluminum	ug/L	Variable	5	<5	<5
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L	5	2	<2	<2
Total Barium	ug/L		5	39	39
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L	29000,	5	7	7
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L	Equation	1	4	1
Total Iron	ug/L	300	50	65	68
Total Lead	ug/L	Equation	0.5	0.6	0.6
Total Manganese	ug/L		2	3	3
Total Molybdenum	ug/L	73	2	<2	<2
Total Nickel	ug/L	Equation	2	2	2
Total Phosphorous	mg/L	Fact Sheet	0.02	0.03	0.03
Total Selenium	ug/L	1	1	<1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1
Total Strontium	ug/L		5	86	88
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	<2	<2
Total Uranium	ug/L	33, 15	0.1	0.4	0.4
Total Vanadium	ug/L		2	<2	<2
Total Zinc	ug/L	30	5	26	15

Certified By: Laura Baker

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

Certified By: Laura Baker

CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals+ DOC,TKN,Bromide

DATE RECEIVED: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS5
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL	9149302
pH				8.13
Reactive Silica as SiO2	mg/L		0.5	5.7
Chloride	mg/L		1	12
Fluoride	mg/L		0.12	<0.12
Sulphate	mg/L		2	4
Alkalinity	mg/L		5	143
True Color	TCU		5	<5
Turbidity	NTU		0.1	0.7
Electrical Conductivity	umho/cm		1	322
Nitrate + Nitrite as N	mg/L		0.05	0.37
Nitrate as N	mg/L		0.05	0.37
Nitrite as N	mg/L		0.05	<0.05
Ammonia as N	mg/L		0.03	<0.03
Total Organic Carbon	mg/L		0.5	1.7
Ortho-Phosphate as P	mg/L		0.01	0.08
Total Sodium	mg/L		0.1	8.2
Total Potassium	mg/L		0.1	0.9
Total Calcium	mg/L		0.1	49.7
Total Magnesium	mg/L		0.1	6.8
Bicarb. Alkalinity (as CaCO3)	mg/L		5	143
Carb. Alkalinity (as CaCO3)	mg/L		10	<10
Hydroxide	mg/L		5	<5
Calculated TDS	mg/L		1	169
Hardness	mg/L			152
Langelier Index (@20C)	NA			0.37
Langelier Index (@ 4C)	NA			0.05
Saturation pH (@ 20C)	NA			7.76
Saturation pH (@ 4C)	NA			8.08
Anion Sum	me/L			3.31

Certified By: Laura Baker

CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals+ DOC,TKN,Bromide

DATE RECEIVED: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS5
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL	9149302
Cation sum	me/L			3.42
% Difference/ Ion Balance (NS)	%			1.7
Total Aluminum	ug/L		5	<5
Total Antimony	ug/L		2	<2
Total Arsenic	ug/L		2	<2
Total Barium	ug/L		5	39
Total Beryllium	ug/L		2	<2
Total Bismuth	ug/L		2	<2
Total Boron	ug/L		5	6
Total Cadmium	ug/L		0.017	<0.017
Total Chromium	ug/L		1	<1
Total Cobalt	ug/L		1	<1
Total Copper	ug/L		1	1
Total Iron	ug/L		50	63
Total Lead	ug/L		0.5	<0.5
Total Manganese	ug/L		2	3
Total Molybdenum	ug/L		2	<2
Total Nickel	ug/L		2	2
Total Phosphorous	mg/L		0.02	0.02
Total Selenium	ug/L		1	<1
Total Silver	ug/L		0.1	<0.1
Total Strontium	ug/L		5	87
Total Thallium	ug/L		0.1	<0.1
Total Tin	ug/L		2	<2
Total Titanium	ug/L		2	<2
Total Uranium	ug/L		0.1	0.3
Total Vanadium	ug/L		2	<2
Total Zinc	ug/L		5	22
Bromide	µg/L		50	<50

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Certificate of Analysis

AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
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SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals+ DOC,TKN,Bromide

DATE RECEIVED: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS5
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL	9149302
TKN Digest				Y
Total Kjeldahl Nitrogen as N	mg/L		0.4	<0.4
Dissolved Organic Carbon	mg/L		0.5	<0.5

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

Certified By: Laura Baker

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Trace Organics Analysis

RPT Date: Apr 19, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level															
Benzene	1	9149010	< 0.001	< 0.001	NA	< 0.001	103%	70%	130%	112%	70%	130%	NA		
Toluene	1	9149010	< 0.001	< 0.001	NA	< 0.001	106%	70%	130%	108%	70%	130%	NA		
Ethylbenzene	1	9149010	< 0.001	< 0.001	NA	< 0.001	104%	70%	130%	102%	70%	130%	NA		
Xylene (Total)	1	9149010	< 0.001	< 0.001	NA	< 0.001	109%	70%	130%	110%	70%	130%	NA		
C6-C10 (less BTEX)	1	9149010	< 0.01	< 0.01	NA	< 0.01	100%	70%	130%	106%	70%	130%	106%	70%	130%
>C10-C16 Hydrocarbons	1	9149302	< 0.05	< 0.05	NA	< 0.05	109%	70%	130%	123%	70%	130%	125%	70%	130%
>C16-C21 Hydrocarbons	1	9149302	< 0.05	< 0.05	NA	< 0.05	116%	70%	130%	123%	70%	130%	125%	70%	130%
>C21-C32 Hydrocarbons	1	9149302	< 0.01	< 0.01	NA	< 0.01	104%	70%	130%	123%	70%	130%	125%	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:

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis

RPT Date: Apr 19, 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
Standard Water Analysis + Total Metals															
pH	9148925		7.75	7.77	0.3%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1	9149300	6.0	5.9	1.7%	< 0.5	98%	80%	120%		80%	120%	100%	80%	120%
Chloride	9149375		4	4	NA	< 1	92%	80%	120%	NA	80%	120%	90%	80%	120%
Fluoride	9149375		<0.12	<0.12	NA	< 0.12	104%	80%	120%	NA	80%	120%	90%	80%	120%
Sulphate	9149375		<2	<2	NA	< 2	113%	80%	120%	NA	80%	120%	94%	80%	120%
Alkalinity	9148925		213	213	0.1%	< 5	97%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9149300	9149300	<5	6	NA	< 5	105%	80%	120%	NA			NA		
Turbidity	9149300	9149300	0.5	0.4	NA	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	9148925		1530	1540	0.5%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9149375		0.20	0.18	NA	< 0.05	101%	80%	120%	NA	80%	120%	82%	80%	120%
Nitrite as N	9149375		<0.05	<0.05	NA	< 0.05	105%	80%	120%	NA	80%	120%	87%	80%	120%
Ammonia as N	1	9144766	0.03	0.02	NA	< 0.03	92%	80%	120%		80%	120%	95%	80%	120%
Total Organic Carbon	1	9149300	<0.5	<0.5	NA	< 0.5	108%	80%	120%		80%	120%	105%	80%	120%
Ortho-Phosphate as P	1	9149300	0.08	0.07	13.3%	< 0.01	115%	80%	120%		80%	120%	90%	80%	120%
Total Sodium	9150501		19.1	19.8	3.7%	< 0.1	105%	80%	120%	108%	80%	120%	NA	70%	130%
Total Potassium	9150501		1.7	1.6	1.7%	< 0.1	103%	80%	120%	104%	80%	120%	NA	70%	130%
Total Calcium	9150501		85.9	88.9	3.4%	< 0.1	109%	80%	120%	106%	80%	120%	NA	70%	130%
Total Magnesium	9150501		9.4	9.2	2.4%	< 0.1	105%	80%	120%	107%	80%	120%	NA	80%	120%
Bicarb. Alkalinity (as CaCO3)	9148925		213	213	0.1%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9148925		<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9148925		<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9150501		9	9	NA	< 5	108%	80%	120%	109%	80%	120%	97%	70%	130%
Total Antimony	9150501		<2	<2	NA	< 2	92%	80%	120%	103%	80%	120%	98%	70%	130%
Total Arsenic	9150501		<2	<2	NA	< 2	98%	80%	120%	92%	80%	120%	97%	70%	130%
Total Barium	9150501		49	49	0.2%	< 5	99%	80%	120%	97%	80%	120%	NA	70%	130%
Total Beryllium	9150501		<2	<2	NA	< 2	102%	80%	120%	105%	80%	120%	97%	70%	130%
Total Bismuth	9150501		<2	<2	NA	< 2	97%	80%	120%	106%	80%	120%	92%	70%	130%
Total Boron	9150501		12	11	NA	< 5	104%	80%	120%	102%	80%	120%	102%	70%	130%
Total Cadmium	9150501		0.051	0.050	NA	< 0.017	98%	80%	120%	97%	80%	120%	93%	70%	130%
Total Chromium	9150501		<1	<1	NA	< 1	107%	80%	120%	107%	80%	120%	106%	70%	130%
Total Cobalt	9150501		<1	<1	NA	< 1	105%	80%	120%	103%	80%	120%	103%	70%	130%
Total Copper	9150501		34	33	2.5%	< 1	107%	80%	120%	103%	80%	120%	NA	70%	130%
Total Iron	9150501		90	85	NA	< 50	114%	80%	120%	115%	80%	120%	113%	70%	130%
Total Lead	9150501		11.6	11.5	0.6%	< 0.5	107%	80%	120%	105%	80%	120%	NA	70%	130%
Total Manganese	9150501		373	386	3.3%	< 2	115%	80%	120%	114%	80%	120%	NA	70%	130%
Total Molybdenum	9150501		<2	<2	NA	< 2	92%	80%	120%	94%	80%	120%	102%	70%	130%
Total Nickel	9150501		4	4	NA	< 2	106%	80%	120%	104%	80%	120%	97%	70%	130%
Total Phosphorous	9150501		0.03	0.03	NA	< 0.02	106%	80%	120%	91%	80%	120%	101%	70%	130%
Total Selenium	9150501		<1	<1	NA	< 1	96%	80%	120%	85%	80%	120%	92%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 19, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Silver	9150501		<0.1	<0.1	NA	< 0.1	99%	80%	120%	102%	80%	120%	95%	70%	130%
Total Strontium	9150501		288	298	3.1%	< 5	102%	80%	120%	103%	80%	120%	NA	70%	130%
Total Thallium	9150501		<0.1	<0.1	NA	< 0.1	103%	80%	120%	105%	80%	120%	97%	70%	130%
Total Tin	9150501		<2	<2	NA	< 2	95%	80%	120%	94%	80%	120%	95%	70%	130%
Total Titanium	9150501		<2	<2	NA	< 2	107%	80%	120%	108%	80%	120%	86%	70%	130%
Total Uranium	9150501		<0.1	<0.1	NA	< 0.1	101%	80%	120%	100%	80%	120%	98%	70%	130%
Total Vanadium	9150501		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	110%	70%	130%
Total Zinc	9150501		41	41	1.9%	< 5	112%	80%	120%	109%	80%	120%	122%	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.															
Standard Water Analysis + Total Metals+ DOC,TKN,Bromide															
pH	9148925		7.75	7.77	0.3%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Chloride	9149375		4	4	NA	< 1	92%	80%	120%	NA	80%	120%	90%	80%	120%
Fluoride	9149375		<0.12	<0.12	NA	< 0.12	104%	80%	120%	NA	80%	120%	90%	80%	120%
Sulphate	9149375		<2	<2	NA	< 2	113%	80%	120%	NA	80%	120%	94%	80%	120%
Alkalinity	9148925		213	213	0.1%	< 5	97%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9149300	9149300	<5	6	NA	< 5	105%	80%	120%	NA			NA		
Turbidity	9149300	9149300	0.5	0.4	NA	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	9148925		1530	1540	0.5%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9149375		0.20	0.18	NA	< 0.05	101%	80%	120%	NA	80%	120%	82%	80%	120%
Nitrite as N	9149375		<0.05	<0.05	NA	< 0.05	105%	80%	120%	NA	80%	120%	87%	80%	120%
Total Sodium	9150501		19.1	19.8	3.7%	< 0.1	105%	80%	120%	108%	80%	120%	NA	70%	130%
Total Potassium	9150501		1.7	1.6	1.7%	< 0.1	103%	80%	120%	104%	80%	120%	NA	70%	130%
Total Calcium	9150501		85.9	88.9	3.4%	< 0.1	109%	80%	120%	106%	80%	120%	NA	70%	130%
Total Magnesium	9150501		9.4	9.2	2.4%	< 0.1	105%	80%	120%	107%	80%	120%	NA	80%	120%
Bicarb. Alkalinity (as CaCO3)	9148925		213	213	0.1%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9148925		<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9148925		<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9150501		9	9	NA	< 5	108%	80%	120%	109%	80%	120%	97%	70%	130%
Total Antimony	9150501		<2	<2	NA	< 2	92%	80%	120%	103%	80%	120%	98%	70%	130%
Total Arsenic	9150501		<2	<2	NA	< 2	98%	80%	120%	92%	80%	120%	97%	70%	130%
Total Barium	9150501		49	49	0.2%	< 5	99%	80%	120%	97%	80%	120%	NA	70%	130%
Total Beryllium	9150501		<2	<2	NA	< 2	102%	80%	120%	105%	80%	120%	97%	70%	130%
Total Bismuth	9150501		<2	<2	NA	< 2	97%	80%	120%	106%	80%	120%	92%	70%	130%
Total Boron	9150501		12	11	NA	< 5	104%	80%	120%	102%	80%	120%	102%	70%	130%
Total Cadmium	9150501		0.051	0.050	NA	< 0.017	98%	80%	120%	97%	80%	120%	93%	70%	130%
Total Chromium	9150501		<1	<1	NA	< 1	107%	80%	120%	107%	80%	120%	106%	70%	130%
Total Cobalt	9150501		<1	<1	NA	< 1	105%	80%	120%	103%	80%	120%	103%	70%	130%
Total Copper	9150501		34	33	2.5%	< 1	107%	80%	120%	103%	80%	120%	NA	70%	130%
Total Iron	9150501		90	85	NA	< 50	114%	80%	120%	115%	80%	120%	113%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 19, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Lead	9150501		11.6	11.5	0.6%	< 0.5	107%	80%	120%	105%	80%	120%	NA	70%	130%
Total Manganese	9150501		373	386	3.3%	< 2	115%	80%	120%	114%	80%	120%	NA	70%	130%
Total Molybdenum	9150501		<2	<2	NA	< 2	92%	80%	120%	94%	80%	120%	102%	70%	130%
Total Nickel	9150501		4	4	NA	< 2	106%	80%	120%	104%	80%	120%	97%	70%	130%
Total Phosphorous	9150501		0.03	0.03	NA	< 0.02	106%	80%	120%	91%	80%	120%	101%	70%	130%
Total Selenium	9150501		<1	<1	NA	< 1	96%	80%	120%	85%	80%	120%	92%	70%	130%
Total Silver	9150501		<0.1	<0.1	NA	< 0.1	99%	80%	120%	102%	80%	120%	95%	70%	130%
Total Strontium	9150501		288	298	3.1%	< 5	102%	80%	120%	103%	80%	120%	NA	70%	130%
Total Thallium	9150501		<0.1	<0.1	NA	< 0.1	103%	80%	120%	105%	80%	120%	97%	70%	130%
Total Tin	9150501		<2	<2	NA	< 2	95%	80%	120%	94%	80%	120%	95%	70%	130%
Total Titanium	9150501		<2	<2	NA	< 2	107%	80%	120%	108%	80%	120%	86%	70%	130%
Total Uranium	9150501		<0.1	<0.1	NA	< 0.1	101%	80%	120%	100%	80%	120%	98%	70%	130%
Total Vanadium	9150501		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	110%	70%	130%
Total Zinc	9150501		41	41	1.9%	< 5	112%	80%	120%	109%	80%	120%	122%	70%	130%
Bromide	9149375		<50	<50	NA	< 50	92%	80%	120%	NA	80%	120%	88%	80%	120%
Total Kjeldahl Nitrogen as N	1	9144766	0.4	0.5	NA	< 0.4	98%	80%	120%		80%	120%	105%	80%	120%

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

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Lower	Upper	Recovery	Lower	Upper	Recovery	Lower	Upper
Dissolved Metals															
Dissolved Aluminum	9150500		<5	<5	NA	< 5	108%	80%	120%	106%	80%	120%	93%	70%	130%
Dissolved Antimony	9150500		<2	<2	NA	< 2	95%	80%	120%	106%	80%	120%	115%	70%	130%
Dissolved Arsenic	9150500		7	6	NA	< 2	97%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Barium	9150500		98	98	0.3%	< 5	100%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Beryllium	9150500		<2	<2	NA	< 2	102%	80%	120%	106%	80%	120%	107%	70%	130%
Dissolved Bismuth	9150500		<2	<2	NA	< 2	93%	80%	120%	105%	80%	120%	NA	70%	130%
Dissolved Boron	9150500		140	138	1.8%	< 5	104%	80%	120%	107%	80%	120%	NA	70%	130%
Dissolved Cadmium	9150500		0.026	0.025	NA	< 0.017	97%	80%	120%	99%	80%	120%	103%	70%	130%
Dissolved Chromium	9150500		2	3	NA	< 1	92%	80%	120%	97%	80%	120%	102%	70%	130%
Dissolved Cobalt	9150500		2	2	NA	< 1	103%	80%	120%	108%	80%	120%	114%	70%	130%
Dissolved Copper	9150500		<2	<2	NA	< 2	95%	80%	120%	99%	80%	120%	83%	70%	130%
Dissolved Iron	9150500		<50	<50	NA	< 50	100%	80%	120%	102%	80%	120%	98%	70%	130%
Dissolved Lead	9150500		<0.5	<0.5	NA	< 0.5	100%	80%	120%	101%	80%	120%	90%	70%	130%
Dissolved Manganese	9150500		1140	1100	3.1%	< 2	99%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Molybdenum	9150500		<2	<2	NA	< 2	93%	80%	120%	97%	80%	120%	97%	70%	130%
Dissolved Nickel	9150500		12	12	0.4%	< 2	95%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Selenium	9150500		2	2	NA	< 1	104%	80%	120%	103%	80%	120%	NA	70%	130%
Dissolved Silver	9150500		<0.1	<0.1	NA	< 0.1	95%	80%	120%	100%	80%	120%	95%	70%	130%
Dissolved Strontium	9150500		1230	1190	3.5%	< 5	103%	80%	120%	104%	80%	120%	NA	70%	130%
Dissolved Thallium	9150500		<0.1	<0.1	NA	< 0.1	99%	80%	120%	103%	80%	120%	98%	70%	130%
Dissolved Tin	9150500		<2	<2	NA	< 2	96%	80%	120%	99%	80%	120%	98%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 19, 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 Titanium	9150500		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	94%	70%	130%
Dissolved Uranium	9150500		0.4	0.4	NA	< 0.1	95%	80%	120%	98%	80%	120%	102%	70%	130%
Dissolved Vanadium	9150500		3	3	NA	< 2	91%	80%	120%	92%	80%	120%	113%	70%	130%
Dissolved Zinc	9150500		8	8	NA	< 5	93%	80%	120%	95%	80%	120%	94%	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.

Mercury Analysis in Water (Total)

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Lower	Upper	Recovery	Lower	Upper	Recovery	Lower	Upper
Total Mercury	1	9151513	<0.05	<0.05	NA	< 0.026	95%	80%	120%		80%	120%	97%	80%	120%

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:

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K323461

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-120-5010	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
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	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	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:
AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Mercury	MET-121-6100 & MET-121-6107	SM 3112 B	CV/AA
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INORG-121-6028	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Total Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bromide	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
TKN Digest			COLORIMETER
Total Kjeldahl Nitrogen as N	INOR-121-6020	SM 4500 NORG D	COLORIMETER
Dissolved Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only

Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 7.1
Hold Time:
AGAT Job Number: 18K323461
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#: 3881

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
☐ Res/Park ☐ HRM 101
☐ Agricultural ☐ Storm Water
☑ FWAL ☐ Waste Water
☐ 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: Diss Organic Carbon	Other: Bromide & TKN	Hazardous (Y/N)
3113-MHPW1-WS3	March 21, 2018 08:30	Water	9	1x500, 3x100, 2x250, 3x40		✓	✓								✓													
				Diss.Metal filtered																								
3113-MHPW1-WS5	March 22, 2018 17:27	Water	11	1x500, 5x100, 2x250, 3x40		✓	✓	✓							✓											✓	✓	
				Doc & Diss.Metal filtered																								

Samples Relinquished By (Print Name): Eunjeong Seok
Date/Time: March 26/18
Samples Relinquished By (Sign): E Sk
Date/Time: 12:45
Samples Received By (Print Name): A Clamily
Date/Time: 03/26/18
Samples Received By (Sign):
Date/Time: 12:45

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

Page 1 of 2
Nº: FFC-3113-COC-08

Document ID: DIV-133-1501.002
Date revised: January 2018

AGAT Laboratories

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webearth.agatlabs.com ▪ www.agatlabs.com

Chain of Custody Record

P: 902.468.8718 ▪ F: 902.468.8924

Laboratory Use Only

Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 7 1
Hold Time:
AGAT Job Number: 18K323461
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#: 3881

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-MHPW1-WS4	March 22, 2018 7:54	Water	4	1x500, 3x100		✓	✓																					

Samples Relinquished By (Print Name): Eunjeong Seok
Date/Time: March 26/18
Samples Relinquished By (Sign):
Date/Time: 12:45
Samples Received By (Print Name): A Cammy
Date/Time: 03/26/18
Samples Received By (Sign):
Date/Time: 12:45

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

Page 2 of 2

Nº: FFC-3113-COC-08

APPENDIX C

Reports of Grain Size Analysis

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

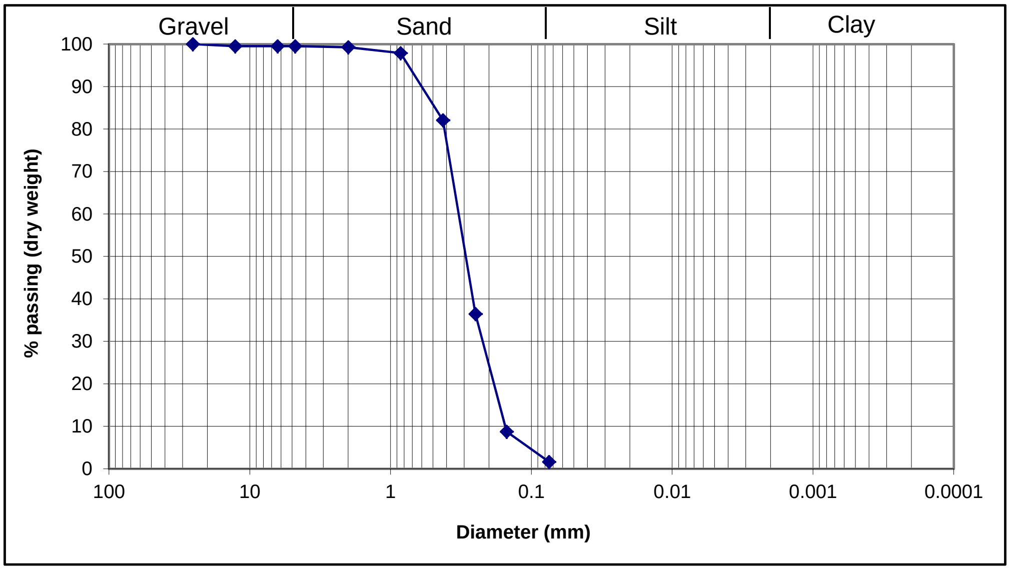
Sample No. : MHPW1-160-165

Depth below GS : 48.77 - 50.29 m
(160 - 165 ft)

Sieve Analysis

Dry weight of sample (g) = 734.02

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	3.66	0.50	0.50	99.50
1/4"	6.35	0.00	0.00	0.50	99.50
4	4.76	0.00	0.00	0.50	99.50
10	2.00	1.68	0.23	0.73	99.27
20	0.85	10.19	1.39	2.12	97.88
40	0.425	115.95	15.80	17.91	82.09
60	0.25	334.85	45.62	63.53	36.47
100	0.15	203.38	27.71	91.24	8.76
200	0.075	52.28	7.12	98.36	1.64
pan	---	12.03	1.64	100.00	---
		734.02			



D_{10} = 0.16

D_{30} = 0.22

D_{60} = 0.33

Cu = 2.06

Cc = 0.92

USCS: SP (Poorly graded sand)

R_{200} = 98.36

R_4 = 0.50

R_4/R_{200} = 0.01

SF = 97.86

GF = 0.50

% Gravel = 0.50

% Sand = 97.86

% Silt & Clay = 1.64

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

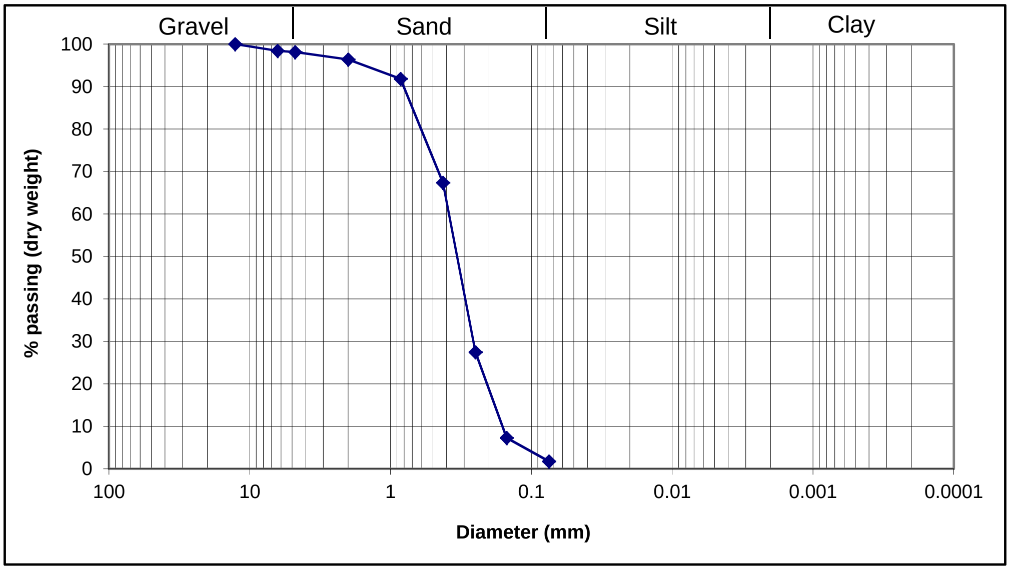
Sample No. : MHPW1-165-170

Depth below GS : 50.29 - 51.82 m
(165 - 170 ft)

Sieve Analysis

Dry weight of sample (g) = 434.51

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	6.87	1.58	1.58	98.42
4	4.76	1.28	0.29	1.88	98.12
10	2.00	7.61	1.75	3.63	96.37
20	0.85	19.66	4.52	8.15	91.85
40	0.425	106.32	24.47	32.62	67.38
60	0.25	173.40	39.91	72.53	27.47
100	0.15	87.65	20.17	92.70	7.30
200	0.075	24.05	5.53	98.23	1.77
pan	---	7.67	1.77	100.00	---
		434.51			



D_{10} = 0.16

D_{30} = 0.26

D_{60} = 0.38

Cu = 2.38

Cc = 1.11

USCS: SP (Poorly graded sand)

R_{200} = 98.23

R_4 = 1.88

R_4/R_{200} = 0.02

SF = 96.36

GF = 1.88

% Gravel = 1.88

% Sand = 96.36

% Silt & Clay = 1.77

% Clay = NA

CFEM: Sand, trace Gravel, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

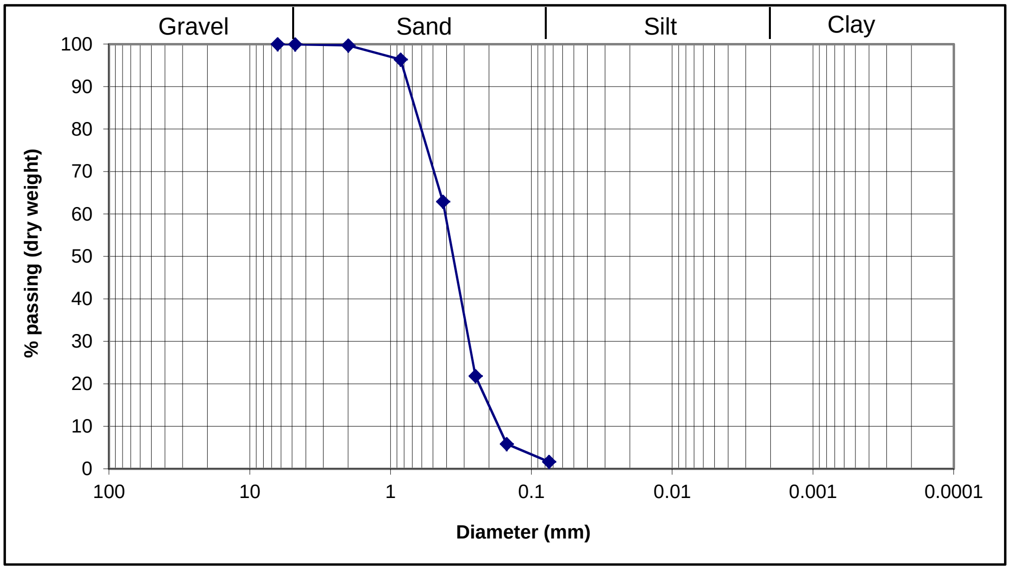
Sample No. : MHPW1-170-175

Depth below GS : 51.82 - 53.34 m
(170 - 175 ft)

Sieve Analysis

Dry weight of sample (g) = 434.30

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	0.00	0.00	0.00	100.00
4	4.76	0.22	0.05	0.05	99.95
10	2.00	1.04	0.24	0.29	99.71
20	0.85	14.47	3.33	3.62	96.38
40	0.425	145.38	33.47	37.10	62.90
60	0.25	178.32	41.06	78.16	21.84
100	0.15	69.45	15.99	94.15	5.85
200	0.075	18.21	4.19	98.34	1.66
pan	---	7.21	1.66	100.00	---
		434.30			



D_{10} = 0.17

D_{30} = 0.28

D_{60} = 0.41

Cu = 2.41

Cc = 1.12

USCS: SP (Poorly graded sand)

R_{200} = 98.34

R_4 = 0.05

R_4/R_{200} = 0.00

SF = 98.29

GF = 0.05

% Gravel = 0.05

% Sand = 98.29

% Silt & Clay = 1.66

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

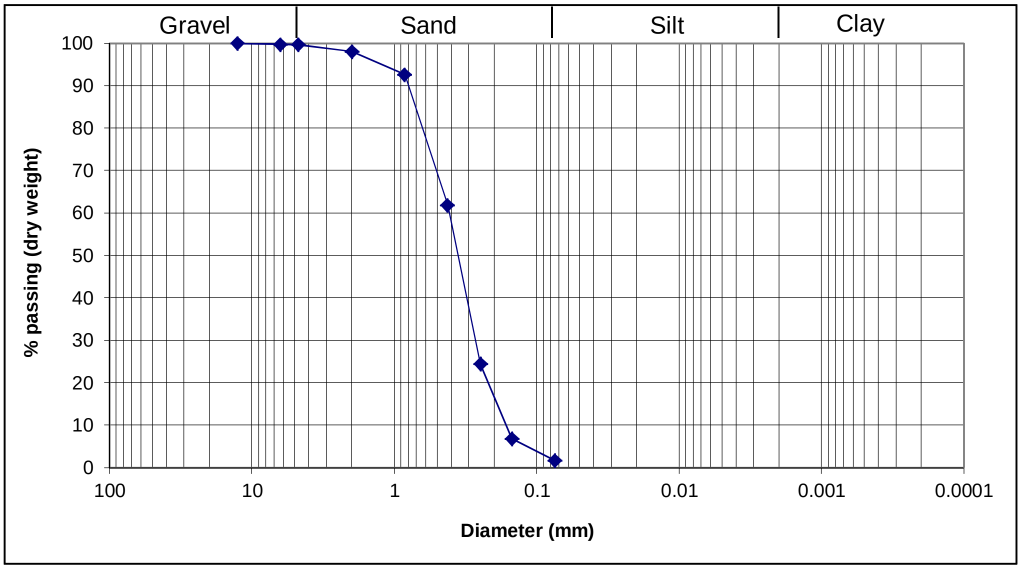
Sample No. : MHPW1-175-180

Depth below GS : 53.34 - 54.86 m
(175 - 180 ft)

Sieve Analysis

Dry weight of sample (g) = 462.23

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	1.13	0.24	0.24	99.76
4	4.76	0.36	0.08	0.32	99.68
10	2.00	7.19	1.56	1.88	98.12
20	0.85	25.31	5.48	7.35	92.65
40	0.425	141.93	30.71	38.06	61.94
60	0.25	173.38	37.51	75.57	24.43
100	0.15	81.28	17.58	93.15	6.85
200	0.075	23.36	5.05	98.21	1.79
pan	---	8.29	1.79	100.00	---
		462.23			



D_{10} = 0.16

D_{30} = 0.27

D_{60} = 0.41

Cu = 2.56

Cc = 1.11

USCS: SP (Poorly graded sand)

R_{200} = 98.21

R_4 = 0.32

R_4/R_{200} = 0.00

SF = 97.88

GF = 0.32

% Gravel = 0.32

% Sand = 97.88

% Silt & Clay = 1.79

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

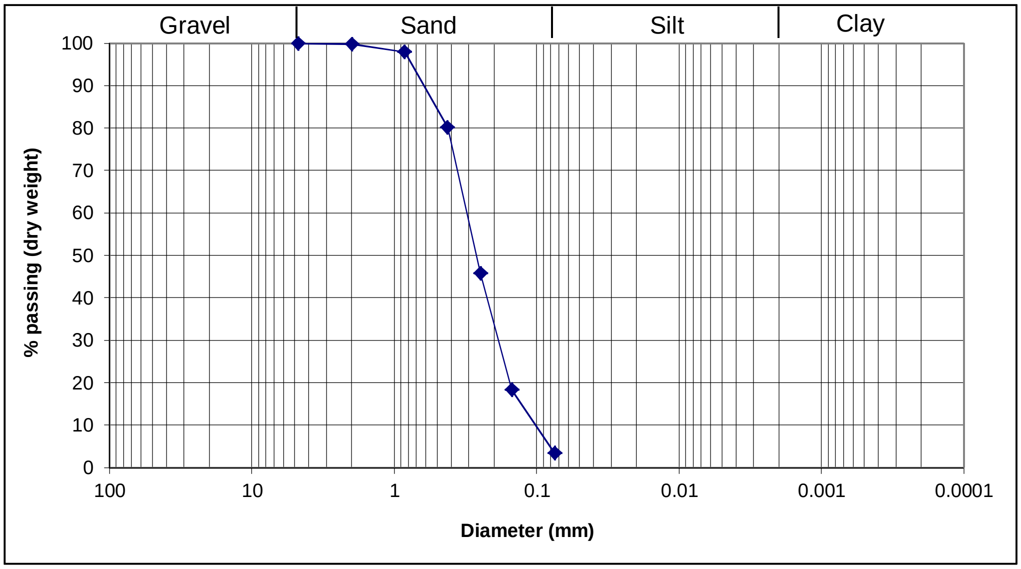
Sample No. : MHPW1-180-185

Depth below GS : 54.86 - 56.39 m
(180 - 185 ft)

Sieve Analysis

Dry weight of sample (g) = 458.75

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	0.68	0.15	0.15	99.85
20	0.85	8.42	1.84	1.98	98.02
40	0.425	81.53	17.77	19.76	80.24
60	0.25	157.81	34.40	54.16	45.84
100	0.15	125.92	27.45	81.60	18.40
200	0.075	68.46	14.92	96.53	3.47
pan	---	15.93	3.47	100.00	---
		458.75			



D_{10} = 0.1

D_{30} = 0.19

D_{60} = 0.31

Cu = 3.10

Cc = 1.16

USCS: SP (Poorly graded sand)

R_{200} = 96.53

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 96.53

GF = 0.00

% Gravel = 0.00

% Sand = 96.53

% Silt & Clay = 3.47

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

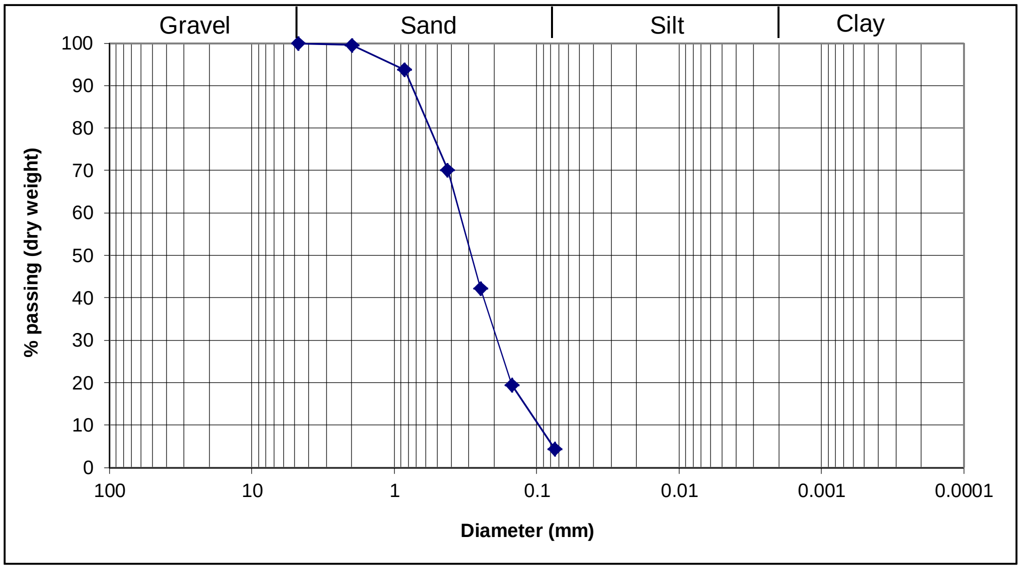
Sample No. : MHPW1-185-190

Depth below GS : 56.39 - 57.91 m
(185 - 190 ft)

Sieve Analysis

Dry weight of sample (g) = 429.71

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	1.59	0.37	0.37	99.63
20	0.85	25.02	5.82	6.19	93.81
40	0.425	101.61	23.65	29.84	70.16
60	0.25	119.92	27.91	57.75	42.25
100	0.15	97.52	22.69	80.44	19.56
200	0.075	65.03	15.13	95.57	4.43
pan	---	19.02	4.43	100.00	---
		429.71			



D_{10} = 0.095

D_{30} = 0.19

D_{60} = 0.35

Cu = 3.68

Cc = 1.09

USCS: SP (Poorly graded sand)

R_{200} = 95.57

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 95.57

GF = 0.00

% Gravel = 0.00

% Sand = 95.57

% Silt & Clay = 4.43

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

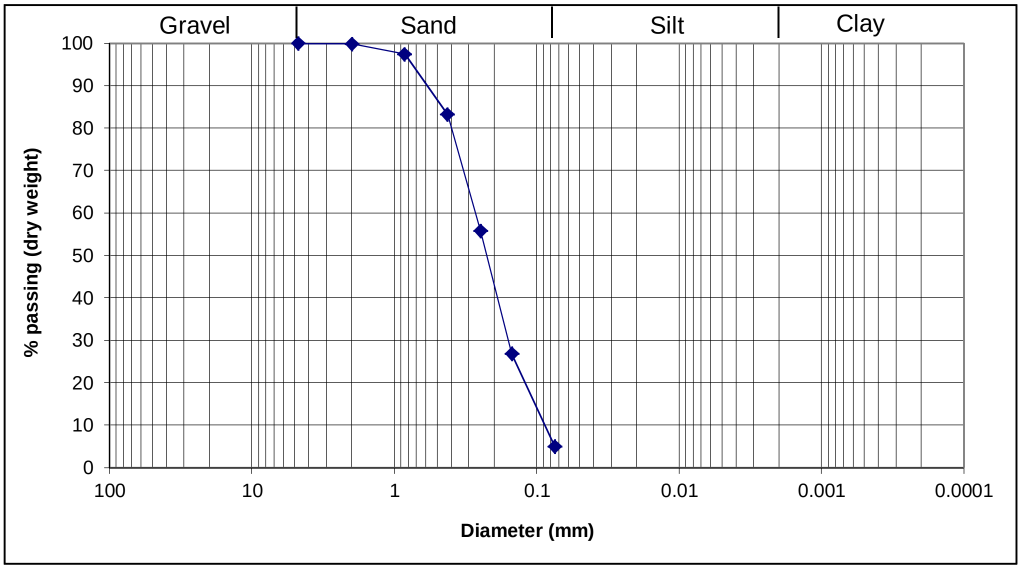
Sample No. : MHPW1-190-195

Depth below GS : 57.91 - 59.44 m
(190 - 195 ft)

Sieve Analysis

Dry weight of sample (g) = 588.54

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	0.55	0.09	0.09	99.91
20	0.85	13.90	2.36	2.46	97.54
40	0.425	84.06	14.28	16.74	83.26
60	0.25	161.35	27.42	44.15	55.85
100	0.15	170.70	29.00	73.16	26.84
200	0.075	127.95	21.74	94.90	5.10
pan	---	30.03	5.10	100.00	---
		588.54			



D_{10} = 0.087

D_{30} = 0.16

D_{60} = 0.27

Cu = 3.10

Cc = 1.09

USCS: SP (Poorly graded sand)

R_{200} = 94.90

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 94.90

GF = 0.00

% Gravel = 0.00

% Sand = 94.90

% Silt & Clay = 5.10

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

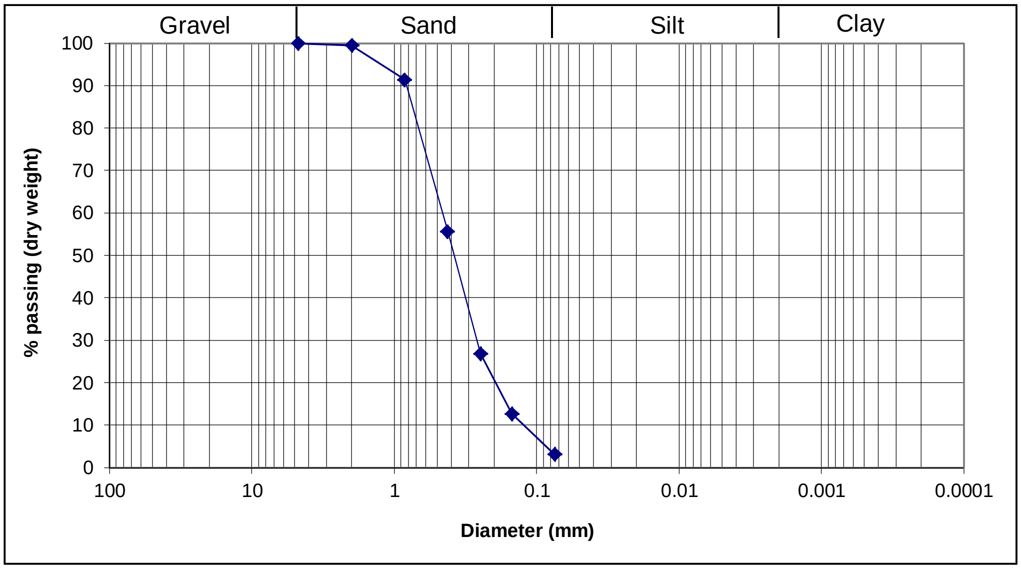
Sample No. : MHPW1-195-200

Depth below GS : 59.44 - 60.96 m
(195 - 200 ft)

Sieve Analysis

Dry weight of sample (g) = 604.39

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	2.66	0.44	0.44	99.56
20	0.85	48.75	8.07	8.51	91.49
40	0.425	216.37	35.80	44.31	55.69
60	0.25	173.97	28.78	73.09	26.91
100	0.15	85.58	14.16	87.25	12.75
200	0.075	57.91	9.58	96.83	3.17
pan	---	19.15	3.17	100.00	---
		604.39			



D_{10} = 0.12

D_{30} = 0.26

D_{60} = 0.46

Cu = 3.83

Cc = 1.22

USCS: SP (Poorly graded sand)

R_{200} = 96.83

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 96.83

GF = 0.00

% Gravel = 0.00

% Sand = 96.83

% Silt & Clay = 3.17

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

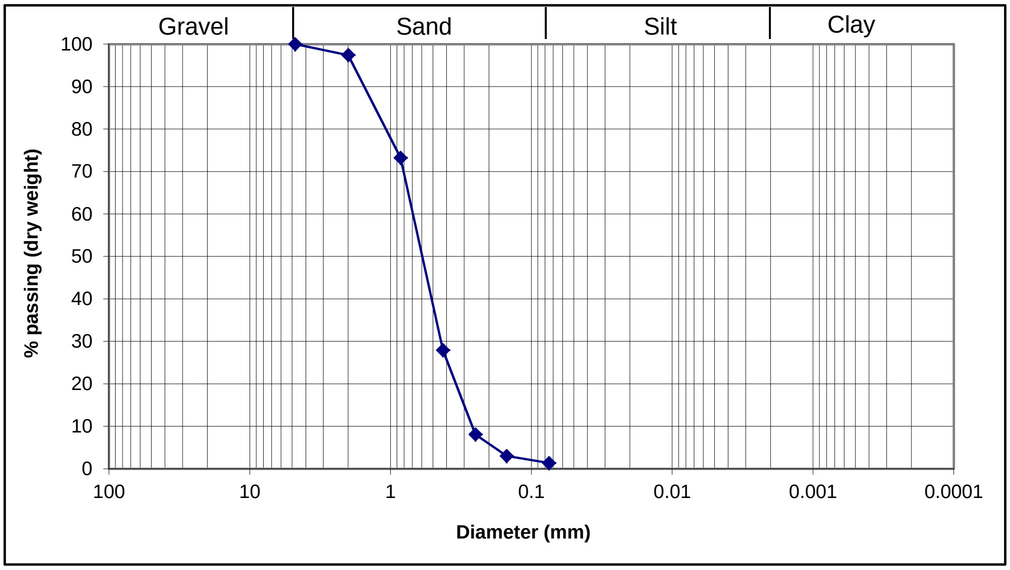
Sample No. : MHPW1-200-205

Depth below GS : 60.96 - 62.48 m
(200 - 205 ft)

Sieve Analysis

Dry weight of sample (g) = 516.24

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	13.30	2.58	2.58	97.42
20	0.85	124.78	24.17	26.75	73.25
40	0.425	233.85	45.30	72.05	27.95
60	0.25	102.51	19.86	91.90	8.10
100	0.15	26.10	5.06	96.96	3.04
200	0.075	8.55	1.66	98.61	1.39
pan	---	7.15	1.39	100.00	---
		516.24			



D_{10} = 0.265

D_{30} = 0.44

D_{60} = 0.7

Cu = 2.64

Cc = 1.04

USCS: SP (Poorly graded sand)

R_{200} = 98.61

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 98.61

GF = 0.00

% Gravel = 0.00

% Sand = 98.61

% Silt & Clay = 1.39

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

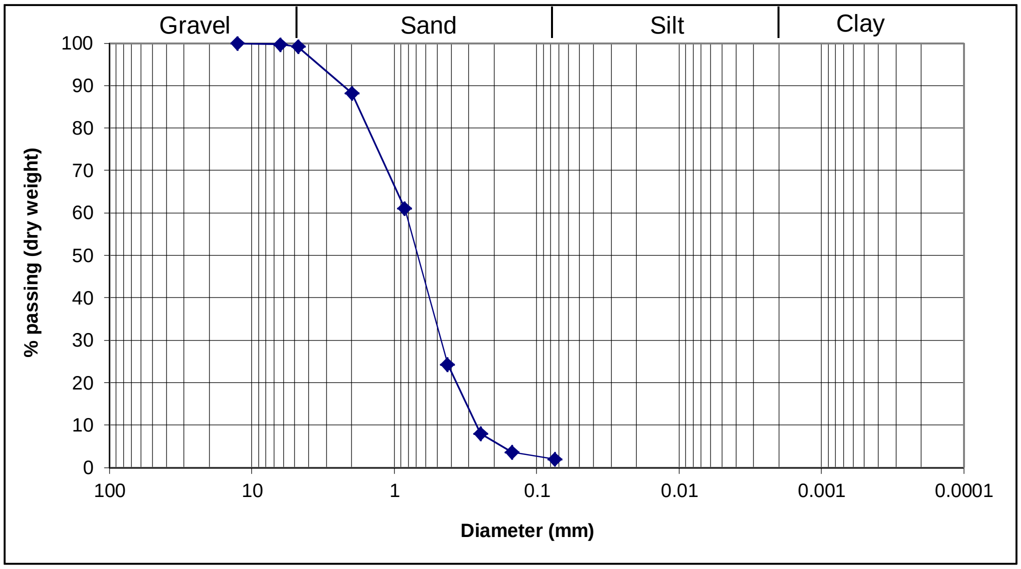
Sample No. : MHPW1-205-210

Depth below GS : 62.48 - 64.01 m
(205 - 210 ft)

Sieve Analysis

Dry weight of sample (g) = 572.85

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	1.20	0.21	0.21	99.79
4	4.76	3.13	0.55	0.76	99.24
10	2.00	62.76	10.96	11.71	88.29
20	0.85	155.88	27.21	38.92	61.08
40	0.425	210.45	36.74	75.66	24.34
60	0.25	93.31	16.29	91.95	8.05
100	0.15	24.89	4.34	96.29	3.71
200	0.075	9.64	1.68	97.98	2.02
pan	---	11.59	2.02	100.00	---
		572.85			



D_{10} = 0.27

D_{30} = 0.47

D_{60} = 0.81

Cu = 3.00

Cc = 1.01

USCS: SP (Poorly graded sand)

R_{200} = 97.98

R_4 = 0.76

R_4/R_{200} = 0.01

SF = 97.22

GF = 0.76

% Gravel = 0.76

% Sand = 97.22

% Silt & Clay = 2.02

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

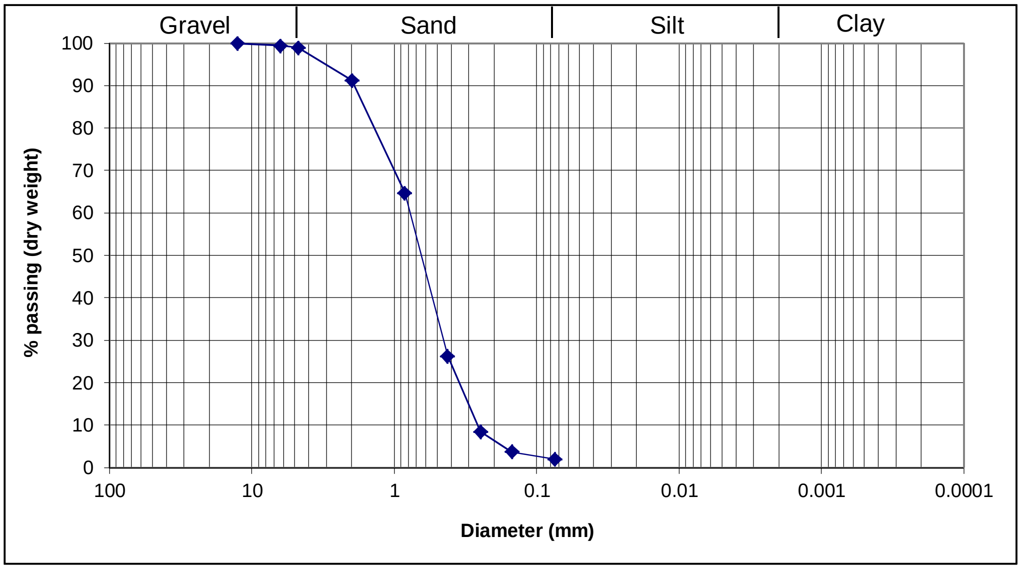
Sample No. : MHPW1-210-215

Depth below GS : 64.01 - 65.53 m
(210 - 215 ft)

Sieve Analysis

Dry weight of sample (g) = 446.43

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	2.62	0.59	0.59	99.41
4	4.76	1.56	0.35	0.94	99.06
10	2.00	34.37	7.70	8.64	91.36
20	0.85	118.45	26.53	35.17	64.83
40	0.425	171.93	38.51	73.68	26.32
60	0.25	79.29	17.76	91.44	8.56
100	0.15	21.38	4.79	96.23	3.77
200	0.075	7.94	1.78	98.01	1.99
pan	---	8.89	1.99	100.00	---
		446.43			



D_{10} = 0.26

D_{30} = 0.45

D_{60} = 0.77

Cu = 2.96

Cc = 1.01

USCS: SP (Poorly graded sand)

R_{200} = 98.01

R_4 = 0.94

R_4/R_{200} = 0.01

SF = 97.07

GF = 0.94

% Gravel = 0.94

% Sand = 97.07

% Silt & Clay = 1.99

% Clay = NA

CFEM: Sand, trace Silt/Clay

APPENDIX D

Water Budget Analysis

APPENDIX D: WATER BUDGET ANALYSIS

D1 CLIMATIC DATA

Figure D1 shows the temperature statistics at the Stephenville Airport for each month for the period of 1942 to 2014. The annual mean temperature for the area was about 4.93°C. The mean monthly temperatures were highest during July (16.21°C and August (16.42°C) and decreased to the lowest values during February (-6.42°C). The temperature statistics indicate that the mean monthly temperature between December and March is below zero degrees Celsius. All of the climatic data have been obtained from Environment Canada websites.

Figure D2 shows the monthly variations in total precipitation at the Stephenville Airport for the period of 1942 to 2014. The mean monthly precipitation varies from 67.60 mm (April) to 120.71 mm (December). Stephenville had a mean yearly precipitation of 1226.76 mm between 1942 and 2014. The snowfall component (**Figure D3**) of the mean annual precipitation is 302.24mm (equivalent rainfall) typically occurring between November and April with the highest monthly snowfall occurring in January (102 cm). **Figure D4** displays the historical annual precipitation values at the Stephenville Airport from 1942 to 2014. There are periods of low and high precipitation that tend to oscillate every five to ten years with a 30 to 40 year period of low precipitation (1942 to about 1970), increasing average precipitation between 1970 and 1985 followed by a period of higher but declining precipitation between 1985 and 2010. Overall, the recent trend appears to be one of decreasing annual precipitation.

The mean annual potential evapotranspiration for the area has been calculated to be approximately 500 mm per year (DOE, 1992). Calculations, by Fracflow, using the Stephenville International Airport weather records for the period of 1942 to 2007 and the Thornthwaite Equation yield approximately 518 mm per year. The Thornthwaite equation tends to overestimate potential evapotranspiration which will lead to calculation of lower runoff estimates (Shaw, 1994).

As the Thornthwaite equation is dependent on average temperatures above freezing, it does not account for snow sublimation in winter months. Sublimation of snow can vary significantly from 5% to 50% of the snow pack. Sublimation is dependent on the groundcover, the latitude, the elevation, and climatic conditions. We have assumed sublimation accounts for precipitation loss in the study area by 10% during the months with average daily temperatures below freezing. On average, this is a loss of 41 mm of rainfall equivalent to sublimation per year.

D2 WATER BUDGET

D2.1 Average Annual Water Budget

The area from which the Marine Harvest Atlantic Canada fish hatchery would draw its groundwater supply is located partly within the drainage basin that drains into and includes Noel's Pond and Muddy Pond which is linked by a constructed/culverted channel to Noel's Pond. For the purposes of this discussion, Muddy Pond on which the pump house is located that has been used to pump water to Mine Pond, through an existing water main, to support the industrial facilities, now decommissioned, at what was then known as Port Harmon, will be considered to be part of Noel's Pond. The overall watershed is estimated to be approximately 54.6 km^2 (Acres, 1994). However, the area that is of interest in terms of estimating groundwater recharge for the potential production wells for a new fish hatchery is much smaller and it includes the area through which Warm Creek passes as it flows through the small community of Noel's Pond and into the impounded waters of Noel's Pond itself. The recharge area for the future water supply wells is also assumed to extend back to Long Pond. The Mine Pond drainage basin to the east side of the drainage basin drains into Mine Pond which is also impounded. The overflow from the Mine Pond berm or dam drains as a perched water system along the eastern edge of the valley or marsh area and this perched stream flows into Port Harmon following a small stream or brook that flows along the eastern edge of the old Abitibi mill site and a similar stream that flows along the west side of the old Abitibi mill site. There is no obvious or major surface drainage from the main marsh area and what surface drainage does take place is perched above the deeper water table.

For the purposes of this discussion, four (4) sub-areas (**Figure D5**) within the Noel's Pond or Warm Creek drainage basin have been identified as potential areas that recharge the groundwater aquifer system in this area. These areas include Areas 1 and 3 that are primarily marsh covered, Area 2 that is covered by surface water, forested areas with ponds and streams and minor areas of pavement that are underlain by thick granular deposits, and Area 4 that is covered by forest but underlain by thin overburden over fractured granitic bedrock. In Areas 1 and 3, the near surface water table is perched with the actual water table from which the wells would draw their water being located some 10 to 20 m or more below the ground surface. In area 2, the water table is also some depth below the ground surface. In Area 4, the water table is relatively shallow and this groundwater then recharges to the area that is underlain by the marsh and the forest covered areas. As noted above, groundwater recharge in the Mine Pond drainage basin, Area 5, discharges primarily to the perched streams that then run along the east side of the marsh area.

In Areas 1, 2 and 3, most of the surface water bodies are perched in that the elevation of the water level in those surface water bodies is above the elevation of the water table in the underlying granular aquifer.

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. Therefore, an assessment of the water balance within the drainage basin in which Noel’s Pond is located was carried out with adjustments made to the normal assessment procedures to reflect that conditions that exist in each of the four (4) sub-areas as defined above.

A water balance can be defined simply as,

$$P = R + E$$

where, P = Mean Annual Precipitation, R = Mean Annual Runoff, and E = Mean Annual Evapotranspiration. Each of these components are defined and discussed separately below.

Determination of the surface runoff at the site is difficult to accurately assess without data collected in or near the drainage basin being studied. Typically, one would analyze hydrographs from gauged streams in the vicinity of the study area. Ideally these streams would have similar catchment areas and surficial geology to the study area. In this area, data are available for the Blanche Brook drainage basin but not for the Noel’s Pond-Warm Creek drainage basin. The other gauged streams in the area are Harry’s River and Little Barachois Brook and these were much too large to obtain reasonable data for comparison purposes. However, the typical response of these rivers has been studied for use in comparison with Blanche Brook drainage basin and for the analysis of the Noel’s Pond-Warm Creek drainage basin.

Preliminary studies conducted by the Newfoundland and Labrador Department of Environment on Little Barachois Brook indicate that groundwater recharge for that drainage basin was approximately 24% of the total precipitation (DOE, 1986). For the purposes of this analysis it is assumed that 24% of the precipitation input is contributing to deep and shallow groundwater recharge for areas that are not covered by marsh. The recharge calculated for the area is 294 mm.

<u>Average Generalized Water Budget (Expressed as Depths)</u>

Input	=	1,226 mm	
Output	=	1,226 mm	
Precipitation	=	1,226 mm	
Evapotranspiration	=	518 mm	(42%)
Sublimation	=	41 mm	(3%)
Recharge*	=	294 mm	(24%)
Runoff	=	373 mm	(30%)

> * Recharge to deep and shallow groundwater systems. Local topography and local hydraulic gradients in the overall area will result in some direct contributions to surface water.

The average generalized water budget presented above is useful in determining approximate volumes of water that will travel through a specific region during any given year. However, when assessing the risk of potential contaminant migrations and assessing concentrations / dilution factors, it is important to have an understanding of the seasonal fluctuations in the water budget. As such, Fracflow split the average generalized water budget into 12 months using average monthly data climate data for the Stephenville Airport from Environment Canada.

To complete this analysis, it was necessary to make some assumptions about frozen conditions in the winter months and the spring melt characteristics. To assess this, Fracflow examined the historical flow records that were reported for Harry's River and historical snowfall and snowpack data for the Stephenville Airport.

Using the flow records of the Harry's River, it was determined that the river system was typically in a base flow recession from December until the end of March. The size of the Harrys River drainage basin is 640 km^2 and encompasses portions of the Long Range Mountains; as such, portions of this basin will freeze up before, and melt after Stephenville has had its freeze and thaw periods. When analyzing the snow fall and snow pack data from Environment Canada for the Stephenville Airport, one can see a similar trend. These data show that typically there is snow pack recorded at the airport, starting at the end of December through to February or March where it will typically be gone by the end of April. Based on this data it was assumed that other drainage basins and sub-basins in the area would normally have no groundwater recharge or surface water runoff during January and February. Stream flow would be contributed primarily by groundwater discharge during those periods. Recharge would begin to occur again in March and April. The combined precipitation occurring in January and February is assumed to runoff or recharge in March and April with 50% occurring in each of these melt months.

However, as will be discussed later, the marsh covered areas do not freeze to any great depth and the thick marsh area over a large area of the underlying granular aquifer was observed to be saturated with significant volumes of free water when the edge of the marsh was excavated to prepare a drill pad for the drilling of a new test well in February 2018. This free water is available to recharge the underlying aquifer on a daily basis and is not affected by the surface temperatures, sublimation or evapotranspiration.

D3 WATER BALANCE CALCULATIONS

D3.1 Precipitation

It is worthwhile noting, that there are records from a second precipitation station close to the study area that are available from the Atmospheric Environment Service of Environment Canada, in addition to the station located at the Stephenville Airport, which is adjacent to St. George's Bay, at an approximate elevation of 15 m above mean sea level. The other station is/was located in the community of Black Duck, which is approximately 14 km inland of Stephenville and at an approximate elevation of 45 m above mean sea level.

Mean annual precipitation at Stephenville, between 1943 and 1992, ranged from a low of 838 mm (year 1943) to a high of 1,661 mm (year 1982). The calculated average mean annual precipitation for the period of record was 1,197 mm (Acres, 1994). On average, approximately 365 mm, or 30%, of this precipitation fell as snow between 1951 and 1980 (Environment Canada, 1982). Mean annual precipitation at Black Duck, between 1984 and 1992, ranged from a low of 1,374 mm (year 1985) to a high of 1,643 mm (year 1984). The calculated average mean annual precipitation for this relatively short period of record was 1,507 mm (Acres, 1994).

The 300 mm difference for average precipitation at Stephenville and Black Duck is considered to be significant given the proximity of these communities and the potential that underlying bedrock aquifers or bedrock units can be recharged in the upland areas of the local drainage basins or areas with higher elevation. An analysis of these and other data for southwestern Newfoundland suggest that an orographic effect may be the cause (Acres, 1994), although other factors such as wind effects may be partly responsible as well. Precipitation gauges will tend to underestimate snow and rain accumulations under windy conditions (Winter, 1981) and this may partly explain the lower precipitation at Stephenville, which appears to be more exposed to incoming weather systems.

Given the length and linear shape of the Blanche Brook drainage basin, the gauged stream, and the more coastal location of the lower part of the Noel's Pond-Warm Creek drainage basin, it is reasonable to accept that there is a real variation in total precipitation within the study area as one moves inland from the coast. The average total precipitation calculated for the weather stations at Stephenville and Black Duck is taken to be the best estimate of precipitation that is available for this analysis. The value of precipitation used in this second analysis for comparative purposes is 1,227 mm and is extracted from the available climatic data from the Stephenville airport.

D3.2 Runoff

Mean annual runoff (R) is defined as the average annual discharge (Q) divided by the surface area (A) of the catchment of interest. The value of R is usually expressed as a depth in millimeters.

In the most recent evaluation of the water resources of Southwestern Newfoundland (Acres, 1994), R was calculated for a number of gauged catchments, including Blanche Brook. The runoff estimates were based on an analysis of streamflow data, supplemented by precipitation data. The analysis involved establishing the best estimates of long-term R for all gauged catchments, relating R from the gauged catchments to physiographic characteristics, and then preparing a runoff map that shows the variation in average annual runoff as a series of contours or isolines. The runoff map enables an estimate of R to be derived for ungauged catchments and sub-catchments.

The average R for Blanche Brook, for the period of record, was reported by Acres to be representative of the long-term R because the record covered the 1980s, which included both wet and dry periods. For smaller sub-catchments in the Blanche Brook Catchment, the runoff map indicates that R will vary from about 1100 mm near the coast to approximately 1300 mm in the headwater area, which is adjacent to the Harry's River catchment. Obviously, the computed or predicted R value, which includes groundwater discharge during baseflow conditions, exceeds the total precipitation in some years and leaves very little water for evapotranspiration.

A review of the minimum daily discharge records for gauged rivers in southwestern Newfoundland, including Blanche Brook, indicates that annual low flows occur predominantly in late winter (February and March) and summer (July and August) (Acres, 1994). During such periods of low flow or baseflow conditions, groundwater discharge is often the primary contributor to surface water flow. Acres (1994) calculated that in terms of water availability, the average specific runoff for the Stephenville and Port au Port area was 0.037 m^3/s per km^2. This includes groundwater discharge as part of baseflow. For the immediate area of interest for the proposed fish hatchery well field, much of the groundwater is discharged directly in the Port of Stephenville and the coastal area.

D3.3 Evapotranspiration

Evapotranspiration is defined as the combined water loss from evaporating surface water bodies and soil surfaces, and transpiring vegetation. Intuitively, the rate of evaporation from open water bodies should be greatest because of the availability of a constant supply of water. Unsaturated soil conditions limit the amount of moisture available for direct evaporation from soil surfaces and for transpiration by plants.

Average annual lake evaporation in southwestern Newfoundland is reported to be between 450 and 500 mm, according to adjusted evaporation pan measurements for that area (Environment Canada, 1990). Evaporative water losses in the area that is assumed to contribute recharge to the groundwater system are related to the area of the surface water bodies. For the marsh areas (sub-Areas 1 and 3) which overlie the area in which it is planned to develop the well field or part of the assumed recharge area, the surface water bodies at 15% of the area only represent a small portion of the total evapotranspiration. In sub-Area 2, the surface water bodies represent 14% of the sub-area. For the marsh areas, the sponge like nature of the marsh area ensures that the total evapotranspiration will be higher but should be less than the range reported for lake evaporation.

Methods for the direct measurement of plant transpiration are not readily available and such data for the study area could not be obtained.

Two methods that are sometimes employed to estimate the total amount of evapotranspiration involve (1) a direct rainfall-runoff comparison and (2) the Thornthwaite evapotranspiration method (Thornthwaite, 1948).

(1) A direct rainfall-runoff comparison requires that the mean runoff value at the centroid of the catchment be equal to the mean actual value and that precipitation data are being collected from a station located at or near that centroid. These requirements are not met in the Noel’s Pond-Warm Creek basin, but they are satisfied in the adjoining Harry’s River catchment. In the Harry’s River catchment, the estimated evapotranspiration is reported to be 170 mm, the difference between the measured precipitation (1,461 mm) and the calculated runoff (1,291 mm) (Acres, 1994).

(2) Using the Thornthwaite Method, which has established a mathematical correlation between temperature and evapotranspiration, the calculated average annual evapotranspiration for the Stephenville area is 528 mm (Acres, 1994).

The above calculations are in poor agreement, but they are believed to bracket the upper and lower limits for evapotranspiration. Furthermore, since total evapotranspiration should not exceed total evaporation, for the marsh area, even though the area of the surface water bodies is small, the sponge-like nature of the ground cover ensures that free water is held close to the surface of the ground cove producing evapotranspiration that is in the upper range of the computed value and close to the 450-500 mm range established for lake evaporation. For the areas that are not covered by marsh and where the water table is some depth below the ground surface it is more likely that the direct rainfall-runoff comparison provides the closest estimate to actual evapotranspiration. However, considering that the measured precipitation may be underestimated due to wind effects, it is expected that a value of 200 mm would be an acceptable lower estimate of the average annual evapotranspiration from the expected recharge area for the proposed well field in areas that are not covered by marsh. Note again, the values for evapotranspiration are estimates that have a great deal of uncertainty.

D3.4 Calculated Recharge

Groundwater recharge rates are typically between 7% and 30% of total precipitation in good ground conditions and the full range of recharge rates can be expected to occur locally in the Noel's Pond-Warm Creek basin area. Normally, the lowest recharge rates will be associated with barren rock and clay tills while the highest rates will occur through deposits of coarse sands and gravels. Sub-Areas 1 and 3 are expected to have the highest recharge rates (approximately 30% of precipitation) since there is little to no runoff from the main marsh areas and there are a number of perched ponds or bodies of surface water. However, evaporative and evapotranspiration losses are expected to be high for part of the year. Since the thick marsh layer is fully saturated due to the high porosity of the bog or peat material and the perched nature of the upper water table the water is this upper layer is available to recharge the granular aquifer system below the marsh areas during the entire year.

The other areas in the drainage basin have forest cover and granular overburden that varies in thickness with a range of depths to the water table. In the section of the drainage basin that is assumed to contribute recharge to the granular aquifer the 3D model indicates that Warm Creek is also perched or recharges the aquifer. For those areas, evapotranspiration losses are expected to be moderate to low and recharge is expected to be in the range of 24% of precipitation.

Table D1 shows the monthly estimates of recharge for areas that are covered by marsh within the Noel's Pond Warm Creek drainage basin.

Table D1 Twelve month average generalized water budget based on the Stephenville airport climatic data for sub-Areas 1 and 3 of the Noel's Pond and Warm Creek drainage basin.

Month	Avg. Temp (oC)	Avg. Snowfall (cm)	Avg. Precip. (mm)	Pot. Evapotrans. (mm)	Sublimation (mm)	Recharge (mm)	Runoff (mm)
January	-5.44	102.08	120.71	0.00	12.10	30.67	0.00
February	-6.42	81.81	98.00	0.00	9.79	30.67	0.00
March	-3.23	52.80	79.27	0.00	8.06	30.67	88.01
April	2.08	19.36	67.60	14.95	0.00	30.67	109.99
May	7.28	3.22	86.30	54.34	0.00	30.67	1.29
June	11.96	0.03	91.88	88.39	0.00	30.67	0.00
July	16.21	0.00	104.90	119.41	0.00	30.67	0.00
August	16.42	0.00	111.03	111.33	0.00	30.67	0.00
September	12.51	0.05	116.77	74.00	0.00	30.67	0.00
October	7.35	2.94	118.04	40.50	0.00	30.67	0.00
November	2.85	23.53	118.46	13.88	0.00	30.67	29.58
December	-2.38	79.82	113.78	0.00	11.50	30.67	71.62
Total	**--**	**365.6**	**1226.8**	**516.8**	**41.5**	**368.0**	**300.5**

D4 NOEL'S POND-WARM CREEK DRAINAGE BASIN, WATER AVAILABILITY

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. Therefore, this assessment of the water balance within the drainage basin in which Noel's Pond/Warm Creek and the existing and proposed well fields are and may be located was carried out with adjustments made to the normal procedure for calculating recharge to reflect the conditions that exist in each of the four sub-areas as defined above.

Based on the analysis and climatic data provided, we assumed that the recharge through the marsh covered areas of the granular aquifer could be assigned at a rate of 368 mm per year. Areas (Areas 2, 4 and 5) that are not predominantly covered by marsh can be assigned a recharge rate of 294 mm per year. The 3D model was then used to obtain a balance between the measured K-values, the measured drawdowns during the aquifer test, and the water levels in a representative group of monitoring wells. For these monitoring well measurements, one has to note that the existing production wells in the Northern Harvest Smolt Limited well field were operating at different flowrates at different times of the year based on the hatchery's water needs. The estimated recharge rates were then adjusted to provide the best fit to the measured hydraulic head and aquifer test data.

Water availability can also be assessed using simple balk-park calculations. For example, since monitoring wells were installed across the aquifer with BH3 located up-gradient from the marsh covered area of the granular aquifer, the gradient on the water table aquifer in this area is known to range from 0.005 to 0.0065 m/m. Using a reference cross-section of 1,500 m, an assumed aquifer thickness of 50 m, a gradient or I of 0.006 m/m and a hydraulic conductivity (K) of 0.0002 to 0.0004 m/s, Darcy's Law, Q = KIA, gives a flux of 2.8 to 5.7 million cubic metres per year towards that part of the granular aquifer that is covered by marsh. By comparison, the up-gradient and trans-gradient areas have a combined area of more than 12 km2. With a recharge estimated at 294 mm for part of this area, the total annual recharge would be 3.56 million cubic metres, 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 marsh layer into the underlying granular aquifer, in Area 1, is approximately 1.386 million cubic metres of water per year. For reference, a production well that is producing 2,000 litres per minute, will extract approximately 1.05 million cubic metres of groundwater 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 marsh in Area 1, is estimated at 48 to 58 million cubic metres of groundwater. Again, potential contributions from the bedrock aquifer that is assumed to underlie the granular aquifer have not been considered.

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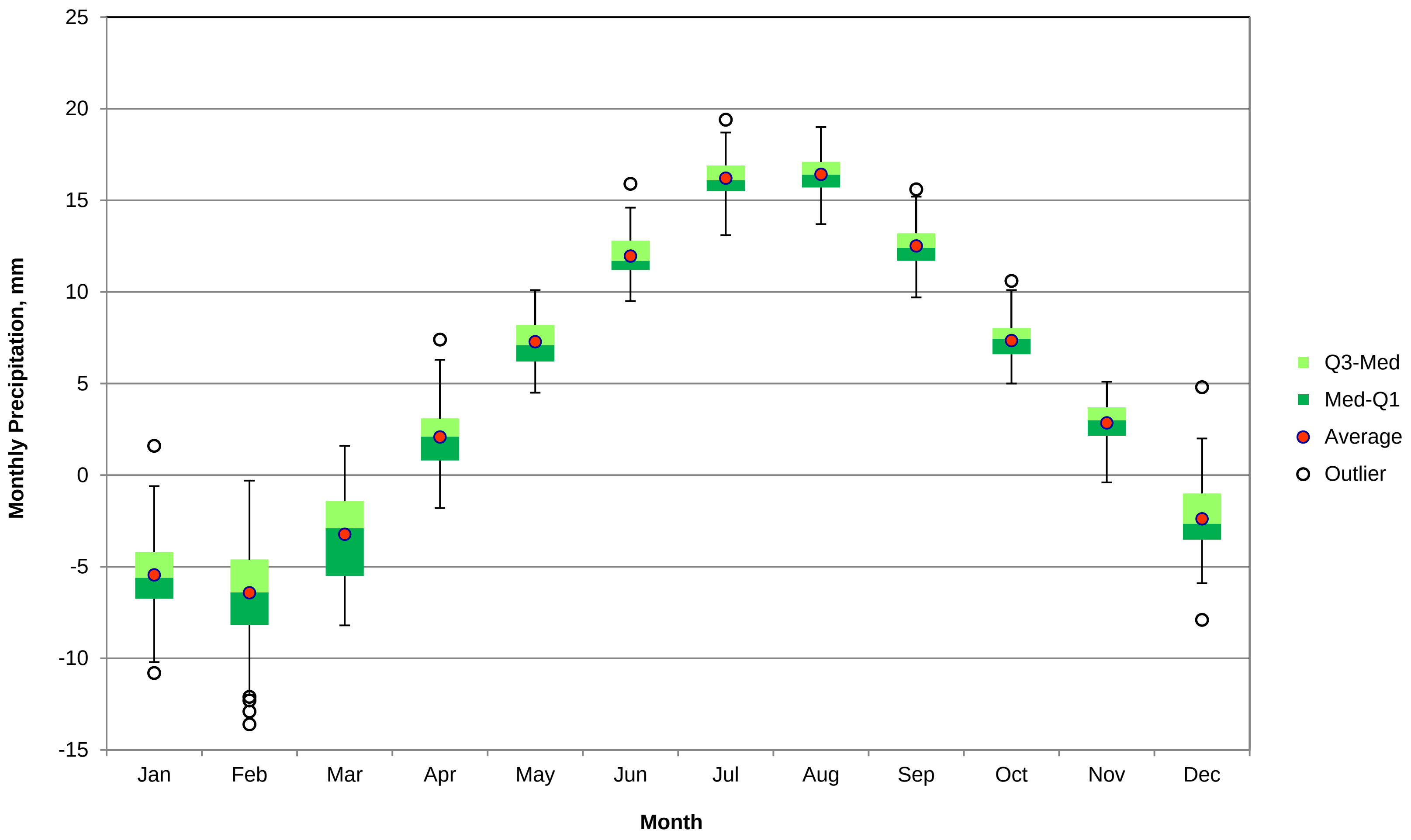

Figure D1 Monthly mean temperature from 1942 to 2014 at STN - Stephenville A, NL (EC, 2017).

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

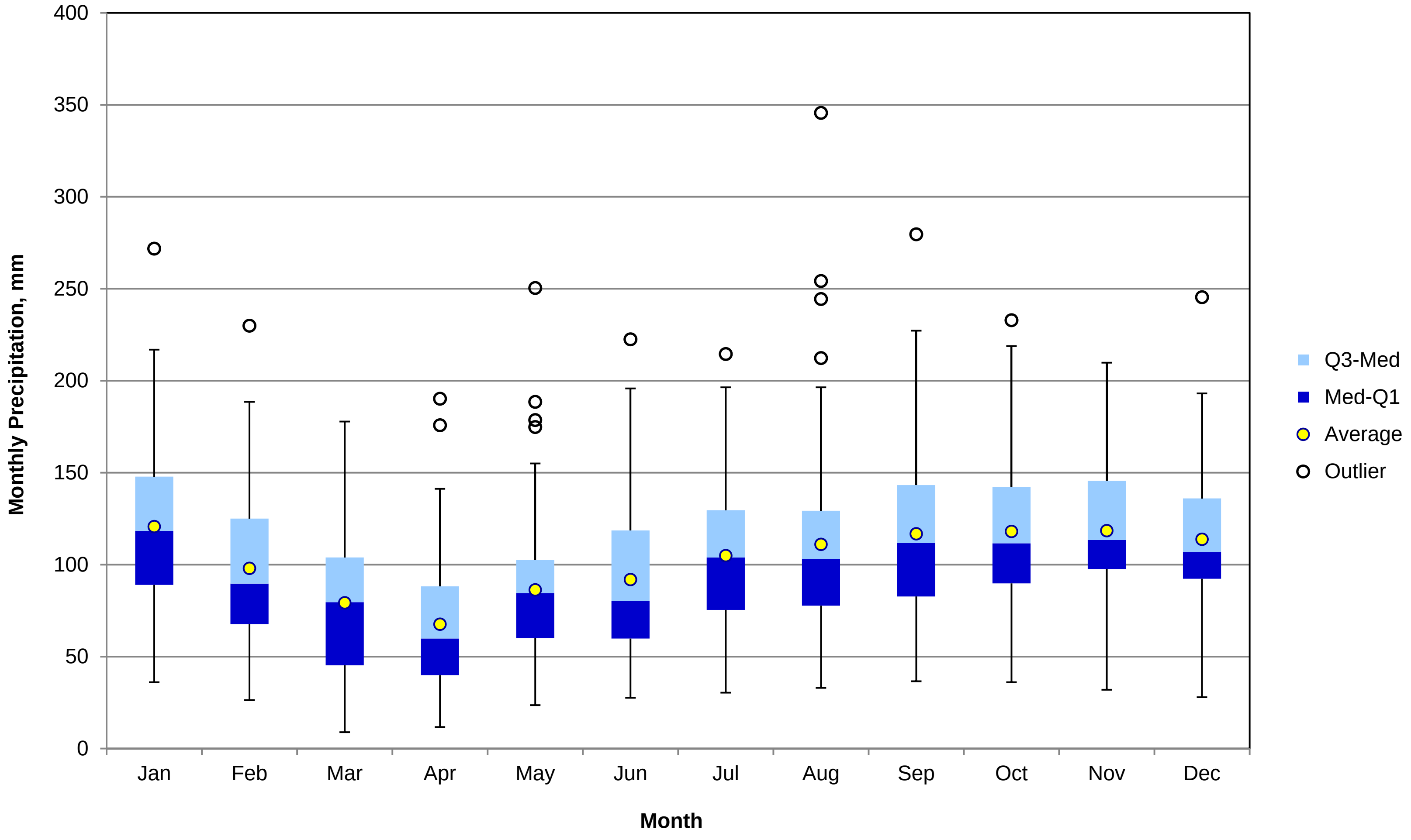

Figure D2 Monthly total precipitation from 1942 to 2014 at STN - Stephenville A, NL (EC, 2017).

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

FFC

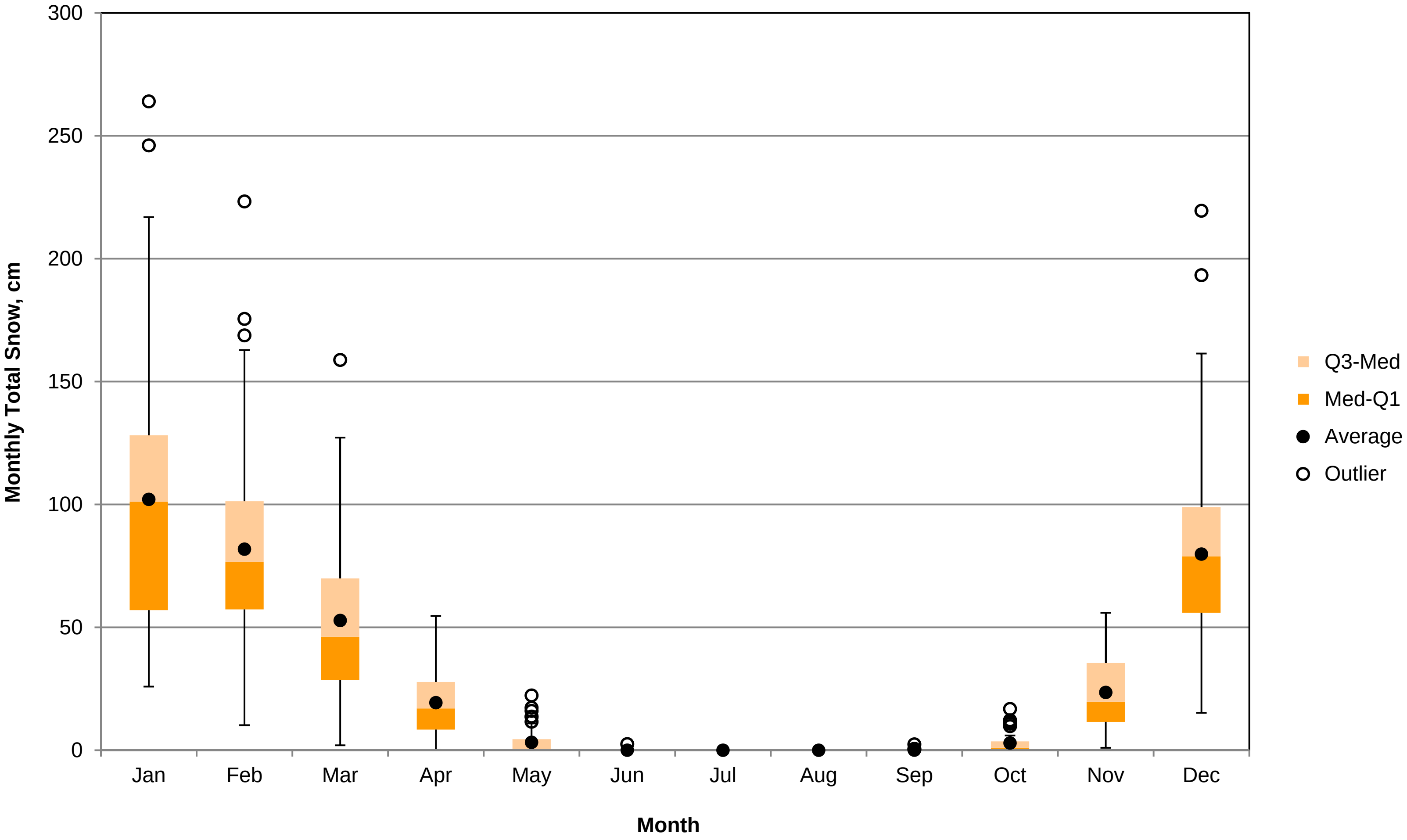

Figure D3 Monthly total snow from 1942 to 2014 at STN - Stephenville A, NL (EC, 2017).

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

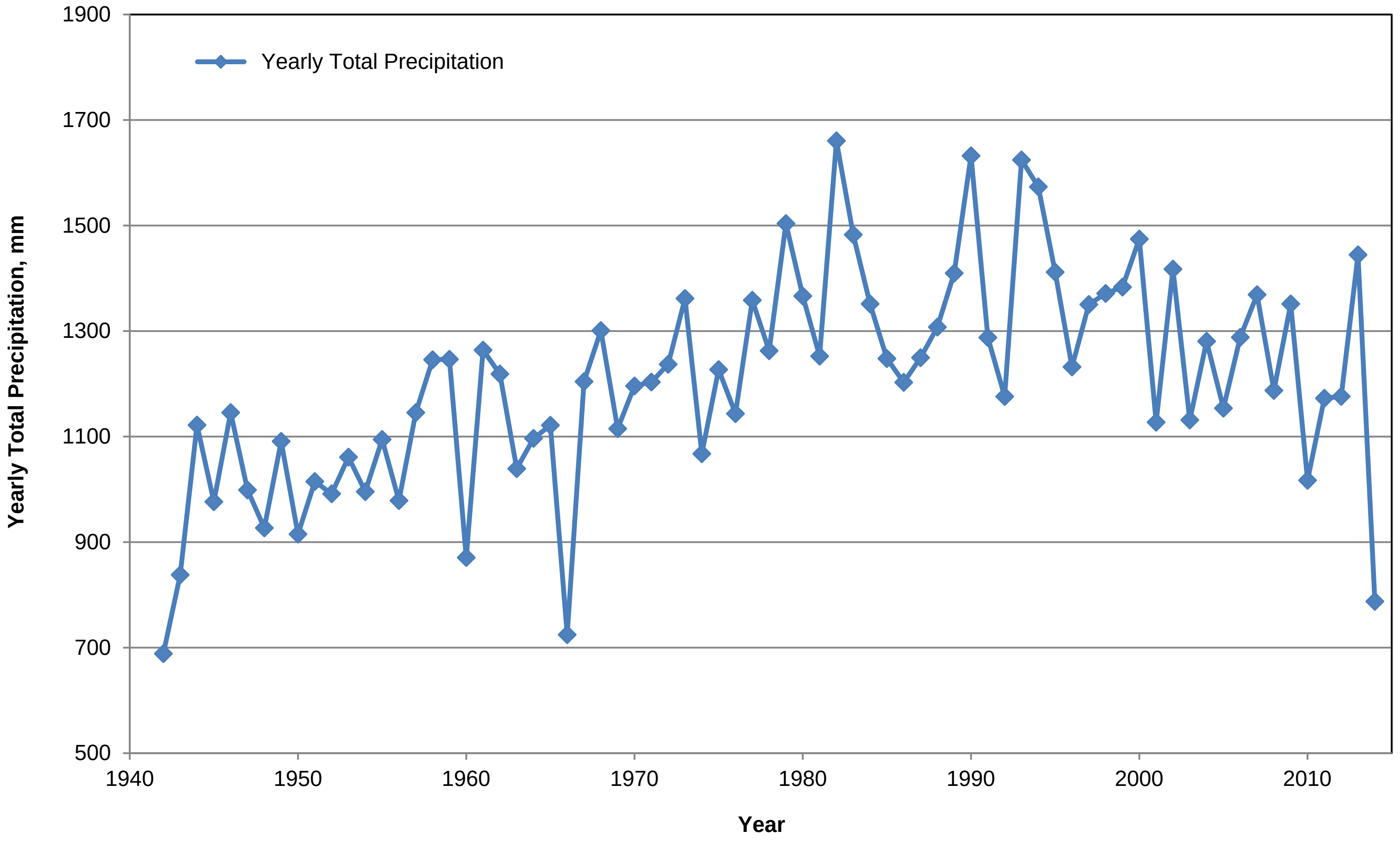

Figure D4 Yearly total precipitation from 1942 to 2014 at STN - Stephenville A, NL (EC, 2017).

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

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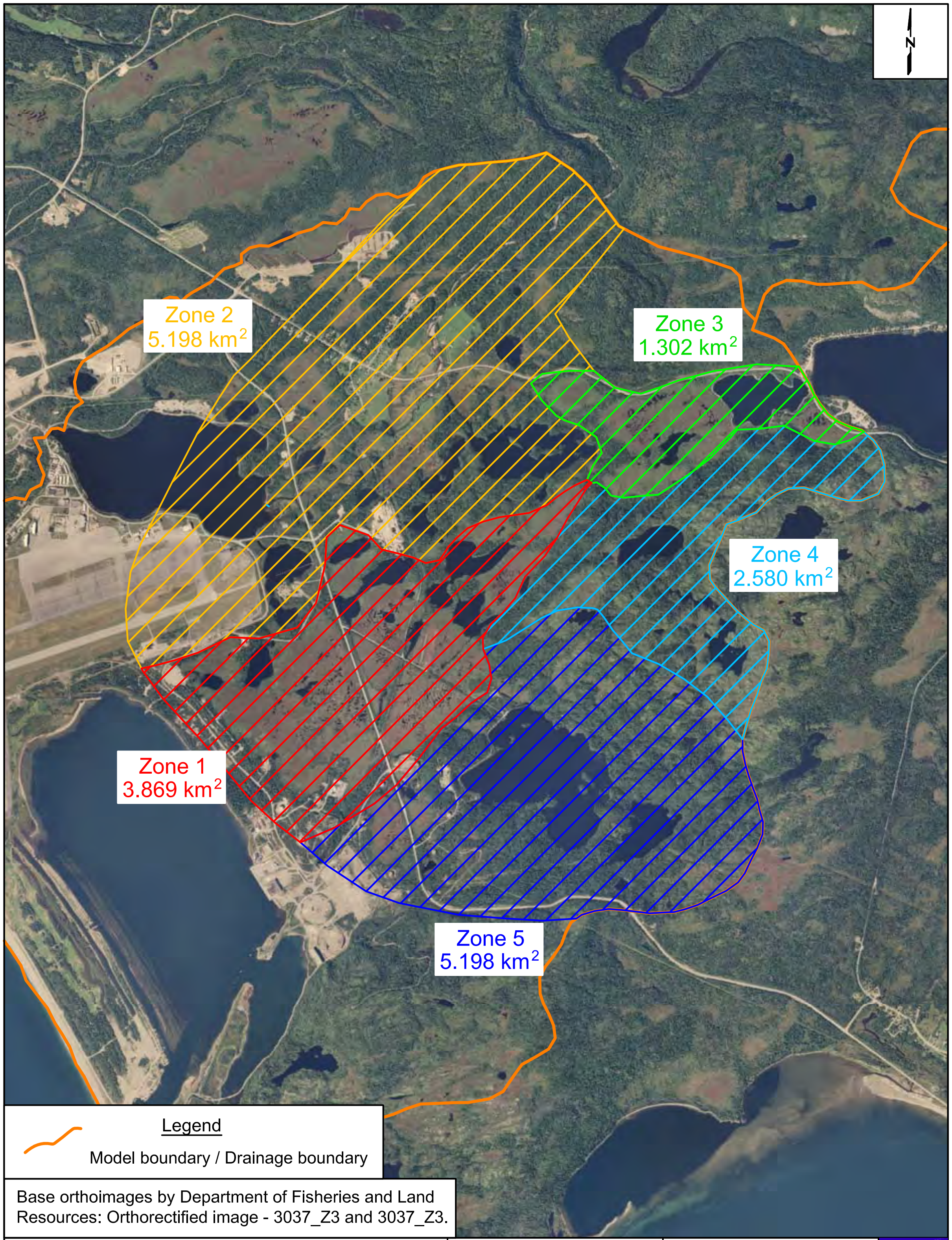

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Figure D5 Sub-areas of recharge within the Noel's Pond or Warm Creek drainage basin.

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

FFC

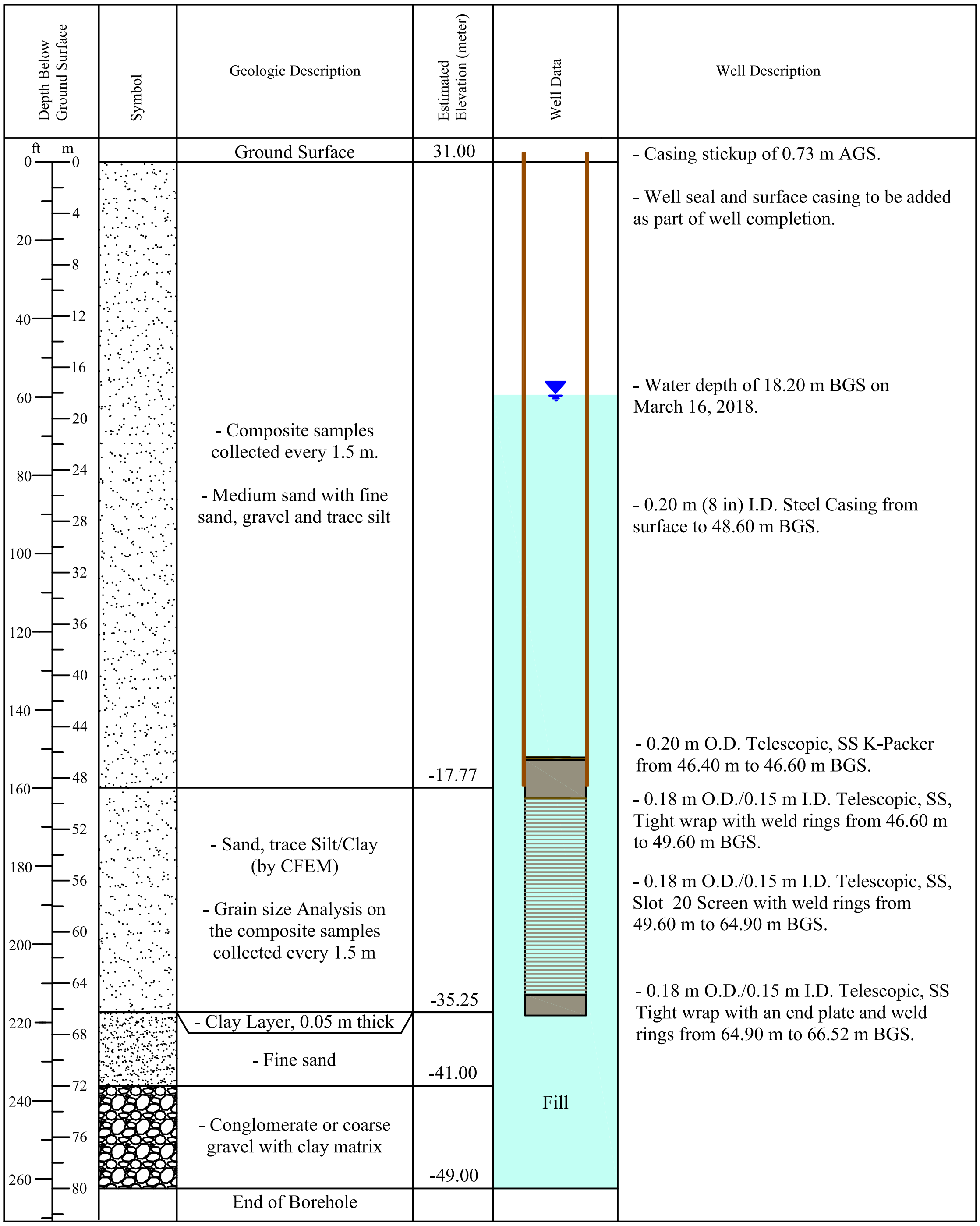
APPENDIX A

Borehole Logs

Project: Water Suppy Well - Test Well
Location: Stephenville, NL
Client: Marine Harvest Atlantic Canada
Drilling Supervisor: Kevin Gale

Well Log: MHPW1

Project No: 3113
Date: February 8 - 11, 2018



- Composite samples collected every 1.5 m.

- Medium sand with fine sand, gravel and trace silt

- Sand, trace Silt/Clay (by CFEM)

- Grain size Analysis on the composite samples collected every 1.5 m

- Clay Layer, 0.05 m thick

- Fine sand

- Conglomerate or coarse gravel with clay matrix

- Casing stickup of 0.73 m AGS.

- Well seal and surface casing to be added as part of well completion.

- Water depth of 18.20 m BGS on March 16, 2018.

- 0.20 m (8 in) I.D. Steel Casing from surface to 48.60 m BGS.

- 0.20 m O.D. Telescopic, SS K-Packer from 46.40 m to 46.60 m BGS.

- 0.18 m O.D./0.15 m I.D. Telescopic, SS, Tight wrap with weld rings from 46.60 m to 49.60 m BGS.

- 0.18 m O.D./0.15 m I.D. Telescopic, SS, Slot 20 Screen with weld rings from 49.60 m to 64.90 m BGS.

- 0.18 m O.D./0.15 m I.D. Telescopic, SS Tight wrap with an end plate and weld rings from 64.90 m to 66.52 m BGS.

Figure A1 Borehole and well construction log.

Project No.
3113

Document No.
FFC-NL3113-007

Location
Stephenville

Date
April 2018

Project: Geotechnical Investigation

Log of Borehole: BH1

Client: Marine Harvest Atlantic Canada

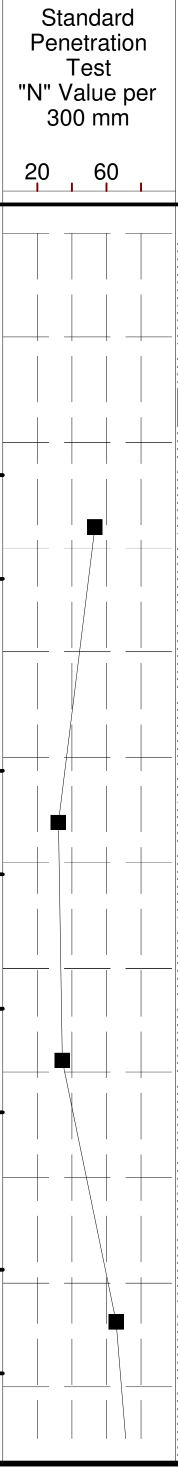
Project No: 3113

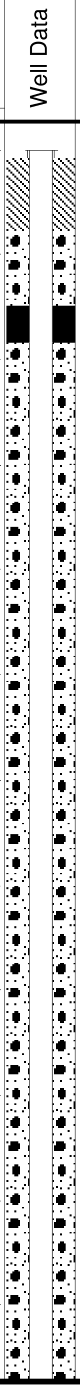
Location: Stephenville, NL

Date: November 16 - 19, 2017

SUBSURFACE PROFILE | SAMPLE

Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
0 / 0		Ground Surface (GS)	31.4					
		Auger	30					
		SPT: 4 / 18 / 36 / 36 Wet, brown, medium sand	29.4	SS	1	54	31	
		Auger	28.3					
		SPT: 7 / 12 / 21 / 22 Damp, brown, medium sand with red and black particles	27.7	SS	2	33	52	
		Auger	26.9					
		SPT: 13 / 16 / 19 /14 Damp,brown, medium sand	26.3	SS	3	35	25	
		Auger	25.4					
		SPT: 10 / 39 / 27 / 16 No recovery	24.8	SS	4	66	0	
		Auger						





Well Description

Well head protection installed

Cement packing from 0.05 m to 0.46 m

Native sand packing from 0.46 m to 0.91 m

Bentonite packing from 0.91 m to 1.12 m

0.05 m dia. riser from 0 m to 16.68 m

Native sand packing from 1.12 m to 26.48 m

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 1 of 5

Project: Geotechnical Investigation

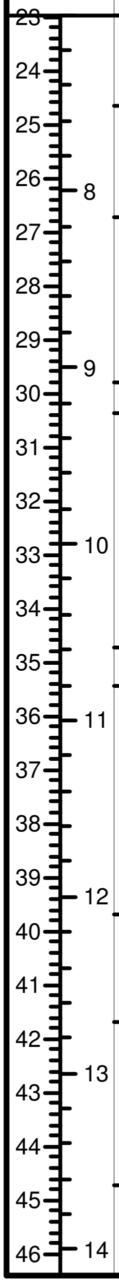
Log of Borehole: BH1

Client: Marine Harvest Atlantic Canada

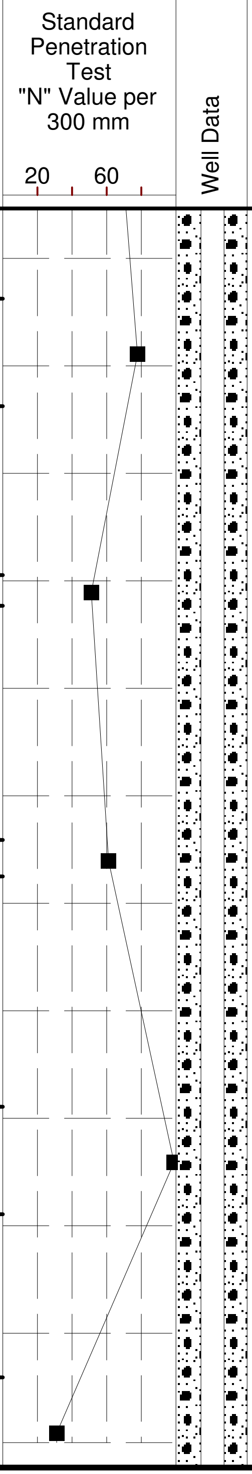
Project No: 3113

Location: Stephenville, NL

Date: November 16 - 19, 2017



SUBSURFACE PROFILE	SAMPLE							
Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
	23.9						
SPT: 7 / 25 / 53 / 53 Dry, brown, fine to medium sand with some rock fragments	23.3	SS	5	78	20		
Auger	22.4						0.05 m dia. riser from 0 m to 16.68 m
SPT: 43 / 52 for 0.03 m (Refusal) Brown and tan, fine sand with some rock fragments	22.2	SS	6	52	36		
Auger	20.9						
SPT: 44 / 62 for 0.06 m (Refusal) Dry, grey and brown, fine sand with some rock fragments	20.6	SS	7	62	97		Native sand packing from 1.12 m to 26.48 m
Auger	19.3						
SPT: 17 / 52 / 66 / 42 Dry, light grey to dark brown, fine sand with some coarse sand	18.7	SS	8	118	62		
Auger	17.8						
SPT: 9 / 15 / 17 / 20 Dry, grey and some brown, fine sand with some rock fragments					41		



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 2 of 5

Project: Geotechnical Investigation

Log of Borehole: BH1

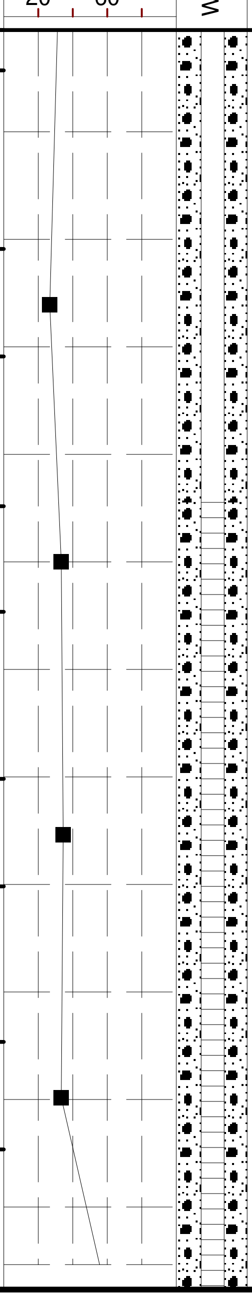
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 16 - 19, 2017

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
46			17.2	SS	9	32	41				
47–50 15		Auger	16.2								Native sand packing from 1.12 m to 26.48 m
50–52		SPT: 10 / 12 / 15 / 13 Brown and grey, fine sand with some rock fragments	15.6	SS	10	27	54				
52–55 16		Auger	14.7								
55–57 17		SPT: 9 / 17 / 17 / 16 Damp, brown, fine sand	14.1	SS	11	34	67				0.05 m dia. screen from 16.68 m to 25.82 m
57–60 18		Auger	13.2								
60–62		SPT: 10 / 18 / 17 / 15 Dry, grey and brown, fine sand	12.6	SS	12	35	58				
62–65 19		Auger	11.7								▼ 19.17 m BGS (Nov. 27, 2017)
65–67 20		SPT: 9 / 15 / 19 / 19 Wet, grey, very fine sand	11.1	SS	13	34	46				
67–69 21		Auger									



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 3 of 5

Project: Geotechnical Investigation

Log of Borehole: BH1

Client: Marine Harvest Atlantic Canada

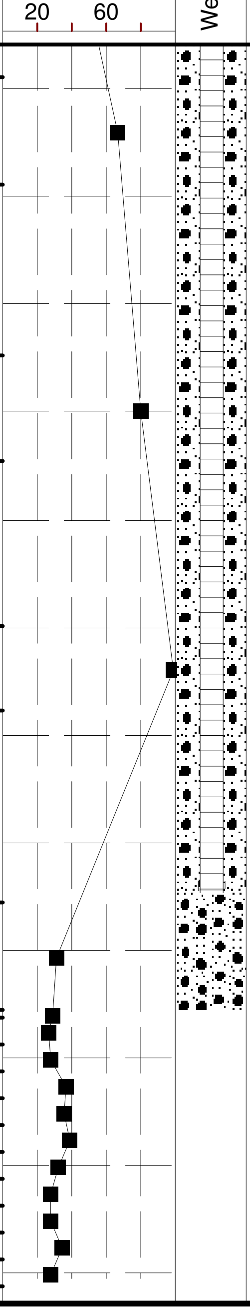
Project No: 3113

Location: Stephenville, NL

Date: November 16 - 19, 2017

SUBSURFACE PROFILE		SAMPLE					
Depth	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
69		10.3					
70–71	SPT: 12 / 28 / 39 / 18 CFEM: Sand, trace Gravel, trace Silt/Clay	9.65	SS	14	67	37	
72–74 (22)	Auger	8.68					
75–76 (23)	SPT: 32 / 49 / 32 / 34 CFEM: Gravelly Sand, trace Silt/Clay	8.07	SS	15	81	33	
77–79 (24)	Auger	7.14					
80–81	SPT: 29 / 54 / 67 / 52 for 0.03 m (Refusal) No recovery	6.66	SS	16	121	0	
82–84 (25)	Auger	5.57					
85–86 (26)	SPT: 14 / 13 / 19 / 23 CFEM: Sand, some Silt/Clay, trace Gravel	4.97	SS	17	32	27	
87–92 (27, 28)	DCPT (Blow counts per 150 mm)		PC	--	29		
			PC	--	27		
			PC	--	28		
			PC	--	37		
			PC	--	36		
			PC	--	39		
			PC	--	33		
			PC	--	28		
			PC	--	28		
			PC	--	35		
			PC	--	28		

Standard Penetration Test "N" Value per 300 mm



Well Description

0.05 m dia. screen from 16.68 m to 25.82 m

Native sand packing from 1.12 m to 26.48 m

Screw-on cap

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 4 of 5

Project: Geotechnical Investigation

Log of Borehole: BH1

Client: Marine Harvest Atlantic Canada

Project No: 3113

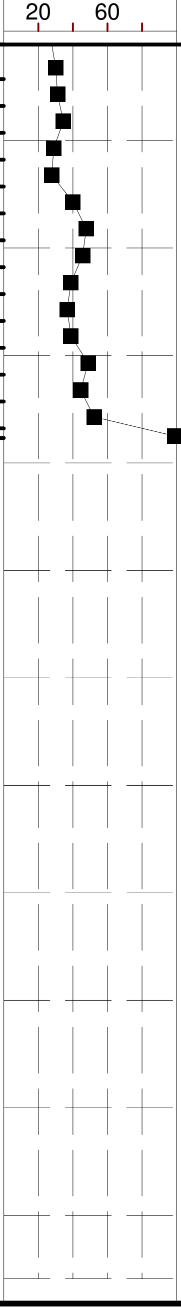
Location: Stephenville, NL

Date: November 16 - 19, 2017

SUBSURFACE PROFILE			SAMPLE					
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
92		DCPT (Blow counts per 150 mm)		PC	--	[illegible]		
				PC	--	31		
93				PC	--	32		
				PC	--	35		
94				PC	--	29		
				PC	--	28		
95 / 29				PC	--	41		
				PC	--	48		
96				PC	--	46		
				PC	--	40		
97				PC	--	37		
				PC	--	39		
98				PC	--	49		
30				PC	--	45		
99			1.2	PC	--	53		
				PC	--	104		
		End of Borehole						

Depth: 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115 / 29, 30, 31, 32, 33, 34, 35

Standard Penetration Test "N" Value per 300 mm



Well Data

Well Description

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical Investigation

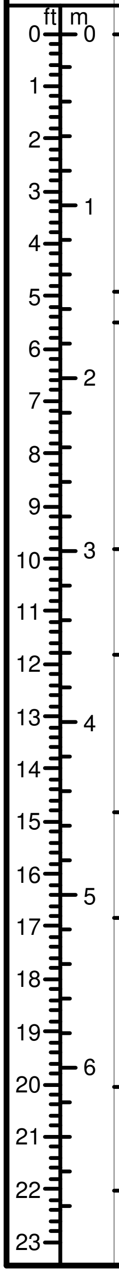
Log of Borehole: BH2

Client: Marine Harvest Atlantic Canada

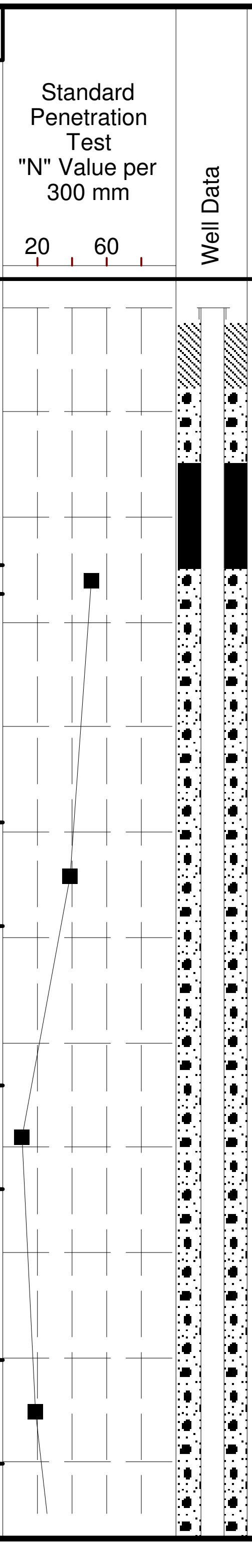
Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017



SUBSURFACE PROFILE			SAMPLE					
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
		Ground Surface (GS)	31.8					
		Auger	30.3					
		SPT: 4 / 52 for 0.03 m (Refusal) Wet, dark brown coarse sand	30.1	SS	1	52	100	
		Auger	28.8					
		SPT: 4 / 20 / 19 / 6 0 m - 0.31 m: damp, brown gravel with coarse sand with red and black particles 0.31 m - 0.56 m: wet, silt/clay	28.2	SS	2	39	92	
		Auger	27.3					
		SPT: 5 / 6 / 6 / 5 Wet, brown 0 m - 0.15 m: medium sand 0.15 m - 0.25 m: silt/clay	26.7	SS	3	12	42	
		Auger	25.7					
		SPT: 10 / 11 / 8 / 6 Wet, dark brown, medium sand with gravel	25.1	SS	4	19	23	



Well Description

Flush mount installed

Cement packing from 0.1 m to 0.46 m

Native sand packing from 0.46 m to 0.91 m

Bentonite packing from 0.91 m to 1.52 m

0.05 m dia. riser from 0 m to 15.76 m

Native sand packing from 1.52 m to 31.00 m

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Sheet: 1 of 6

Project: Geotechnical Investigation

Log of Borehole: BH2

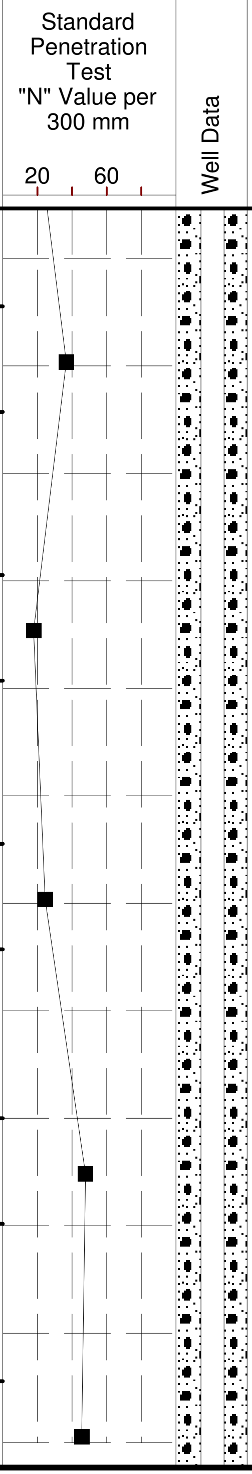
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017

SUBSURFACE PROFILE				SAMPLE					
Depth (ft)	Depth (m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
23 24 25			Auger	24.2					
26 27	8		SPT: 11 / 18 / 19 / 10 Damp, light brown, medium sand	23.6	SS	5	37	8	
28 29 30	9		Auger	22.7					
31 32			SPT: 10 / 9 / 9 / 21 Damp, brown 0 m - 0.07 m: fine sand 0.07 m - 0.15 m: gravel with coarse sand	22.1	SS	6	18	25	
33 34 35	10		Auger	21.2					
36 37	11		SPT: 9 / 12 / 13 / 14 Damp, light brown, medium sand with red and black particles	20.6	SS	7	25	42	
38 39 40	12		Auger	19.6					
41 42			SPT: 12 / 25 / 23 / 29 Damp, light brown, fine sand with gravel with red and black particles	19	SS	8	48	44	
43 44 45	13		Auger	18.1					
46	14		SPT: 8 / 23 / 23 / 20 Dry, light brown, medium sand with red and black particles					56	



Well Description

0.05 m dia. riser from 0 m to 15.76 m

Native sand packing from 1.52 m to 31.00 m

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Sheet: 2 of 6

Project: Geotechnical Investigation

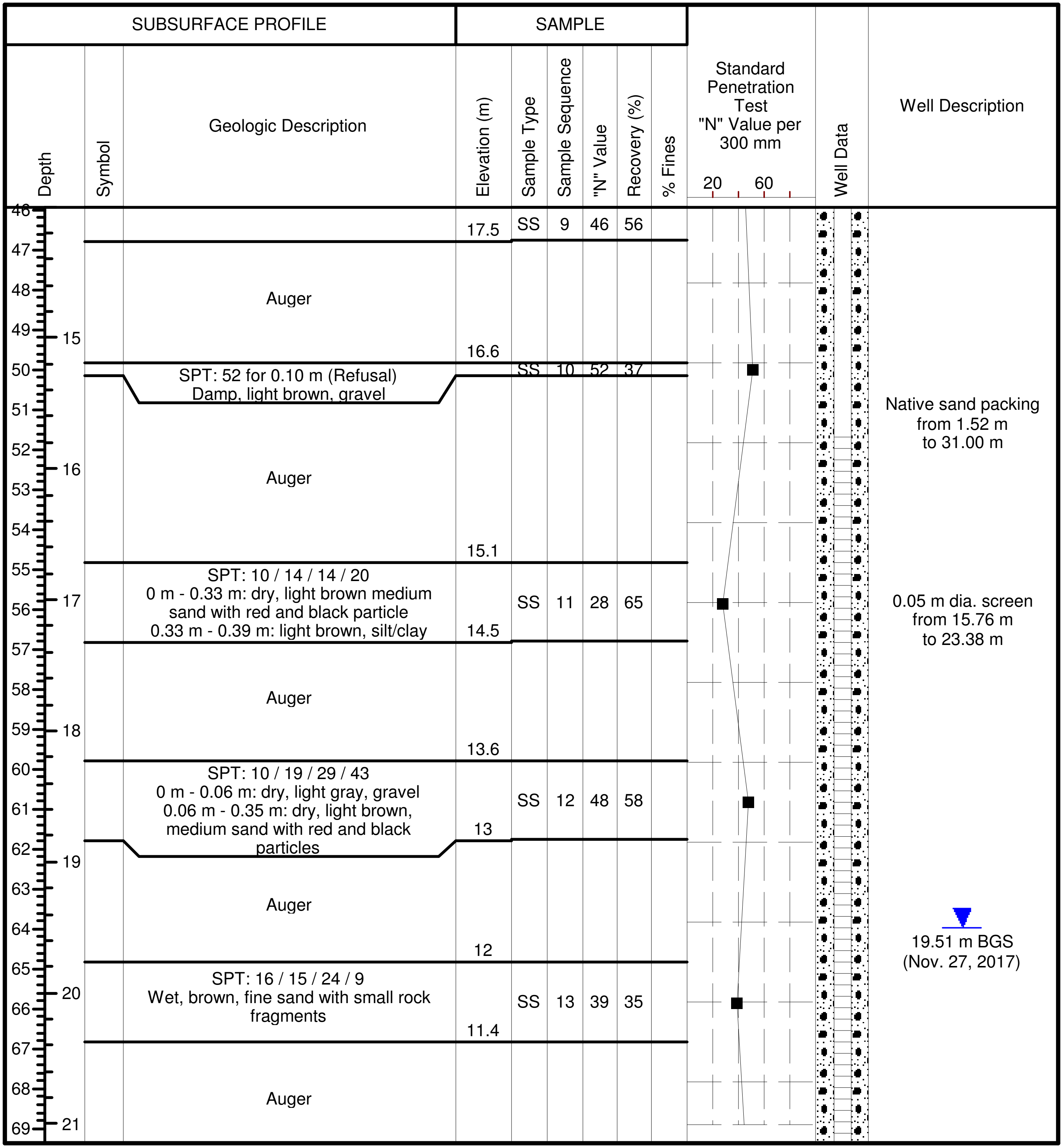
Log of Borehole: BH2

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017



Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
	17.5	SS	9	46	56	
Auger	16.6					
SPT: 52 for 0.10 m (Refusal) Damp, light brown, gravel		SS	10	52	37	
Auger	15.1					
SPT: 10 / 14 / 14 / 20 0 m - 0.33 m: dry, light brown medium sand with red and black particle 0.33 m - 0.39 m: light brown, silt/clay	14.5	SS	11	28	65	
Auger	13.6					
SPT: 10 / 19 / 29 / 43 0 m - 0.06 m: dry, light gray, gravel 0.06 m - 0.35 m: dry, light brown, medium sand with red and black particles	13	SS	12	48	58	
Auger	12					
SPT: 16 / 15 / 24 / 9 Wet, brown, fine sand with small rock fragments	11.4	SS	13	39	35	
Auger						

Well Description

Native sand packing
from 1.52 m
to 31.00 m

0.05 m dia. screen
from 15.76 m
to 23.38 m

▼
19.51 m BGS
(Nov. 27, 2017)

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Project: Geotechnical Investigation

Log of Borehole: BH2

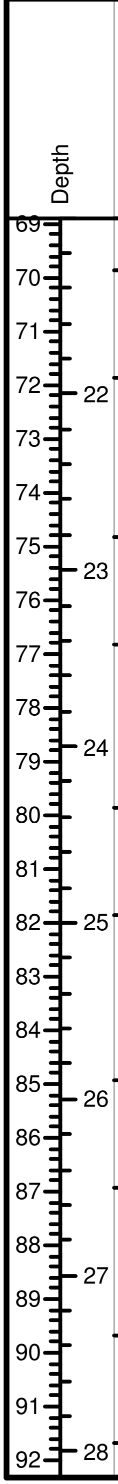
Client: Marine Harvest Atlantic Canada

Project No: 3113

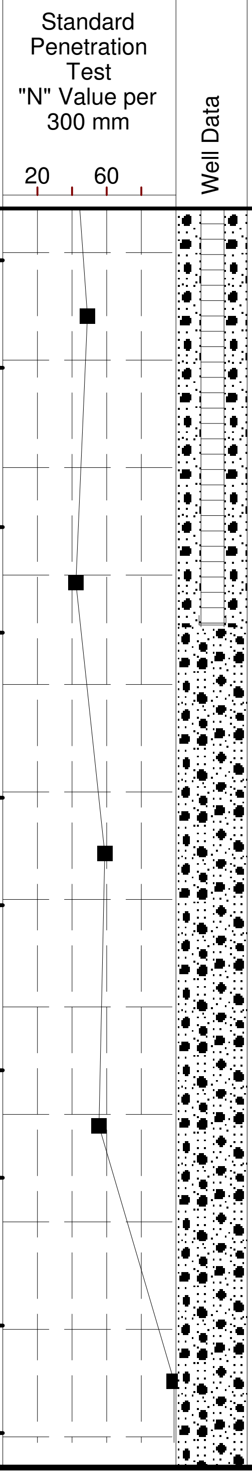
Location: Stephenville, NL

Date: November 19 - 22, 2017

SUBSURFACE PROFILE | SAMPLE



Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
		10.5						
	SPT: 19 / 23 / 26 / 29 Wet, brown, fine sand with small rock fragments	9.87	SS	14	49	29		0.05 m dia. screen from 15.76 m to 23.38 m
	Auger	8.98						
	SPT: 31 / 19 / 24 / 33 Wet, brown, fine to medium sand	8.37	SS	15	43	46		Screw-on cap
	Auger	7.44						
	SPT: 15 / 20 / 39 / 50 Wet, brown, fine to medium sand with red and black particles	6.83	SS	16	59	42		
	Auger	5.89						Native sand packing from 1.52 m to 31.00 m
	SPT: 14 / 21 / 35 / 36 CFEM: Sand, trace Gravel, trace Silt/Clay	5.28	SS	17	56	42		
	Auger	4.44						
	SPT: 18 / 78 / 36 / 45 CFEM: Sand, trace Silt/Clay	3.84	SS	18	114	29		



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Sheet: 4 of 6

Project: Geotechnical Investigation

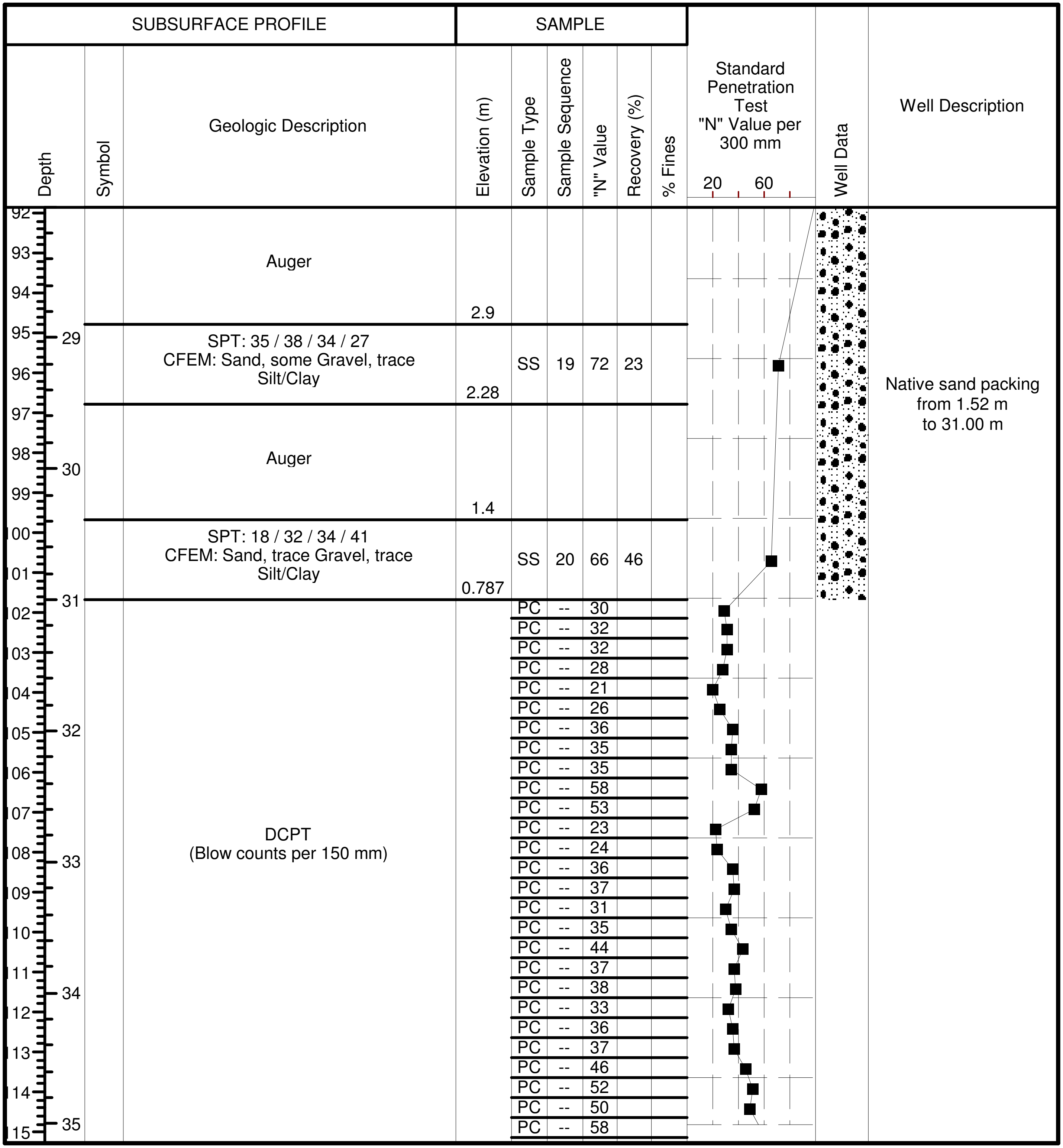
Log of Borehole: BH2

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017



SUBSURFACE PROFILE	SAMPLE						Well Description
Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	
Auger	2.9						Native sand packing from 1.52 m to 31.00 m
SPT: 35 / 38 / 34 / 27 CFEM: Sand, some Gravel, trace Silt/Clay	2.28	SS	19	72	23		
Auger	1.4						
SPT: 18 / 32 / 34 / 41 CFEM: Sand, trace Gravel, trace Silt/Clay	0.787	SS	20	66	46		
DCPT (Blow counts per 150 mm)		PC	--	30			
		PC	--	32			
		PC	--	32			
		PC	--	28			
		PC	--	21			
		PC	--	26			
		PC	--	36			
		PC	--	35			
		PC	--	35			
		PC	--	58			
		PC	--	53			
		PC	--	23			
		PC	--	24			
		PC	--	36			
		PC	--	37			
		PC	--	31			
		PC	--	35			
		PC	--	44			
		PC	--	37			
		PC	--	38			
		PC	--	33			
		PC	--	36			
		PC	--	37			
		PC	--	46			
		PC	--	52			
		PC	--	50			
		PC	--	58			

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Sheet: 5 of 6

Project: Geotechnical Investigation

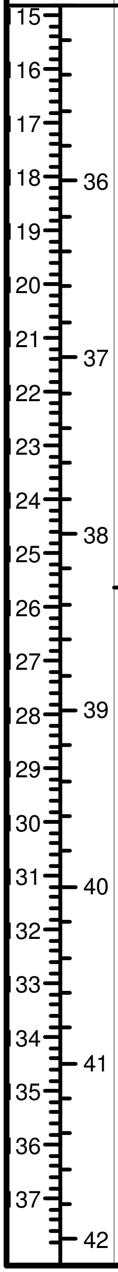
Log of Borehole: BH2

Client: Marine Harvest Atlantic Canada

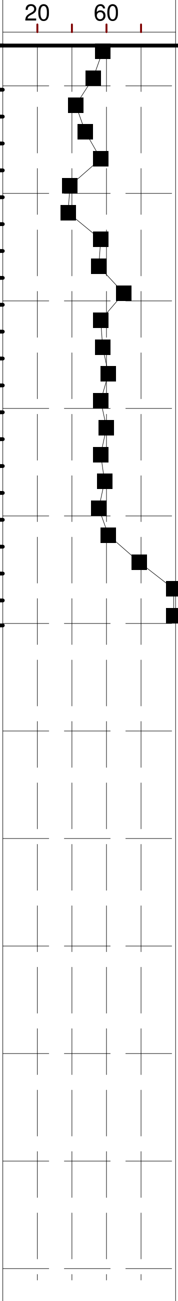
Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017



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	Well Data	Well Description
		DCPT (Blow counts per 150 mm)		PC	--	58					
				PC	--	53					
				PC	--	43					
				PC	--	48					
				PC	--	57					
				PC	--	40					
				PC	--	38					
				PC	--	57					
				PC	--	56					
				PC	--	71					
				PC	--	57					
				PC	--	58					
				PC	--	62					
				PC	--	57					
				PC	--	61					
				PC	--	57					
				PC	--	60					
				PC	--	56					
				PC	--	62					
				PC	--	79					
				PC	--	103					
			-6.52	PC	--	119					
		End of Borehole									



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Sheet: 6 of 6

Project: Geotechnical Investigation

Log of Borehole: BH3

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

SUBSURFACE PROFILE | SAMPLE

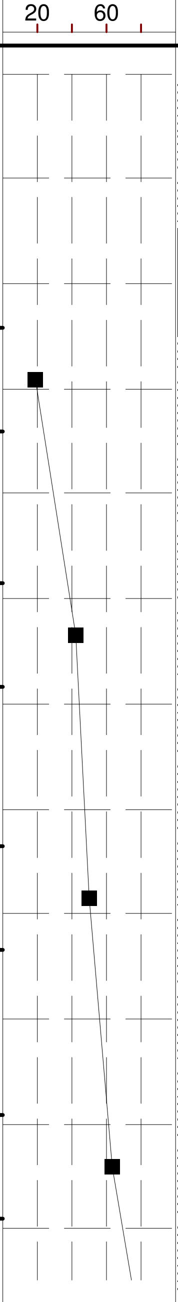
Depth

ft 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

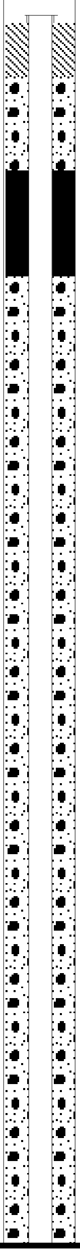
m 0 1 2 3 4 5 6

Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
	Ground Surface (GS)	28.1					
	Auger	26.7					
	SPT: 6 / 9 / 10 / 11 Dry, brown,coarse sand	26	SS	1	19	21	
	Auger	25.2					
	SPT: 17 / 31 / 12 / 20 Medium to coarse sand with small rock fragments	24.6	SS	2	43	29	
	Auger	23.6					
	SPT: 5 / 21 / 30 / 21 Dry, light brown gravel with coarse sand with red and black particles	23	SS	3	51	29	
	Auger	22.1					
	SPT: 10 / 27 / 37 / 30 Dry, light brown, gravel with coarse sand	21.5	SS	4	64	27	

Standard Penetration Test "N" Value per 300 mm



Well Data



Well Description

Well head protection Installed

Cement packing from 0.05 m to 0.36 m

Native sand packing from 0.36 m to 0.91 m

Bentonite packing from 0.91 m to 1.52 m

0.05 m dia. riser from 0 m to 12.21 m

Native sand packing from 1.52 m to 32.71 m

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 1 of 6

Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

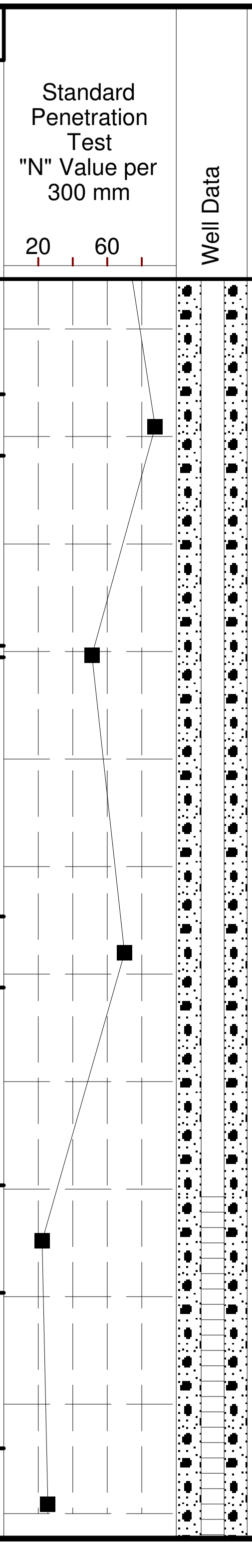
Location: Stephenville, NL

Log of Borehole: BH3

Project No: 3113

Date: November 23 - 26, 2017

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
23 24 25		Auger	20.5						
26 8		SPT: 4 / 36 / 52 for 0.05 m (Refusal) Dry, light brown, coarse sand with gravel	20.1	SS	5	88	25		
27 28 29 9		Auger	19						
30		SPT: 52 for 0.08 m (Refusal) No recovery		SS	6	52	0		
31 32 33 10 34		Auger	17.5						Native sand packing from 1.52 m to 32.71 m
35 11		SPT: 6 / 19 / 52 for 0.10 m (Refusal) Dry, light brown, coarse sand	17.1	SS	7	71	6		
36 37 38 39 12		Auger	16						▼ 11.95 m BGS (Nov. 27, 2017)
40 41		SPT: 4 / 9 / 14 / 16 Wet, light brown, medium sand with red and black particles	15.4	SS	8	23	52		
42 13 43 44 45		Auger	14.5						0.05 m dia. screen from 12.21 m to 21.36 m
46 14							29		



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
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 2 of 6

Project: Geotechnical Investigation

Log of Borehole: BH3

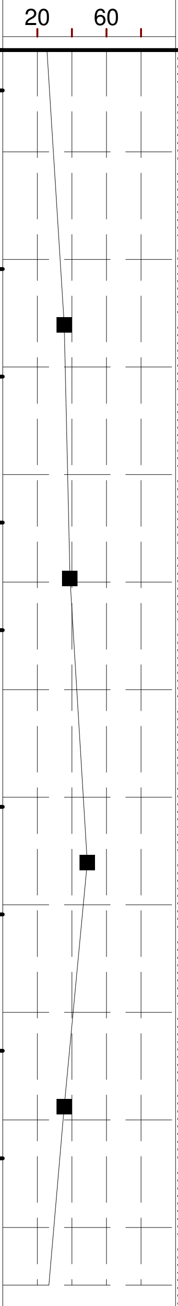
Client: Marine Harvest Atlantic Canada

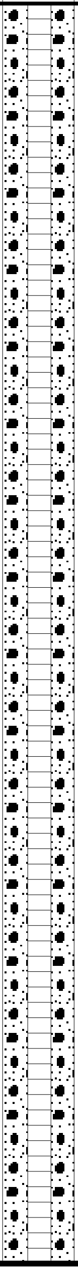
Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

SUBSURFACE PROFILE				SAMPLE							
Depth (ft)	Depth (m)	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm	Well Data	Well Description
46–47		SPT: 3 / 10 / 16 / 17 Wet, light brown with red and black particles 0 m - 0.05 m: fine to medium sand 0.05 m - 0.18 m: medium sand	13.9	SS	9	26	29				
47–50	15	Auger	12.9								
50–52		SPT: 8 / 17 / 19 / 19 Wet, light brown with red and black particles 0 m - 0.18 m: fine sand 0.18 m - 0.23 m: medium sand	12.3	SS	10	36	37				Native sand packing from 1.52 m to 32.71 m
52–55	16	Auger	11.5								
55–57	17	SPT: 8 / 16 / 24 / 29 Wet, light brown, fine sand with red and black particles	10.8	SS	11	40	30				
57–60	18	Auger	9.84								
60–62		SPT: 20 / 22 / 28 / 25 Wet, light brown, fine to medium sand with red and black particles	9.23	SS	12	50	67				0.05 m dia. screen from 12.21 m to 21.36 m
62–65	19	Auger	8.46								
65–67	20	SPT: 7 / 15 / 21 / 16 CFEM: Sand, trace Silt/Clay	7.85	SS	13	36	54				
67–69	21	Auger									





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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 3 of 6

Project: Geotechnical Investigation

Log of Borehole: BH3

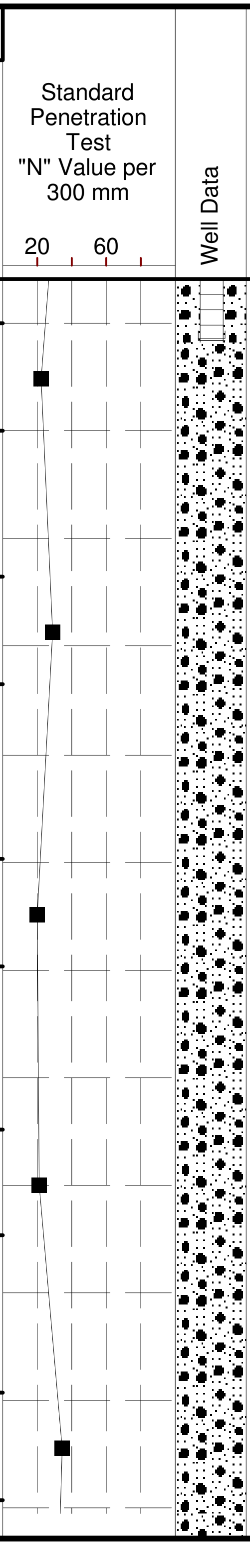
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

SUBSURFACE PROFILE			SAMPLE						
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
69			6.88						
70 71		SPT: 3 / 10 / 13 / 17 Wet, light brown, fine to medium sand with red and white particles	6.27	SS	14	23	37		Screw-on cap
72 22 73 74		Auger	5.44						
75 23 76		SPT: 6 / 12 / 18 / 25 CFEM: Sand, trace Silt/Clay	4.83	SS	15	30	33		
77 78 24 79		Auger	3.84						
80 81		SPT: 2 / 8 / 13 / 14 Wet, brown, fine sand	3.23	SS	16	21	1		Native sand packing from 1.52 m to 32.71 m
82 25 83 84		Auger	2.3						
85 26 86		SPT: 2 / 9 / 13 / 17 Brown, fine to medium sand with red and white particles	1.69	SS	17	22	29		
87 88 27 89		Auger	0.809						
90 91		SPT: 15 / 15 / 20 / 27 CFEM: Sand, trace Silt/Clay, trace Gravel	0.199	SS	18	35	21		
92 28									



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 4 of 6

Project: Geotechnical Investigation

Log of Borehole: BH3

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

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	Well Data	Well Description
		Auger	-0.721								Native sand packing from 1.52 m to 32.71 m
29		SPT: 1 / 9 / 21 / 27 Wet, grey fine to medium sand with red and white particles	-1.33	SS	19	30	21				
30		Auger	-2.27								
		SPT: 3 / 11 / 17 / 26 CFEM: Sand, trace Silt/Clay	-2.88	SS	20	28	21				
31		Auger	-3.74								
32		Sampler sank 0.23 m under own weight	-3.97								
		SPT: 22 / 31 / 36 / 53 Wet, brown, fine to medium sand with silt/clay Rock chip at the tip of sampler	-4.58	SS	21	67	10				
33 34 35		DCPT (Blow counts per 150 mm)		PC	--	21					
				PC	--	24					
				PC	--	33					
				PC	--	26					
				PC	--	25					
				PC	--	28					
				PC	--	36					
				PC	--	31					
				PC	--	40					
				PC	--	41					
				PC	--	35					
				PC	--	29					
				PC	--	32					
				PC	--	26					
				PC	--	44					
				PC	--	38					

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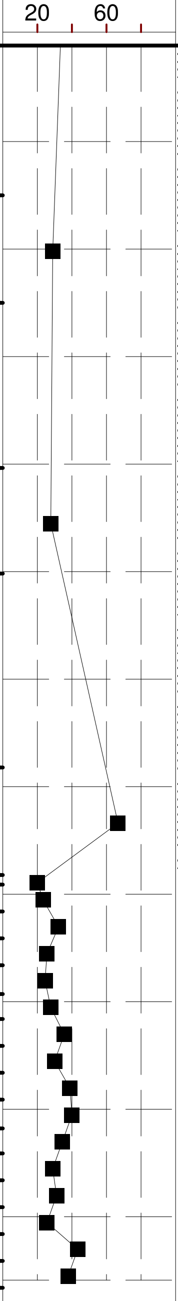

Fracflow Consultants Inc.
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St. John's, NL A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101

Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 5 of 6

Project: Geotechnical Investigation

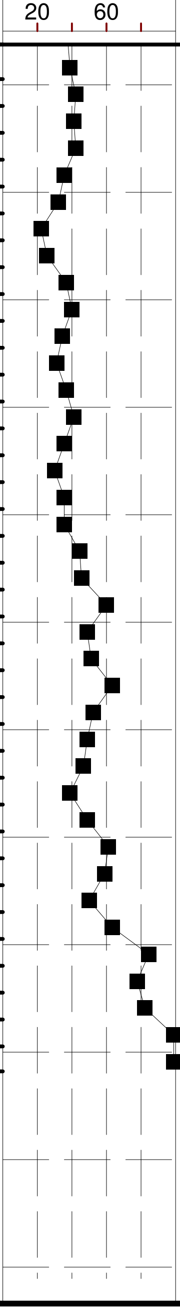
Log of Borehole: BH3

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017



SUBSURFACE PROFILE			SAMPLE							
Depth		Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Data	Well Description
15					PC	--	39				
					PC	--	43				
16					PC	--	42				
					PC	--	43				
17					PC	--	36				
					PC	--	33				
18	36				PC	--	23				
					PC	--	26				
19					PC	--	37				
					PC	--	41				
20					PC	--	35				
					PC	--	32				
21	37				PC	--	37				
					PC	--	42				
22					PC	--	36				
					PC	--	31				
23					PC	--	36				
					PC	--	36				
24					PC	--	45				
	38				PC	--	46				
25			DCPT (Blow counts per 150 mm)		PC	--	61				
					PC	--	50				
26					PC	--	52				
					PC	--	64				
27					PC	--	53				
	39				PC	--	49				
28					PC	--	47				
					PC	--	40				
29					PC	--	50				
					PC	--	62				
30					PC	--	59				
					PC	--	51				
31	40				PC	--	64				
					PC	--	85				
32					PC	--	78				
					PC	--	83				
33					PC	--	127				
				-12.7	PC	--	153				
34	41		End of Borehole								
35											
36											
37	42										

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL A1A 5A1
Phone: (709) 739-7270
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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 6 of 6

APPENDIX B

Laboratory Analytical Reports of Chemical and Bacteriological Analysis

Run Date: 22/03/18
Run Time: 0916

Western Health Care Corp. - LAB **LIVE**
Corner Brook, NL
Department Of Laboratory

Page: 1

** LIVE **

RECEIVED MAR 28 2018

NAME: PW, SEOK EUNJEONG

Report for: GOV.SERV.CENTRE-STEPHEN

SPEC #: 18:WA0000885R
OLL: 19/03/18-1835
RECD: 20/03/18-1522
COLLECTED BY: ES
SOURCE: WATER

COMMENTS: NAME:EUNJEONG SEOK FRACFLOW CONSULTANTS INC ADDRESS:154 MAJORS PATH ST JOHNS A1A 5A1 TELEPHONE:739-7270 BARCODE NUMBER:44516 SPECIMEN TYPE:DRILLED WELL

Procedure	Result	Verified	Site
***** MICROBIOLOGY *****			
> **BACTERIOLOGICAL WATER ANALYSIS**	Final	21/03/18-1538	
TOTAL COLIFORMS	ABSENT / 100ML		
FECAL COLIFORM (E. COLI)	ABSENT / 100ML		

GOVERNMENT SERVICE CENTRE

Stephenville Office
643-8650

INTERPRETATION OF WATER TEST RESULTS:

☑ Satisfactory
☐ Unsatisfactory
☐ Sub-standard
☐ Unable to Interpret

Comments:

Mar. 23/18
Date

Melanie Blaine
Environmental Health Officer III

NAME: PW,THOMPSON SHAWN

Report for: GOV.SERV.CENTRE-STEPHEN

SPEC #: 18:WA0000927R **OLL:** 21/03/18-0832 **COLLECTED BY:** ST
RECD: 22/03/18-1104 **SOURCE:** WATER

COMMENTS: NAME:SHAWN THOMPSON ADDRESS:154 MAJORS PATH ST JOHNS A1A 5A1 TELEPHONE:239-2270 BARCODE NUMBER:44515 SPECIMEN TYPE:DRILLED WELL FRACFLOW CONSULTANTS INC

Procedure	Result	Verified	Site
*** MICROBIOLOGY ***			
> **BACTERIOLOGICAL WATER ANALYSIS**	Final	23/03/18-1144	
TOTAL COLIFORMS	ABSENT / 100ML		
FECAL COLIFORM (E. COLI)	ABSENT / 100ML		

GOVERNMENT SERVICE CENTRE
Stephenville Office
643-8650

INTERPRETATION OF WATER TEST RESULTS:

☑ Satisfactory ☐ Sub-standard
☐ Unsatisfactory ☐ Unable to Interpret

Comments:

Mar 26, 2018
Date

Environmental Health Officer III

NAME: PW,THOMPSON SHAWN

Report for: GOV.SERV.CENTRE-STEPHEN

SPEC #: 18:WA0000928R **OLL:** 21/03/18-1412 **COLLECTED BY:** ST
RECD: 22/03/18-1106 **SOURCE:** WATER

COMMENTS: NAME:SHAWN THOMPSON ADDRESS:154 MAJORS PATH ST JOHNS A1A 5A1 TELEPHONE:739-7270 BARCODE NUMBER:50769 SPECIMEN TYPE:DRILLED WELL FRACFLOW CONSULTANTS INC

Procedure	Result	Verified	Site
	***** MICROBIOLOGY *****		
> **BACTERIOLOGICAL WATER ANALYSIS**	Final	23/03/18-1144	
TOTAL COLIFORMS	ABSENT / 100ML		
FECAL COLIFORM (E. COLI)	ABSENT / 100ML		

GOVERNMENT SERVICE CENTRE
Stephenville Office
643-8650

INTERPRETATION OF WATER TEST RESULTS:
☑ Satisfactory ☐ Sub-standard
☐ Unsatisfactory ☐ Unable to Interpret
Comments:

Mar 26, 2018
Date
Environmental Health Officer III

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: **18K322806**

WATER ANALYSIS REVIEWED BY: **Jason Coughtrey, Inorganics Supervisor**

DATE REPORTED: **Apr 03, 2018**

PAGES (INCLUDING COVER): **14**

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 RDL for Hg. Issued April 3, 2018.

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

Certificate of Analysis

AGAT WORK ORDER: 18K322806
PROJECT: 3113-Stephenville, NL

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 **ATTENTION TO: John Gale**
SAMPLING SITE: **SAMPLED BY:**

Dissolved Metals

DATE RECEIVED: 2018-03-23 **DATE REPORTED: 2018-04-03**

			SAMPLE DESCRIPTION:	3113-MHPW1-WS1
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-19
Parameter	**Unit**	**G / S**	**RDL**	**9144903**
Dissolved Aluminum	ug/L	Variable	5	<5
Dissolved Antimony	ug/L		2	<2
Dissolved Arsenic	ug/L	5	2	<2
Dissolved Barium	ug/L		5	41
Dissolved Beryllium	ug/L		2	<2
Dissolved Bismuth	ug/L		2	<2
Dissolved Boron	ug/L	29000,	5	21
Dissolved Cadmium	ug/L	1.0, 0.09	0.017	<0.017
Dissolved Chromium	ug/L		1	2
Dissolved Cobalt	ug/L		1	<1
Dissolved Copper	ug/L	Equation	2	4
Dissolved Iron	ug/L	300	50	<50
Dissolved Lead	ug/L	Equation	0.5	0.8
Dissolved Manganese	ug/L		2	3
Dissolved Molybdenum	ug/L	73	2	<2
Dissolved Nickel	ug/L	Equation	2	<2
Dissolved Selenium	ug/L	1.0	1	<1
Dissolved Silver	ug/L	0.25	0.1	<0.1
Dissolved Strontium	ug/L		5	84
Dissolved Thallium	ug/L	0.8	0.1	<0.1
Dissolved Tin	ug/L		2	<2
Dissolved Titanium	ug/L		2	<2
Dissolved Uranium	ug/L	33, 15	0.1	0.4
Dissolved Vanadium	ug/L		2	<2
Dissolved Zinc	ug/L	30	5	**81**

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

9144903 Analysis completed on a filtered sample.

Certified By: Jason Coughtrey

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

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

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

			SAMPLE DESCRIPTION:	3113-MHPW1-WS1	3113-MHPW1-WS2
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2018-03-19	2018-03-20
Parameter	**Unit**	**G / S**	**RDL**	**9144903**	**9144904**
pH		6.5-9.0		8.11	8.11
Reactive Silica as SiO2	mg/L		0.5	10.9	7.4
Chloride	mg/L	640, 120	1	13	12
Fluoride	mg/L	0.12	0.12	<0.12	<0.12
Sulphate	mg/L		2	5	4
Alkalinity	mg/L		5	142	142
True Color	TCU	Narrative	5	13	14
Turbidity	NTU	Narrative	0.1	0.8	1.1
Electrical Conductivity	umho/cm		1	310	313
Nitrate + Nitrite as N	mg/L		0.05	0.43	0.37
Nitrate as N	mg/L	550, 13	0.05	0.43	0.37
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.03	0.05
Total Organic Carbon	mg/L		0.5	<0.5	<0.5
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01
Total Sodium	mg/L		0.1	8.2	8.1
Total Potassium	mg/L		0.1	1.0	0.9
Total Calcium	mg/L		0.1	50.3	47.0
Total Magnesium	mg/L		0.1	6.9	6.9
Bicarb. Alkalinity (as CaCO3)	mg/L		5	142	142
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	172	166
Hardness	mg/L			154	146
Langelier Index (@20C)	NA			0.35	0.33
Langelier Index (@ 4C)	NA			0.03	0.01
Saturation pH (@ 20C)	NA			7.76	7.78
Saturation pH (@ 4C)	NA			8.08	8.10
Anion Sum	me/L			3.34	3.29

Certified By: Jason Coughtrey

Results relate only to the items tested and to all the items tested

Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS **ATTENTION TO: John Gale**

SAMPLING SITE: **SAMPLED BY:**

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-23 **DATE REPORTED: 2018-04-03**

			SAMPLE DESCRIPTION:	3113-MHPW1-WS1	3113-MHPW1-WS2
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2018-03-19	2018-03-20
Parameter	**Unit**	**G / S**	**RDL**	**9144903**	**9144904**
Cation sum	me/L			3.47	3.30
% Difference/ Ion Balance (NS)	%			1.9	0.2
Total Aluminum	ug/L	Variable	5	8	7
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L	5	2	<2	<2
Total Barium	ug/L		5	39	39
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L	29000,	5	12	6
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L	Equation	1	44	13
Total Iron	ug/L	300	50	89	65
Total Lead	ug/L	Equation	0.5	4.5	1.8
Total Manganese	ug/L		2	4	3
Total Molybdenum	ug/L	73	2	<2	<2
Total Nickel	ug/L	Equation	2	2	<2
Total Phosphorous	mg/L	Fact Sheet	0.02	0.03	0.03
Total Selenium	ug/L	1	1	<1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1
Total Strontium	ug/L		5	84	86
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	<2	<2
Total Uranium	ug/L	33, 15	0.1	0.4	0.4
Total Vanadium	ug/L		2	<2	<2
Total Zinc	ug/L	30	5	**82**	23

Certified By: Jason Coughtrey

Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

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CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

Certified By: Jason Coughtrey

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http://www.agatlabs.com

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Various Inorganics (Water)

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

		SAMPLE DESCRIPTION:		**3113-MHPW1-WS1**
		SAMPLE TYPE:		**Water**
		DATE SAMPLED:		**2018-03-19**
Parameter	**Unit**	**G / S**	**RDL**	**9144903**
Dissolved Organic Carbon	mg/L		0.5	<0.5
Mercury	mg/L	0.000026	0.000026	<0.000026
Mercury Digest				y
Total Kjeldahl Nitrogen as N	mg/L		0.4	0.5
Bromide	mg/L		0.05	<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

Certified By: Jason Coughtrey

Guideline Violation

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

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http://www.agatlabs.com

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
9144903	3113-MHPW1-WS1	NS-CCME FWAL	Dissolved Metals	Dissolved Zinc	ug/L	30	81
9144903	3113-MHPW1-WS1	NS-CCME FWAL	Standard Water Analysis + Total Metals	Total Zinc	ug/L	30	82

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St. John's, NL
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http://www.agatlabs.com

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS | **AGAT WORK ORDER: 18K322806**

PROJECT: 3113-Stephenville, NL | **ATTENTION TO: John Gale**

SAMPLING SITE: | **SAMPLED BY:**

Water Analysis

RPT Date: Apr 03, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Standard Water Analysis + Total Metals															
pH	9144903	9144903	8.11	8.10	0.1%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1	9133260	7.0	10	35.3%	< 0.5	113%	80%	120%		80%	120%	120%	80%	120%
Chloride	9148923		(256)	(263)	2.5%	< 1	91%	80%	120%	NA	80%	120%	NA	80%	120%
Fluoride	9148923		<0.12	<0.12	NA	< 0.12	107%	80%	120%	NA	80%	120%	97%	80%	120%
Sulphate	9148923		23	23	3.4%	< 2	109%	80%	120%	NA	80%	120%	NA	80%	120%
Alkalinity	9144903	9144903	142	142	0.3%	< 5	97%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9142642		8	10	NA	< 5	120%	80%	120%	NA			NA		
Turbidity	9142642		87.2	86.8	0.5%	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	9144903	9144903	310	312	0.7%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9148923		(7.64)	(7.95)	3.9%	< 0.05	98%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrite as N	9148923		0.41	0.42	1.9%	< 0.05	103%	80%	120%	NA	80%	120%	100%	80%	120%
Ammonia as N	1	9142979	<0.03	<0.03	NA	< 0.03	95%	80%	120%		80%	120%	92%	80%	120%
Total Organic Carbon	1	9143876	8.5	8.3	2.4%	< 0.5	94%	80%	120%		80%	120%	83%	80%	120%
Ortho-Phosphate as P	1	9133260	0.14	0.16	13.3%	< 0.01	115%	80%	120%		80%	120%	113%	80%	120%
Total Sodium	9149177		39.8	41.3	3.6%	< 0.1	103%	80%	120%	100%	80%	120%	NA	70%	130%
Total Potassium	9149177		1.3	1.4	8.3%	< 0.1	101%	80%	120%	99%	80%	120%	NA	70%	130%
Total Calcium	9149177		8.2	8.6	4.8%	< 0.1	107%	80%	120%	101%	80%	120%	NA	70%	130%
Total Magnesium	9149177		0.9	1.0	7.7%	< 0.1	105%	80%	120%	101%	80%	120%	85%	80%	120%
Bicarb. Alkalinity (as CaCO3)	9144903	9144903	142	142	0.3%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9144903	9144903	<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9144903	9144903	<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9149177		101	109	7.6%	< 5	107%	80%	120%	106%	80%	120%	103%	70%	130%
Total Antimony	9149177		<2	<2	NA	< 2	98%	80%	120%	112%	80%	120%	103%	70%	130%
Total Arsenic	9149177		<2	<2	NA	< 2	97%	80%	120%	100%	80%	120%	97%	70%	130%
Total Barium	9149177		25	25	NA	< 5	98%	80%	120%	98%	80%	120%	NA	70%	130%
Total Beryllium	9149177		<2	<2	NA	< 2	100%	80%	120%	102%	80%	120%	97%	70%	130%
Total Bismuth	9149177		<2	<2	NA	< 2	108%	80%	120%	116%	80%	120%	98%	70%	130%
Total Boron	9149177		12	12	NA	< 5	100%	80%	120%	108%	80%	120%	101%	70%	130%
Total Cadmium	9149177		0.047	0.049	NA	< 0.017	98%	80%	120%	99%	80%	120%	94%	70%	130%
Total Chromium	9149177		<1	<1	NA	< 1	107%	80%	120%	108%	80%	120%	102%	70%	130%
Total Cobalt	9149177		<1	<1	NA	< 1	119%	80%	120%	120%	80%	120%	119%	70%	130%
Total Copper	9149177		96	100	3.7%	< 1	109%	80%	120%	113%	80%	120%	NA	70%	130%
Total Iron	9149177		227	239	NA	< 50	116%	80%	120%	119%	80%	120%	NA	70%	130%
Total Lead	9149177		2.4	2.4	NA	< 0.5	118%	80%	120%	119%	80%	120%	102%	70%	130%
Total Manganese	9149177		16	16	3.6%	< 2	113%	80%	120%	113%	80%	120%	NA	70%	130%
Total Molybdenum	9149177		<2	<2	NA	< 2	99%	80%	120%	103%	80%	120%	107%	70%	130%
Total Nickel	9149177		<2	<2	NA	< 2	107%	80%	120%	110%	80%	120%	103%	70%	130%
Total Phosphorous	9149177		0.02	0.02	NA	< 0.02	97%	80%	120%	87%	80%	120%	104%	70%	130%
Total Selenium	9149177		<1	<1	NA	< 1	92%	80%	120%	96%	80%	120%	87%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS **AGAT WORK ORDER: 18K322806**

PROJECT: 3113-Stephenville, NL **ATTENTION TO: John Gale**

SAMPLING SITE: **SAMPLED BY:**

Water Analysis (Continued)

RPT Date: Apr 03, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Silver	9149177		<0.1	<0.1	NA	< 0.1	107%	80%	120%	108%	80%	120%	99%	70%	130%
Total Strontium	9149177		28	28	0.0%	< 5	104%	80%	120%	103%	80%	120%	NA	70%	130%
Total Thallium	9149177		<0.1	<0.1	NA	< 0.1	110%	80%	120%	114%	80%	120%	104%	70%	130%
Total Tin	9149177		<2	<2	NA	< 2	98%	80%	120%	101%	80%	120%	101%	70%	130%
Total Titanium	9149177		<2	<2	NA	< 2	104%	80%	120%	105%	80%	120%	100%	70%	130%
Total Uranium	9149177		0.6	0.6	1.3%	< 0.1	109%	80%	120%	110%	80%	120%	107%	70%	130%
Total Vanadium	9149177		<2	<2	NA	< 2	103%	80%	120%	104%	80%	120%	106%	70%	130%
Total Zinc	9149177		11	10	NA	< 5	108%	80%	120%	109%	80%	120%	92%	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.															
Dissolved Metals															
Dissolved Aluminum	9150500		<5	<5	NA	< 5	108%	80%	120%	106%	80%	120%	93%	70%	130%
Dissolved Antimony	9150500		<2	<2	NA	< 2	95%	80%	120%	106%	80%	120%	115%	70%	130%
Dissolved Arsenic	9150500		7	6	NA	< 2	97%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Barium	9150500		98	98	0.3%	< 5	100%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Beryllium	9150500		<2	<2	NA	< 2	102%	80%	120%	106%	80%	120%	107%	70%	130%
Dissolved Bismuth	9150500		<2	<2	NA	< 2	93%	80%	120%	105%	80%	120%	NA	70%	130%
Dissolved Boron	9150500		140	138	1.8%	< 5	104%	80%	120%	107%	80%	120%	NA	70%	130%
Dissolved Cadmium	9150500		0.026	0.025	NA	< 0.017	97%	80%	120%	99%	80%	120%	103%	70%	130%
Dissolved Chromium	9150500		2	3	NA	< 1	92%	80%	120%	97%	80%	120%	102%	70%	130%
Dissolved Cobalt	9150500		2	2	NA	< 1	103%	80%	120%	108%	80%	120%	114%	70%	130%
Dissolved Copper	9150500		<2	<2	NA	< 2	95%	80%	120%	99%	80%	120%	83%	70%	130%
Dissolved Iron	9150500		<50	<50	NA	< 50	100%	80%	120%	102%	80%	120%	98%	70%	130%
Dissolved Lead	9150500		<0.5	<0.5	NA	< 0.5	100%	80%	120%	101%	80%	120%	90%	70%	130%
Dissolved Manganese	9150500		1140	1100	3.1%	< 2	99%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Molybdenum	9150500		<2	<2	NA	< 2	93%	80%	120%	97%	80%	120%	97%	70%	130%
Dissolved Nickel	9150500		12	12	0.4%	< 2	95%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Selenium	9150500		2	2	NA	< 1	104%	80%	120%	103%	80%	120%	NA	70%	130%
Dissolved Silver	9150500		<0.1	<0.1	NA	< 0.1	95%	80%	120%	100%	80%	120%	95%	70%	130%
Dissolved Strontium	9150500		1230	1190	3.5%	< 5	103%	80%	120%	104%	80%	120%	NA	70%	130%
Dissolved Thallium	9150500		<0.1	<0.1	NA	< 0.1	99%	80%	120%	103%	80%	120%	98%	70%	130%
Dissolved Tin	9150500		<2	<2	NA	< 2	96%	80%	120%	99%	80%	120%	98%	70%	130%
Dissolved Titanium	9150500		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	94%	70%	130%
Dissolved Uranium	9150500		0.4	0.4	NA	< 0.1	95%	80%	120%	98%	80%	120%	102%	70%	130%
Dissolved Vanadium	9150500		3	3	NA	< 2	91%	80%	120%	92%	80%	120%	113%	70%	130%
Dissolved Zinc	9150500		8	8	NA	< 5	93%	80%	120%	95%	80%	120%	94%	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.															
Various Inorganics (Water)															
Mercury	1	9143899	<0.	<0.	NA	< 0.000026	100%	80%	120%		80%	120%	99%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS **AGAT WORK ORDER: 18K322806**

PROJECT: 3113-Stephenville, NL **ATTENTION TO: John Gale**

SAMPLING SITE: **SAMPLED BY:**

Water Analysis (Continued)

RPT Date: Apr 03, 2018

PARAMETER	Batch	Sample Id	DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
			Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Kjeldahl Nitrogen as N	1	9142487	0.5	0.5	NA	< 0.4	120%	80%	120%		80%	120%	90%	80%	120%
Bromide	9148923		0.09	0.10	NA	< 0.05	94%	80%	120%	NA	80%	120%	114%	80%	120%

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: Jason Coughtrey

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K322806
ATTENTION TO: John Gale
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INORG-121-6028	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 18K322806
PROJECT: 3113-Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Total Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Mercury	MET-121-6100 & MET-121-6107	SM 3112 B	CVAAS
Mercury Digest	MET-121-6100 & MET-121-6107	EPA 245.5	CV/AA
Total Kjeldahl Nitrogen as N	INOR-121-6020	SM 4500 NORG D	COLORIMETER
Bromide	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

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: 3.8 C
Hold Time:
AGAT Job Number: 18K322806
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:

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.:

Invoice To

Same Yes ☑ / No ☐

Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3880

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:** Diss Organic Carbon	**Other:** Bromide & TKN	Hazardous (Y/N)
3113-MHPW1-WS1	March 19, 2018 18:35	Water	6	Doc & Diss.Metal filtered		✓	✓	✓																		✓	✓	
3113-MHPW1-WS2	March 20, 2018 11:48	Water	4	Diss.Metal filtered		✓	✓																					

Samples Relinquished By (Print Name): Eunjeong Seok
Date/Time: March 23/18
Samples Received By (Print Name): Emma Penney
Date/Time: Mar. 23/18

Samples Relinquished By (Sign):
Date/Time: 10:07
Samples Received By (Sign): Emma Penney
Date/Time: 10:06am.

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

Page 1 of 1

Nº: FFC-3113-COC-07

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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: 18K323461

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

WATER ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

DATE REPORTED: Apr 19, 2018

PAGES (INCLUDING COVER): 21

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. Corrected sampling dates. Issued April 19th, 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: 18K323461
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: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS3	3113-MHPW1-WS5
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149302
Benzene	mg/L		0.001	<0.001	<0.001
Toluene	mg/L		0.001	<0.001	<0.001
Ethylbenzene	mg/L		0.001	<0.001	<0.001
Xylene (Total)	mg/L		0.001	<0.001	<0.001
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C21-C32 Hydrocarbons	mg/L		0.01	<0.01	<0.01
Modified TPH (Tier 1)	mg/L		0.1	<0.1	<0.1
Resemblance Comment				NR	NR
Return to Baseline at C32				Y	Y
Surrogate	Unit	Acceptable Limits			
Isobutylbenzene - EPH	%	70-130		111	119
Isobutylbenzene - VPH	%	70-130		89	94
n-Dotriacontane - EPH	%	70-130		112	122

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

9149300-9149302 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:

Certificate of Analysis

AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Dissolved Metals

DATE RECEIVED: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS3	3113-MHPW1-WS5
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149302
Dissolved Aluminum	ug/L		5	<5	<5
Dissolved Antimony	ug/L		2	<2	<2
Dissolved Arsenic	ug/L		2	<2	<2
Dissolved Barium	ug/L		5	40	39
Dissolved Beryllium	ug/L		2	<2	<2
Dissolved Bismuth	ug/L		2	<2	<2
Dissolved Boron	ug/L		5	7	7
Dissolved Cadmium	ug/L		0.017	<0.017	<0.017
Dissolved Chromium	ug/L		1	2	2
Dissolved Cobalt	ug/L		1	<1	<1
Dissolved Copper	ug/L		2	<2	<2
Dissolved Iron	ug/L		50	<50	<50
Dissolved Lead	ug/L		0.5	<0.5	<0.5
Dissolved Manganese	ug/L		2	2	<2
Dissolved Molybdenum	ug/L		2	<2	<2
Dissolved Nickel	ug/L		2	6	<2
Dissolved Selenium	ug/L		1	<1	<1
Dissolved Silver	ug/L		0.1	<0.1	<0.1
Dissolved Strontium	ug/L		5	83	83
Dissolved Thallium	ug/L		0.1	<0.1	<0.1
Dissolved Tin	ug/L		2	<2	<2
Dissolved Titanium	ug/L		2	<2	<2
Dissolved Uranium	ug/L		0.1	0.3	0.3
Dissolved Vanadium	ug/L		2	<2	<2
Dissolved Zinc	ug/L		5	28	29

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
9149300-9149302 Analysis completed on a filtered sample.

Certified By: Laura Baker

Certificate of Analysis

AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Mercury Analysis in Water (Total)

DATE RECEIVED: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS5
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL	9149302
Total Mercury	ug/L	0.026	0.026	<0.026

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

Certified By: Laura Baker

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Certificate of Analysis

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

		SAMPLE DESCRIPTION:		3113-MHPW1-WS3	3113-MHPW1-WS4
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149305
pH		6.5-9.0		8.14	8.13
Reactive Silica as SiO2	mg/L		0.5	6.0	5.7
Chloride	mg/L	640, 120	1	12	12
Fluoride	mg/L	0.12	0.12	<0.12	<0.12
Sulphate	mg/L		2	4	4
Alkalinity	mg/L		5	143	143
True Color	TCU	Narrative	5	<5	<5
Turbidity	NTU	Narrative	0.1	0.5	0.9
Electrical Conductivity	umho/cm		1	321	323
Nitrate + Nitrite as N	mg/L		0.05	0.36	0.39
Nitrate as N	mg/L	550, 13	0.05	0.36	0.39
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.04	0.04
Total Organic Carbon	mg/L		0.5	<0.5	0.7
Ortho-Phosphate as P	mg/L		0.01	0.08	0.07
Total Sodium	mg/L		0.1	8.2	8.3
Total Potassium	mg/L		0.1	0.9	0.9
Total Calcium	mg/L		0.1	50.0	47.3
Total Magnesium	mg/L		0.1	7.2	7.1
Bicarb. Alkalinity (as CaCO3)	mg/L		5	143	143
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	170	167
Hardness	mg/L			154	147
Langelier Index (@20C)	NA			0.38	0.35
Langelier Index (@ 4C)	NA			0.06	0.03
Saturation pH (@ 20C)	NA			7.76	7.78
Saturation pH (@ 4C)	NA			8.08	8.10
Anion Sum	me/L			3.31	3.31

Certified By: Laura Baker

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Certificate of Analysis

AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS3	3113-MHPW1-WS4
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149305
Cation sum	me/L			3.48	3.34
% Difference/ Ion Balance (NS)	%			2.5	0.4
Total Aluminum	ug/L	Variable	5	<5	<5
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L	5	2	<2	<2
Total Barium	ug/L		5	39	39
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L	29000,	5	7	7
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L	Equation	1	4	1
Total Iron	ug/L	300	50	65	68
Total Lead	ug/L	Equation	0.5	0.6	0.6
Total Manganese	ug/L		2	3	3
Total Molybdenum	ug/L	73	2	<2	<2
Total Nickel	ug/L	Equation	2	2	2
Total Phosphorous	mg/L	Fact Sheet	0.02	0.03	0.03
Total Selenium	ug/L	1	1	<1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1
Total Strontium	ug/L		5	86	88
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	<2	<2
Total Uranium	ug/L	33, 15	0.1	0.4	0.4
Total Vanadium	ug/L		2	<2	<2
Total Zinc	ug/L	30	5	26	15

Certified By: Laura Baker

Certificate of Analysis

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 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.

Certified By: Laura Baker

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AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Standard Water Analysis + Total Metals+ DOC,TKN,Bromide

DATE RECEIVED: 2018-03-26
DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS5
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL	9149302
pH				8.13
Reactive Silica as SiO2	mg/L		0.5	5.7
Chloride	mg/L		1	12
Fluoride	mg/L		0.12	<0.12
Sulphate	mg/L		2	4
Alkalinity	mg/L		5	143
True Color	TCU		5	<5
Turbidity	NTU		0.1	0.7
Electrical Conductivity	umho/cm		1	322
Nitrate + Nitrite as N	mg/L		0.05	0.37
Nitrate as N	mg/L		0.05	0.37
Nitrite as N	mg/L		0.05	<0.05
Ammonia as N	mg/L		0.03	<0.03
Total Organic Carbon	mg/L		0.5	1.7
Ortho-Phosphate as P	mg/L		0.01	0.08
Total Sodium	mg/L		0.1	8.2
Total Potassium	mg/L		0.1	0.9
Total Calcium	mg/L		0.1	49.7
Total Magnesium	mg/L		0.1	6.8
Bicarb. Alkalinity (as CaCO3)	mg/L		5	143
Carb. Alkalinity (as CaCO3)	mg/L		10	<10
Hydroxide	mg/L		5	<5
Calculated TDS	mg/L		1	169
Hardness	mg/L			152
Langelier Index (@20C)	NA			0.37
Langelier Index (@ 4C)	NA			0.05
Saturation pH (@ 20C)	NA			7.76
Saturation pH (@ 4C)	NA			8.08
Anion Sum	me/L			3.31

Certified By: Laura Baker

Certificate of Analysis

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals+ DOC,TKN,Bromide

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS5
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL	9149302
Cation sum	me/L			3.42
% Difference/ Ion Balance (NS)	%			1.7
Total Aluminum	ug/L		5	<5
Total Antimony	ug/L		2	<2
Total Arsenic	ug/L		2	<2
Total Barium	ug/L		5	39
Total Beryllium	ug/L		2	<2
Total Bismuth	ug/L		2	<2
Total Boron	ug/L		5	6
Total Cadmium	ug/L		0.017	<0.017
Total Chromium	ug/L		1	<1
Total Cobalt	ug/L		1	<1
Total Copper	ug/L		1	1
Total Iron	ug/L		50	63
Total Lead	ug/L		0.5	<0.5
Total Manganese	ug/L		2	3
Total Molybdenum	ug/L		2	<2
Total Nickel	ug/L		2	2
Total Phosphorous	mg/L		0.02	0.02
Total Selenium	ug/L		1	<1
Total Silver	ug/L		0.1	<0.1
Total Strontium	ug/L		5	87
Total Thallium	ug/L		0.1	<0.1
Total Tin	ug/L		2	<2
Total Titanium	ug/L		2	<2
Total Uranium	ug/L		0.1	0.3
Total Vanadium	ug/L		2	<2
Total Zinc	ug/L		5	22
Bromide	µg/L		50	<50

Certified By: Laura Baker

Results relate only to the items tested and to all the items tested

Certificate of Analysis

AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL

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CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals+ DOC,TKN,Bromide

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS5
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL	9149302
TKN Digest				Y
Total Kjeldahl Nitrogen as N	mg/L		0.4	<0.4
Dissolved Organic Carbon	mg/L		0.5	<0.5

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

Certified By: Laura Baker

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Trace Organics Analysis

RPT Date: Apr 19, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		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	9149010	< 0.001	< 0.001	NA	< 0.001	103%	70%	130%	112%	70%	130%	NA		
Toluene	1	9149010	< 0.001	< 0.001	NA	< 0.001	106%	70%	130%	108%	70%	130%	NA		
Ethylbenzene	1	9149010	< 0.001	< 0.001	NA	< 0.001	104%	70%	130%	102%	70%	130%	NA		
Xylene (Total)	1	9149010	< 0.001	< 0.001	NA	< 0.001	109%	70%	130%	110%	70%	130%	NA		
C6-C10 (less BTEX)	1	9149010	< 0.01	< 0.01	NA	< 0.01	100%	70%	130%	106%	70%	130%	106%	70%	130%
>C10-C16 Hydrocarbons	1	9149302	< 0.05	< 0.05	NA	< 0.05	109%	70%	130%	123%	70%	130%	125%	70%	130%
>C16-C21 Hydrocarbons	1	9149302	< 0.05	< 0.05	NA	< 0.05	116%	70%	130%	123%	70%	130%	125%	70%	130%
>C21-C32 Hydrocarbons	1	9149302	< 0.01	< 0.01	NA	< 0.01	104%	70%	130%	123%	70%	130%	125%	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:

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis

RPT Date: Apr 19, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Standard Water Analysis + Total Metals															
pH	9148925		7.75	7.77	0.3%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1	9149300	6.0	5.9	1.7%	< 0.5	98%	80%	120%		80%	120%	100%	80%	120%
Chloride	9149375		4	4	NA	< 1	92%	80%	120%	NA	80%	120%	90%	80%	120%
Fluoride	9149375		<0.12	<0.12	NA	< 0.12	104%	80%	120%	NA	80%	120%	90%	80%	120%
Sulphate	9149375		<2	<2	NA	< 2	113%	80%	120%	NA	80%	120%	94%	80%	120%
Alkalinity	9148925		213	213	0.1%	< 5	97%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9149300	9149300	<5	6	NA	< 5	105%	80%	120%	NA			NA		
Turbidity	9149300	9149300	0.5	0.4	NA	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	9148925		1530	1540	0.5%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9149375		0.20	0.18	NA	< 0.05	101%	80%	120%	NA	80%	120%	82%	80%	120%
Nitrite as N	9149375		<0.05	<0.05	NA	< 0.05	105%	80%	120%	NA	80%	120%	87%	80%	120%
Ammonia as N	1	9144766	0.03	0.02	NA	< 0.03	92%	80%	120%		80%	120%	95%	80%	120%
Total Organic Carbon	1	9149300	<0.5	<0.5	NA	< 0.5	108%	80%	120%		80%	120%	105%	80%	120%
Ortho-Phosphate as P	1	9149300	0.08	0.07	13.3%	< 0.01	115%	80%	120%		80%	120%	90%	80%	120%
Total Sodium	9150501		19.1	19.8	3.7%	< 0.1	105%	80%	120%	108%	80%	120%	NA	70%	130%
Total Potassium	9150501		1.7	1.6	1.7%	< 0.1	103%	80%	120%	104%	80%	120%	NA	70%	130%
Total Calcium	9150501		85.9	88.9	3.4%	< 0.1	109%	80%	120%	106%	80%	120%	NA	70%	130%
Total Magnesium	9150501		9.4	9.2	2.4%	< 0.1	105%	80%	120%	107%	80%	120%	NA	80%	120%
Bicarb. Alkalinity (as CaCO3)	9148925		213	213	0.1%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9148925		<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9148925		<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9150501		9	9	NA	< 5	108%	80%	120%	109%	80%	120%	97%	70%	130%
Total Antimony	9150501		<2	<2	NA	< 2	92%	80%	120%	103%	80%	120%	98%	70%	130%
Total Arsenic	9150501		<2	<2	NA	< 2	98%	80%	120%	92%	80%	120%	97%	70%	130%
Total Barium	9150501		49	49	0.2%	< 5	99%	80%	120%	97%	80%	120%	NA	70%	130%
Total Beryllium	9150501		<2	<2	NA	< 2	102%	80%	120%	105%	80%	120%	97%	70%	130%
Total Bismuth	9150501		<2	<2	NA	< 2	97%	80%	120%	106%	80%	120%	92%	70%	130%
Total Boron	9150501		12	11	NA	< 5	104%	80%	120%	102%	80%	120%	102%	70%	130%
Total Cadmium	9150501		0.051	0.050	NA	< 0.017	98%	80%	120%	97%	80%	120%	93%	70%	130%
Total Chromium	9150501		<1	<1	NA	< 1	107%	80%	120%	107%	80%	120%	106%	70%	130%
Total Cobalt	9150501		<1	<1	NA	< 1	105%	80%	120%	103%	80%	120%	103%	70%	130%
Total Copper	9150501		34	33	2.5%	< 1	107%	80%	120%	103%	80%	120%	NA	70%	130%
Total Iron	9150501		90	85	NA	< 50	114%	80%	120%	115%	80%	120%	113%	70%	130%
Total Lead	9150501		11.6	11.5	0.6%	< 0.5	107%	80%	120%	105%	80%	120%	NA	70%	130%
Total Manganese	9150501		373	386	3.3%	< 2	115%	80%	120%	114%	80%	120%	NA	70%	130%
Total Molybdenum	9150501		<2	<2	NA	< 2	92%	80%	120%	94%	80%	120%	102%	70%	130%
Total Nickel	9150501		4	4	NA	< 2	106%	80%	120%	104%	80%	120%	97%	70%	130%
Total Phosphorous	9150501		0.03	0.03	NA	< 0.02	106%	80%	120%	91%	80%	120%	101%	70%	130%
Total Selenium	9150501		<1	<1	NA	< 1	96%	80%	120%	85%	80%	120%	92%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 19, 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
Total Silver	9150501		<0.1	<0.1	NA	< 0.1	99%	80%	120%	102%	80%	120%	95%	70%	130%
Total Strontium	9150501		288	298	3.1%	< 5	102%	80%	120%	103%	80%	120%	NA	70%	130%
Total Thallium	9150501		<0.1	<0.1	NA	< 0.1	103%	80%	120%	105%	80%	120%	97%	70%	130%
Total Tin	9150501		<2	<2	NA	< 2	95%	80%	120%	94%	80%	120%	95%	70%	130%
Total Titanium	9150501		<2	<2	NA	< 2	107%	80%	120%	108%	80%	120%	86%	70%	130%
Total Uranium	9150501		<0.1	<0.1	NA	< 0.1	101%	80%	120%	100%	80%	120%	98%	70%	130%
Total Vanadium	9150501		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	110%	70%	130%
Total Zinc	9150501		41	41	1.9%	< 5	112%	80%	120%	109%	80%	120%	122%	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.

Standard Water Analysis + Total Metals+ DOC,TKN,Bromide

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Lower	Upper	Recovery	Lower	Upper	Recovery	Lower	Upper
pH	9148925		7.75	7.77	0.3%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Chloride	9149375		4	4	NA	< 1	92%	80%	120%	NA	80%	120%	90%	80%	120%
Fluoride	9149375		<0.12	<0.12	NA	< 0.12	104%	80%	120%	NA	80%	120%	90%	80%	120%
Sulphate	9149375		<2	<2	NA	< 2	113%	80%	120%	NA	80%	120%	94%	80%	120%
Alkalinity	9148925		213	213	0.1%	< 5	97%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9149300	9149300	<5	6	NA	< 5	105%	80%	120%	NA			NA		
Turbidity	9149300	9149300	0.5	0.4	NA	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	9148925		1530	1540	0.5%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9149375		0.20	0.18	NA	< 0.05	101%	80%	120%	NA	80%	120%	82%	80%	120%
Nitrite as N	9149375		<0.05	<0.05	NA	< 0.05	105%	80%	120%	NA	80%	120%	87%	80%	120%
Total Sodium	9150501		19.1	19.8	3.7%	< 0.1	105%	80%	120%	108%	80%	120%	NA	70%	130%
Total Potassium	9150501		1.7	1.6	1.7%	< 0.1	103%	80%	120%	104%	80%	120%	NA	70%	130%
Total Calcium	9150501		85.9	88.9	3.4%	< 0.1	109%	80%	120%	106%	80%	120%	NA	70%	130%
Total Magnesium	9150501		9.4	9.2	2.4%	< 0.1	105%	80%	120%	107%	80%	120%	NA	80%	120%
Bicarb. Alkalinity (as CaCO3)	9148925		213	213	0.1%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9148925		<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9148925		<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9150501		9	9	NA	< 5	108%	80%	120%	109%	80%	120%	97%	70%	130%
Total Antimony	9150501		<2	<2	NA	< 2	92%	80%	120%	103%	80%	120%	98%	70%	130%
Total Arsenic	9150501		<2	<2	NA	< 2	98%	80%	120%	92%	80%	120%	97%	70%	130%
Total Barium	9150501		49	49	0.2%	< 5	99%	80%	120%	97%	80%	120%	NA	70%	130%
Total Beryllium	9150501		<2	<2	NA	< 2	102%	80%	120%	105%	80%	120%	97%	70%	130%
Total Bismuth	9150501		<2	<2	NA	< 2	97%	80%	120%	106%	80%	120%	92%	70%	130%
Total Boron	9150501		12	11	NA	< 5	104%	80%	120%	102%	80%	120%	102%	70%	130%
Total Cadmium	9150501		0.051	0.050	NA	< 0.017	98%	80%	120%	97%	80%	120%	93%	70%	130%
Total Chromium	9150501		<1	<1	NA	< 1	107%	80%	120%	107%	80%	120%	106%	70%	130%
Total Cobalt	9150501		<1	<1	NA	< 1	105%	80%	120%	103%	80%	120%	103%	70%	130%
Total Copper	9150501		34	33	2.5%	< 1	107%	80%	120%	103%	80%	120%	NA	70%	130%
Total Iron	9150501		90	85	NA	< 50	114%	80%	120%	115%	80%	120%	113%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 19, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Lead	9150501		11.6	11.5	0.6%	< 0.5	107%	80%	120%	105%	80%	120%	NA	70%	130%
Total Manganese	9150501		373	386	3.3%	< 2	115%	80%	120%	114%	80%	120%	NA	70%	130%
Total Molybdenum	9150501		<2	<2	NA	< 2	92%	80%	120%	94%	80%	120%	102%	70%	130%
Total Nickel	9150501		4	4	NA	< 2	106%	80%	120%	104%	80%	120%	97%	70%	130%
Total Phosphorous	9150501		0.03	0.03	NA	< 0.02	106%	80%	120%	91%	80%	120%	101%	70%	130%
Total Selenium	9150501		<1	<1	NA	< 1	96%	80%	120%	85%	80%	120%	92%	70%	130%
Total Silver	9150501		<0.1	<0.1	NA	< 0.1	99%	80%	120%	102%	80%	120%	95%	70%	130%
Total Strontium	9150501		288	298	3.1%	< 5	102%	80%	120%	103%	80%	120%	NA	70%	130%
Total Thallium	9150501		<0.1	<0.1	NA	< 0.1	103%	80%	120%	105%	80%	120%	97%	70%	130%
Total Tin	9150501		<2	<2	NA	< 2	95%	80%	120%	94%	80%	120%	95%	70%	130%
Total Titanium	9150501		<2	<2	NA	< 2	107%	80%	120%	108%	80%	120%	86%	70%	130%
Total Uranium	9150501		<0.1	<0.1	NA	< 0.1	101%	80%	120%	100%	80%	120%	98%	70%	130%
Total Vanadium	9150501		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	110%	70%	130%
Total Zinc	9150501		41	41	1.9%	< 5	112%	80%	120%	109%	80%	120%	122%	70%	130%
Bromide	9149375		<50	<50	NA	< 50	92%	80%	120%	NA	80%	120%	88%	80%	120%
Total Kjeldahl Nitrogen as N	1	9144766	0.4	0.5	NA	< 0.4	98%	80%	120%		80%	120%	105%	80%	120%

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

Dissolved Metals															
Dissolved Aluminum	9150500		<5	<5	NA	< 5	108%	80%	120%	106%	80%	120%	93%	70%	130%
Dissolved Antimony	9150500		<2	<2	NA	< 2	95%	80%	120%	106%	80%	120%	115%	70%	130%
Dissolved Arsenic	9150500		7	6	NA	< 2	97%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Barium	9150500		98	98	0.3%	< 5	100%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Beryllium	9150500		<2	<2	NA	< 2	102%	80%	120%	106%	80%	120%	107%	70%	130%
Dissolved Bismuth	9150500		<2	<2	NA	< 2	93%	80%	120%	105%	80%	120%	NA	70%	130%
Dissolved Boron	9150500		140	138	1.8%	< 5	104%	80%	120%	107%	80%	120%	NA	70%	130%
Dissolved Cadmium	9150500		0.026	0.025	NA	< 0.017	97%	80%	120%	99%	80%	120%	103%	70%	130%
Dissolved Chromium	9150500		2	3	NA	< 1	92%	80%	120%	97%	80%	120%	102%	70%	130%
Dissolved Cobalt	9150500		2	2	NA	< 1	103%	80%	120%	108%	80%	120%	114%	70%	130%
Dissolved Copper	9150500		<2	<2	NA	< 2	95%	80%	120%	99%	80%	120%	83%	70%	130%
Dissolved Iron	9150500		<50	<50	NA	< 50	100%	80%	120%	102%	80%	120%	98%	70%	130%
Dissolved Lead	9150500		<0.5	<0.5	NA	< 0.5	100%	80%	120%	101%	80%	120%	90%	70%	130%
Dissolved Manganese	9150500		1140	1100	3.1%	< 2	99%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Molybdenum	9150500		<2	<2	NA	< 2	93%	80%	120%	97%	80%	120%	97%	70%	130%
Dissolved Nickel	9150500		12	12	0.4%	< 2	95%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Selenium	9150500		2	2	NA	< 1	104%	80%	120%	103%	80%	120%	NA	70%	130%
Dissolved Silver	9150500		<0.1	<0.1	NA	< 0.1	95%	80%	120%	100%	80%	120%	95%	70%	130%
Dissolved Strontium	9150500		1230	1190	3.5%	< 5	103%	80%	120%	104%	80%	120%	NA	70%	130%
Dissolved Thallium	9150500		<0.1	<0.1	NA	< 0.1	99%	80%	120%	103%	80%	120%	98%	70%	130%
Dissolved Tin	9150500		<2	<2	NA	< 2	96%	80%	120%	99%	80%	120%	98%	70%	130%

Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 19, 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 Titanium	9150500		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	94%	70%	130%
Dissolved Uranium	9150500		0.4	0.4	NA	< 0.1	95%	80%	120%	98%	80%	120%	102%	70%	130%
Dissolved Vanadium	9150500		3	3	NA	< 2	91%	80%	120%	92%	80%	120%	113%	70%	130%
Dissolved Zinc	9150500		8	8	NA	< 5	93%	80%	120%	95%	80%	120%	94%	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.

Mercury Analysis in Water (Total)

Total Mercury	1	9151513	<0.05	<0.05	NA	< 0.026	95%	80%	120%		80%	120%	97%	80%	120%

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: Laura Baker

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 18K323461
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-120-5010	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
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	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	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS
PROJECT: 3113-Stephenville, NL
SAMPLING SITE:

AGAT WORK ORDER: 18K323461
ATTENTION TO: John Gale
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Mercury	MET-121-6100 & MET-121-6107	SM 3112 B	CV/AA
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INORG-121-6028	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Total Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bromide	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
TKN Digest			COLORIMETER
Total Kjeldahl Nitrogen as N	INOR-121-6020	SM 4500 NORG D	COLORIMETER
Dissolved Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER

AGAT Laboratories

Unit 122 ▪ 11 Morris Drive
Dartmouth, NS
B3B 1M2
webearth.agatlabs.com ▪ www.agatlabs.com

Chain of Custody Record

P: 902.468.8718 ▪ F: 902.468.8924

Laboratory Use Only

Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 7 · 1
Hold Time:
AGAT Job Number: 18K323461
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#: 3881

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:** Diss Organic Carbon	**Other:** Bromide & TKN	Hazardous (Y/N)
3113-MHPW1-WS3	March 21, 2018 08:30	Water	9	1x500, 3x100, 2x250, 3x40		✓	✓								✓													
				Diss.Metal filtered																								
3113-MHPW1-WS5	March 22, 2018 17:27	Water	11	1x500, 5x100, 2x250, 3x40		✓	✓	✓							✓											✓	✓	
				Doc & Diss.Metal filtered																								

Samples Relinquished By (Print Name): Eunjeong Seok
Date/Time: March 26/18
Samples Received By (Print Name): A Camiy
Date/Time: 03/26/18
Samples Relinquished By (Sign): E Seok
Date/Time: 12:45
Samples Received By (Sign):
Date/Time: 12:45

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

Page 1 of 2

Nº: FFC-3113-COC-08

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: 7 7
Hold Time:
AGAT Job Number: 18K323461
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#: 3881

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-MHPW1-WS4	March 22, 2018 7:54	Water	4	1x500, 3x100		✓	✓																					

Samples Relinquished By (Print Name): Eunjeong Seok
Date/Time: March 26/18
Samples Relinquished By (Sign): ES
Date/Time: 12:45
Samples Received By (Print Name): A Canning
Date/Time: 03/26/18
Samples Received By (Sign):
Date/Time: 12:45

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

Page 2 of 2

Nº: FFC-3113-COC-08

APPENDIX C

Reports of Grain Size Analysis

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

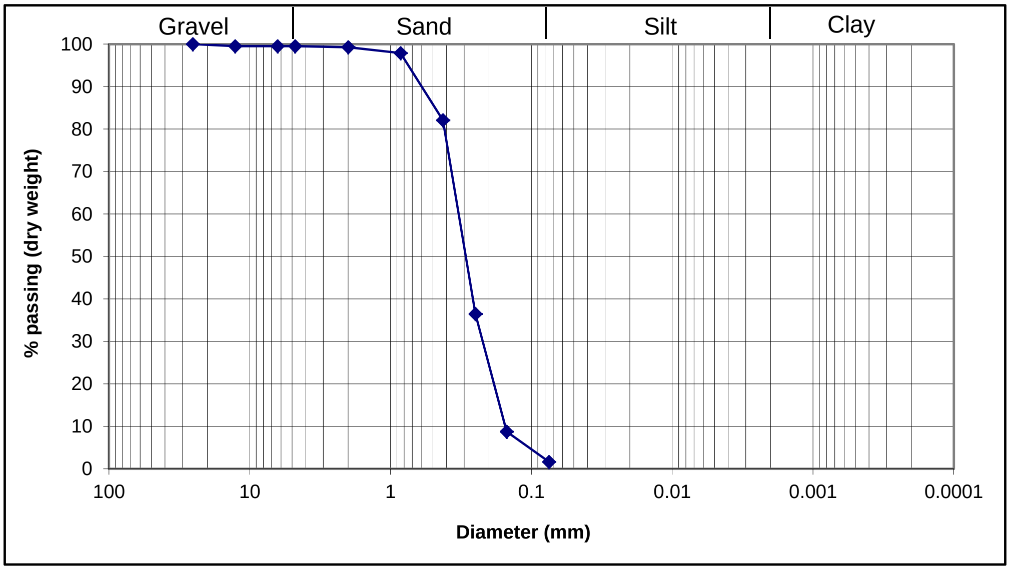
Sample No. : MHPW1-160-165

Depth below GS : 48.77 - 50.29 m
(160 - 165 ft)

Sieve Analysis

Dry weight of sample (g) = 734.02

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	3.66	0.50	0.50	99.50
1/4"	6.35	0.00	0.00	0.50	99.50
4	4.76	0.00	0.00	0.50	99.50
10	2.00	1.68	0.23	0.73	99.27
20	0.85	10.19	1.39	2.12	97.88
40	0.425	115.95	15.80	17.91	82.09
60	0.25	334.85	45.62	63.53	36.47
100	0.15	203.38	27.71	91.24	8.76
200	0.075	52.28	7.12	98.36	1.64
pan	---	12.03	1.64	100.00	---
		734.02			



D_{10} = 0.16

D_{30} = 0.22

D_{60} = 0.33

Cu = 2.06

Cc = 0.92

USCS: SP (Poorly graded sand)

R_{200} = 98.36

R_4 = 0.50

R_4/R_{200} = 0.01

SF = 97.86

GF = 0.50

% Gravel = 0.50

% Sand = 97.86

% Silt & Clay = 1.64

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

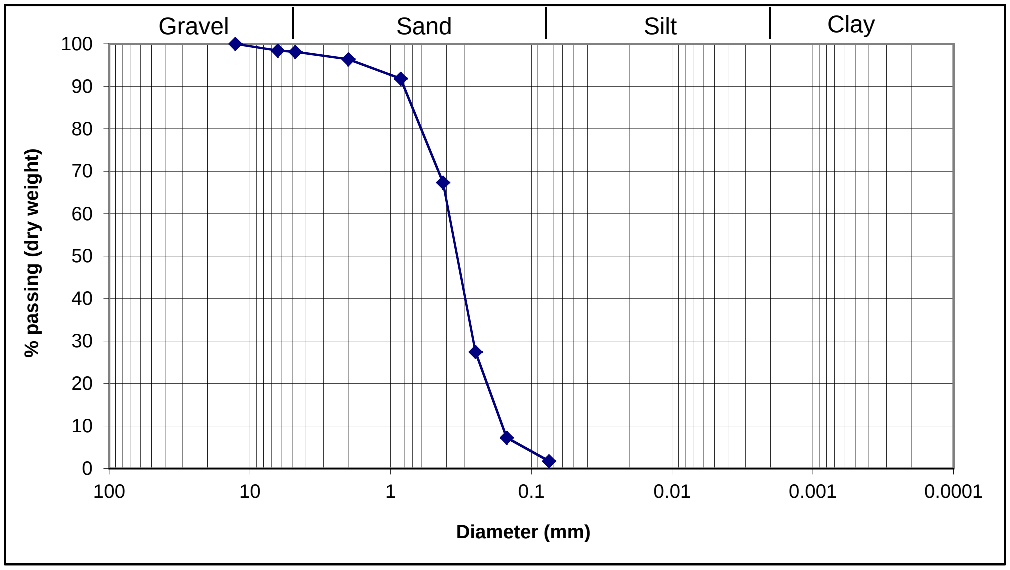
Sample No. : MHPW1-165-170

Depth below GS : 50.29 - 51.82 m
(165 - 170 ft)

Sieve Analysis

Dry weight of sample (g) = 434.51

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	6.87	1.58	1.58	98.42
4	4.76	1.28	0.29	1.88	98.12
10	2.00	7.61	1.75	3.63	96.37
20	0.85	19.66	4.52	8.15	91.85
40	0.425	106.32	24.47	32.62	67.38
60	0.25	173.40	39.91	72.53	27.47
100	0.15	87.65	20.17	92.70	7.30
200	0.075	24.05	5.53	98.23	1.77
pan	---	7.67	1.77	100.00	---
		434.51			



D_{10} = 0.16
D_{30} = 0.26
D_{60} = 0.38

Cu = 2.38
Cc = 1.11

USCS: SP (Poorly graded sand)
R_{200} = 98.23
R_4 = 1.88
R_4/R_{200} = 0.02
SF = 96.36
GF = 1.88

% Gravel = 1.88
% Sand = 96.36
% Silt & Clay = 1.77
% Clay = NA
CFEM: Sand, trace Gravel, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

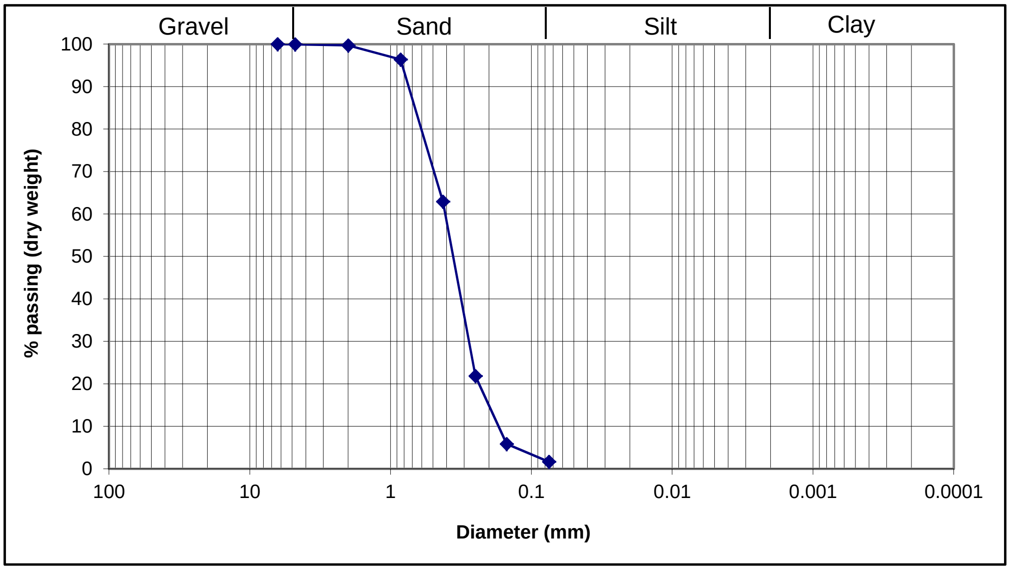
Sample No. : MHPW1-170-175

Depth below GS : 51.82 - 53.34 m
(170 - 175 ft)

Sieve Analysis

Dry weight of sample (g) = 434.30

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	0.00	0.00	0.00	100.00
4	4.76	0.22	0.05	0.05	99.95
10	2.00	1.04	0.24	0.29	99.71
20	0.85	14.47	3.33	3.62	96.38
40	0.425	145.38	33.47	37.10	62.90
60	0.25	178.32	41.06	78.16	21.84
100	0.15	69.45	15.99	94.15	5.85
200	0.075	18.21	4.19	98.34	1.66
pan	---	7.21	1.66	100.00	---
		434.30			



D_{10} = 0.17

D_{30} = 0.28

D_{60} = 0.41

Cu = 2.41

Cc = 1.12

USCS: SP (Poorly graded sand)

R_{200} = 98.34

R_4 = 0.05

R_4/R_{200} = 0.00

SF = 98.29

GF = 0.05

% Gravel = 0.05

% Sand = 98.29

% Silt & Clay = 1.66

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

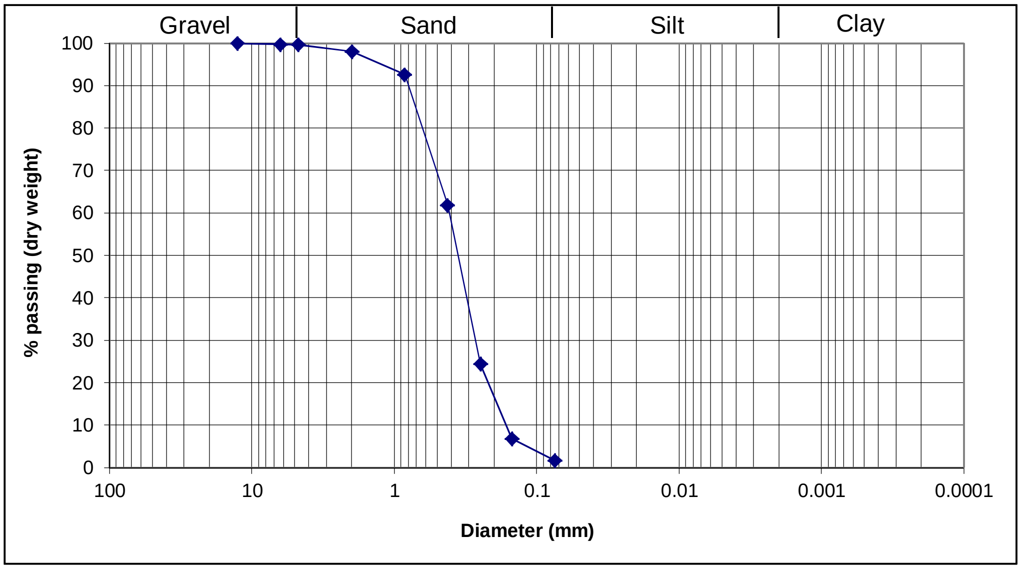
Sample No. : MHPW1-175-180

Depth below GS : 53.34 - 54.86 m
(175 - 180 ft)

Sieve Analysis

Dry weight of sample (g) = 462.23

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	1.13	0.24	0.24	99.76
4	4.76	0.36	0.08	0.32	99.68
10	2.00	7.19	1.56	1.88	98.12
20	0.85	25.31	5.48	7.35	92.65
40	0.425	141.93	30.71	38.06	61.94
60	0.25	173.38	37.51	75.57	24.43
100	0.15	81.28	17.58	93.15	6.85
200	0.075	23.36	5.05	98.21	1.79
pan	---	8.29	1.79	100.00	---
		462.23			



D_{10} = 0.16

D_{30} = 0.27

D_{60} = 0.41

Cu = 2.56

Cc = 1.11

USCS: SP (Poorly graded sand)

R_{200} = 98.21

R_4 = 0.32

R_4/R_{200} = 0.00

SF = 97.88

GF = 0.32

% Gravel = 0.32

% Sand = 97.88

% Silt & Clay = 1.79

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

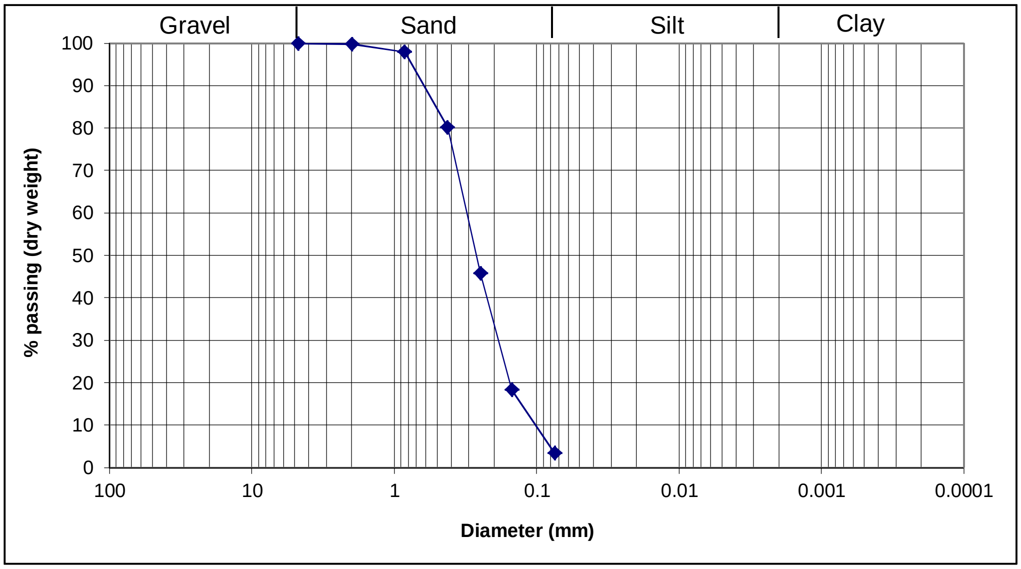
Sample No. : MHPW1-180-185

Depth below GS : 54.86 - 56.39 m
(180 - 185 ft)

Sieve Analysis

Dry weight of sample (g) = 458.75

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	0.68	0.15	0.15	99.85
20	0.85	8.42	1.84	1.98	98.02
40	0.425	81.53	17.77	19.76	80.24
60	0.25	157.81	34.40	54.16	45.84
100	0.15	125.92	27.45	81.60	18.40
200	0.075	68.46	14.92	96.53	3.47
pan	---	15.93	3.47	100.00	---
		458.75			



D_{10} = 0.1

D_{30} = 0.19

D_{60} = 0.31

Cu = 3.10

Cc = 1.16

USCS: SP (Poorly graded sand)

R_{200} = 96.53

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 96.53

GF = 0.00

% Gravel = 0.00

% Sand = 96.53

% Silt & Clay = 3.47

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

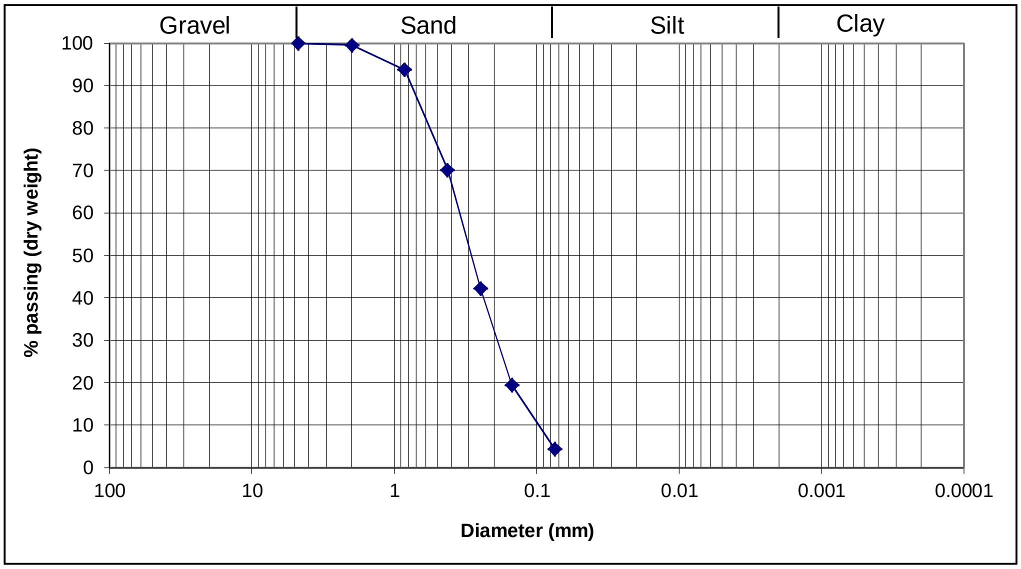
Sample No. : MHPW1-185-190

Depth below GS : 56.39 - 57.91 m
(185 - 190 ft)

Sieve Analysis

Dry weight of sample (g) = 429.71

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	1.59	0.37	0.37	99.63
20	0.85	25.02	5.82	6.19	93.81
40	0.425	101.61	23.65	29.84	70.16
60	0.25	119.92	27.91	57.75	42.25
100	0.15	97.52	22.69	80.44	19.56
200	0.075	65.03	15.13	95.57	4.43
pan	---	19.02	4.43	100.00	---
		429.71			



D_{10} = 0.095

D_{30} = 0.19

D_{60} = 0.35

Cu = 3.68

Cc = 1.09

USCS: SP (Poorly graded sand)

R_{200} = 95.57

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 95.57

GF = 0.00

% Gravel = 0.00

% Sand = 95.57

% Silt & Clay = 4.43

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

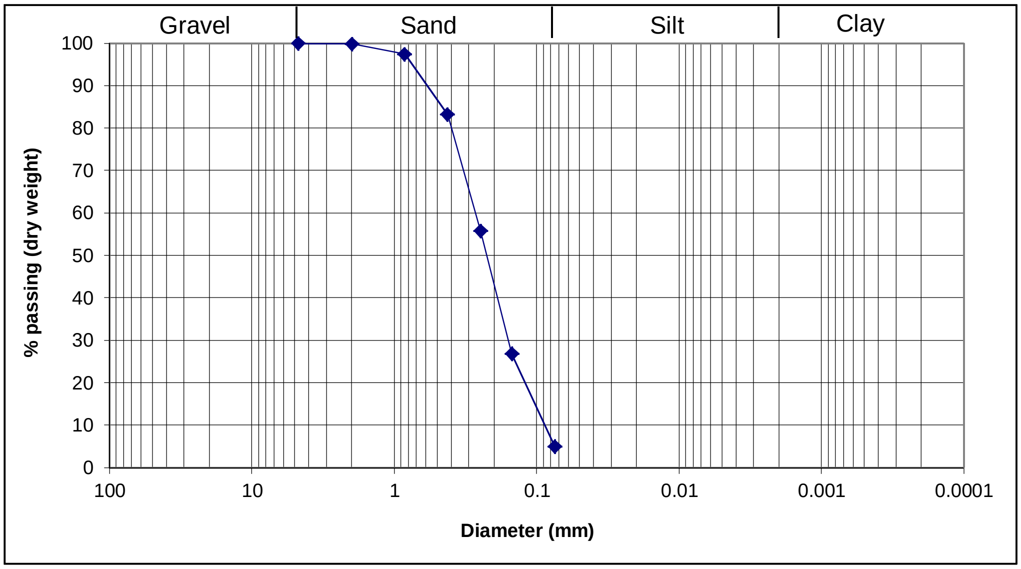
Sample No. : MHPW1-190-195

Depth below GS : 57.91 - 59.44 m
(190 - 195 ft)

Sieve Analysis

Dry weight of sample (g) = 588.54

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	0.55	0.09	0.09	99.91
20	0.85	13.90	2.36	2.46	97.54
40	0.425	84.06	14.28	16.74	83.26
60	0.25	161.35	27.42	44.15	55.85
100	0.15	170.70	29.00	73.16	26.84
200	0.075	127.95	21.74	94.90	5.10
pan	---	30.03	5.10	100.00	---
		588.54			



D_{10} = 0.087

D_{30} = 0.16

D_{60} = 0.27

Cu = 3.10

Cc = 1.09

USCS: SP (Poorly graded sand)

R_{200} = 94.90

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 94.90

GF = 0.00

% Gravel = 0.00

% Sand = 94.90

% Silt & Clay = 5.10

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

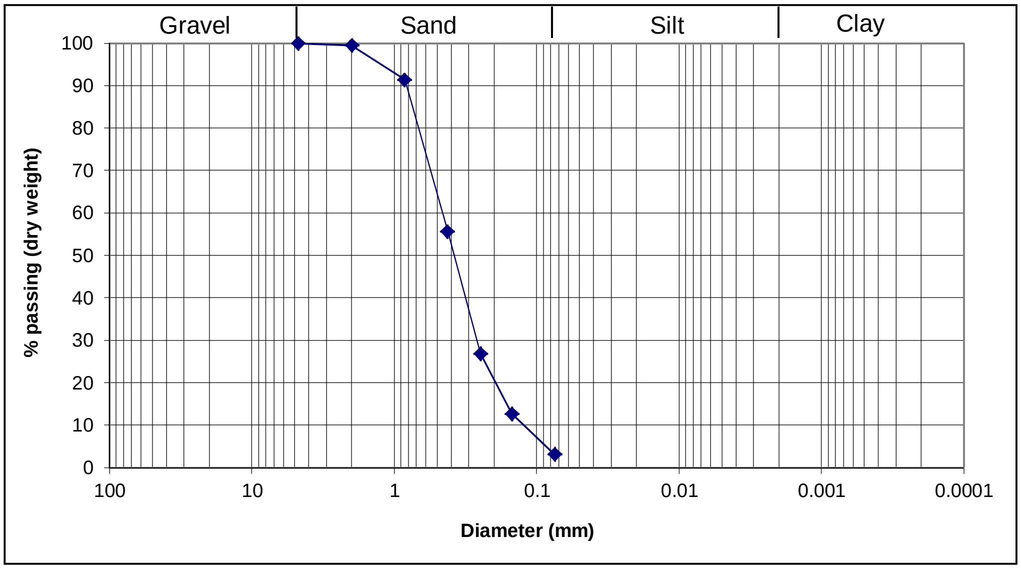
Sample No. : MHPW1-195-200

Depth below GS : 59.44 - 60.96 m
(195 - 200 ft)

Sieve Analysis

Dry weight of sample (g) = 604.39

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	2.66	0.44	0.44	99.56
20	0.85	48.75	8.07	8.51	91.49
40	0.425	216.37	35.80	44.31	55.69
60	0.25	173.97	28.78	73.09	26.91
100	0.15	85.58	14.16	87.25	12.75
200	0.075	57.91	9.58	96.83	3.17
pan	---	19.15	3.17	100.00	---
		604.39			



D_{10} = 0.12

D_{30} = 0.26

D_{60} = 0.46

Cu = 3.83

Cc = 1.22

USCS: SP (Poorly graded sand)

R_{200} = 96.83

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 96.83

GF = 0.00

% Gravel = 0.00

% Sand = 96.83

% Silt & Clay = 3.17

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

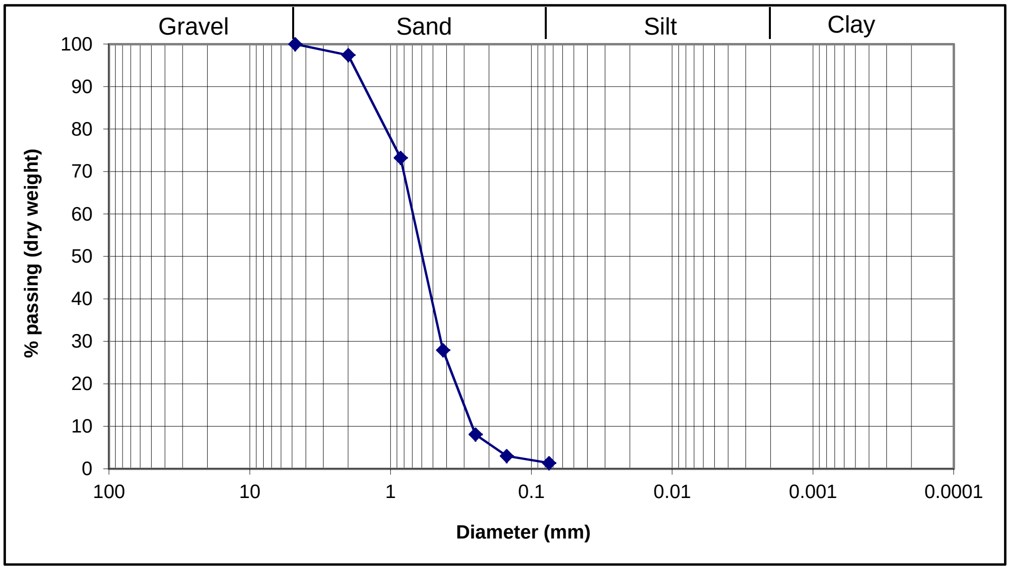
Sample No. : MHPW1-200-205

Depth below GS : 60.96 - 62.48 m
(200 - 205 ft)

Sieve Analysis

Dry weight of sample (g) = 516.24

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	-	-		
1/4"	6.35	-	-		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	13.30	2.58	2.58	97.42
20	0.85	124.78	24.17	26.75	73.25
40	0.425	233.85	45.30	72.05	27.95
60	0.25	102.51	19.86	91.90	8.10
100	0.15	26.10	5.06	96.96	3.04
200	0.075	8.55	1.66	98.61	1.39
pan	---	7.15	1.39	100.00	---
		516.24			



D_{10} = 0.265

D_{30} = 0.44

D_{60} = 0.7

Cu = 2.64

Cc = 1.04

USCS: SP (Poorly graded sand)

R_{200} = 98.61

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 98.61

GF = 0.00

% Gravel = 0.00

% Sand = 98.61

% Silt & Clay = 1.39

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

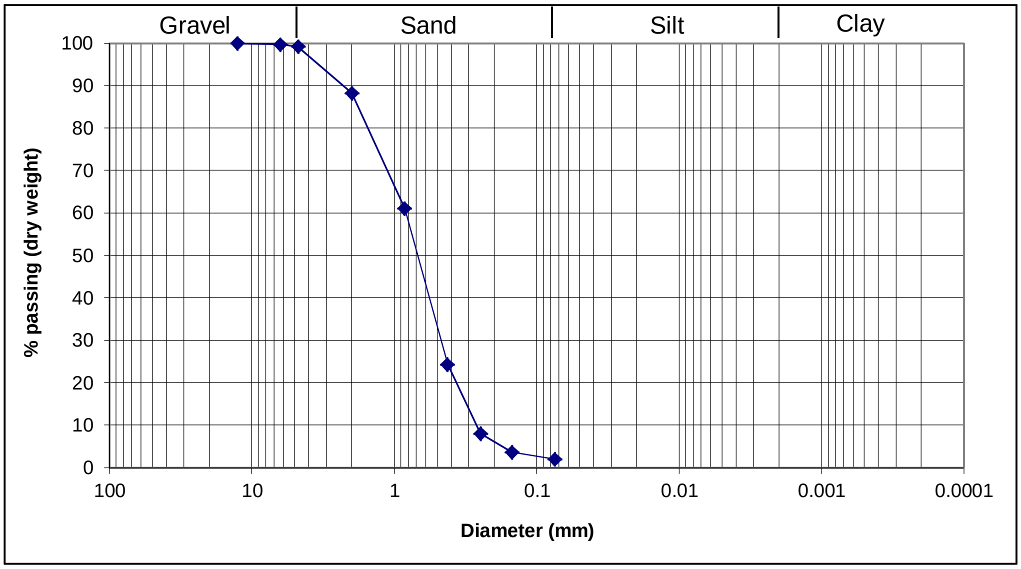
Sample No. : MHPW1-205-210

Depth below GS : 62.48 - 64.01 m
(205 - 210 ft)

Sieve Analysis

Dry weight of sample (g) = 572.85

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	1.20	0.21	0.21	99.79
4	4.76	3.13	0.55	0.76	99.24
10	2.00	62.76	10.96	11.71	88.29
20	0.85	155.88	27.21	38.92	61.08
40	0.425	210.45	36.74	75.66	24.34
60	0.25	93.31	16.29	91.95	8.05
100	0.15	24.89	4.34	96.29	3.71
200	0.075	9.64	1.68	97.98	2.02
pan	---	11.59	2.02	100.00	---
		572.85			



D_{10} = 0.27

D_{30} = 0.47

D_{60} = 0.81

Cu = 3.00

Cc = 1.01

USCS: SP (Poorly graded sand)

R_{200} = 97.98

R_4 = 0.76

R_4/R_{200} = 0.01

SF = 97.22

GF = 0.76

% Gravel = 0.76

% Sand = 97.22

% Silt & Clay = 2.02

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

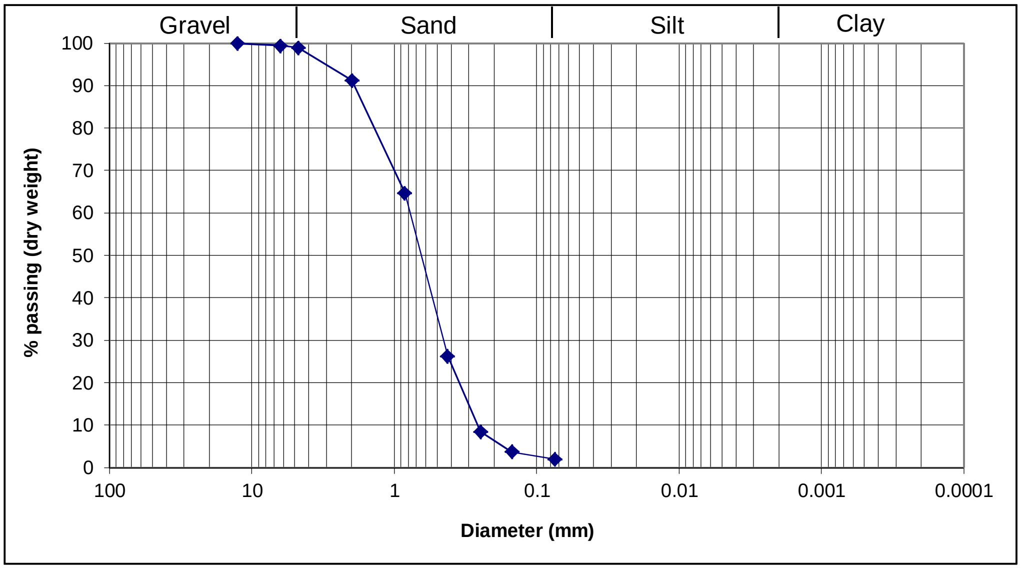
Sample No. : MHPW1-210-215

Depth below GS : 64.01 - 65.53 m
(210 - 215 ft)

Sieve Analysis

Dry weight of sample (g) = 446.43

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	-	-		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	2.62	0.59	0.59	99.41
4	4.76	1.56	0.35	0.94	99.06
10	2.00	34.37	7.70	8.64	91.36
20	0.85	118.45	26.53	35.17	64.83
40	0.425	171.93	38.51	73.68	26.32
60	0.25	79.29	17.76	91.44	8.56
100	0.15	21.38	4.79	96.23	3.77
200	0.075	7.94	1.78	98.01	1.99
pan	---	8.89	1.99	100.00	---
		446.43			



D_{10} = 0.26

D_{30} = 0.45

D_{60} = 0.77

Cu = 2.96

Cc = 1.01

USCS: SP (Poorly graded sand)

R_{200} = 98.01

R_4 = 0.94

R_4/R_{200} = 0.01

SF = 97.07

GF = 0.94

% Gravel = 0.94

% Sand = 97.07

% Silt & Clay = 1.99

% Clay = NA

CFEM: Sand, trace Silt/Clay

APPENDIX D

Water Budget Analysis

APPENDIX D: WATER BUDGET ANALYSIS

D1 CLIMATIC DATA

Figure D1 shows the temperature statistics at the Stephenville Airport for each month for the period of 1942 to 2014. The annual mean temperature for the area was about 4.93°C. The mean monthly temperatures were highest during July (16.21°C and August (16.42°C) and decreased to the lowest values during February (-6.42°C). The temperature statistics indicate that the mean monthly temperature between December and March is below zero degrees Celsius. All of the climatic data have been obtained from Environment Canada websites.

Figure D2 shows the monthly variations in total precipitation at the Stephenville Airport for the period of 1942 to 2014. The mean monthly precipitation varies from 67.60 mm (April) to 120.71 mm (December). Stephenville had a mean yearly precipitation of 1226.76 mm between 1942 and 2014. The snowfall component (**Figure D3**) of the mean annual precipitation is 302.24 mm (equivalent rainfall) typically occurring between November and April with the highest monthly snowfall occurring in January (102 cm). **Figure D4** displays the historical annual precipitation values at the Stephenville Airport from 1942 to 2014. There are periods of low and high precipitation that tend to oscillate every five to ten years with a 30 to 40 year period of low precipitation (1942 to about 1970), increasing average precipitation between 1970 and 1985 followed by a period of higher but declining precipitation between 1985 and 2010. Overall, the recent trend appears to be one of decreasing annual precipitation.

The mean annual potential evapotranspiration for the area has been calculated to be approximately 500 mm per year (DOE, 1992). Calculations, by Fracflow, using the Stephenville International Airport weather records for the period of 1942 to 2007 and the Thornthwaite Equation yield approximately 518 mm per year. The Thornthwaite equation tends to overestimate potential evapotranspiration which will lead to calculation of lower runoff estimates (Shaw, 1994).

As the Thornthwaite equation is dependant on average temperatures above freezing, it does not account for snow sublimation in winter months. Sublimation of snow can vary significantly from 5% to 50% of the snow pack. Sublimation is dependent on the groundcover, the latitude, the elevation, and climatic conditions. We have assumed sublimation accounts for precipitation loss in the study area by 10% during the months with average daily temperatures below freezing. On average, this is a loss of 41 mm of rainfall equivalent to sublimation per year.

D2 WATER BUDGET

D2.1 Average Annual Water Budget

The area from which the Marine Harvest Atlantic Canada fish hatchery would draw its groundwater supply is located partly within the drainage basin that drains into and includes Noel's Pond and Muddy Pond which is linked by a constructed/culverted channel to Noel's Pond. For the purposes of this discussion, Muddy Pond on which the pump house is located that has been used to pump water to Mine Pond, through an existing water main, to support the industrial facilities, now decommissioned, at what was then known as Port Harmon, will be considered to be part of Noel's Pond. The overall watershed is estimated to be approximately 54.6 km^2 (Acres 1994). However, the area that is of interest in terms of estimating groundwater recharge for the potential production wells for a new fish hatchery is much smaller and it includes the area through which Warm Creek passes as it flows through the small community of Noel's Pond and into the impounded waters of Noel's Pond itself. The recharge area for the future water supply wells is also assumed to extend back to Long Pond. The Mine Pond drainage basin to the east side of the drainage basin drains into Mine Pond which is also impounded. The overflow from the Mine Pond berm or dam drains as a perched water system along the eastern edge of the valley or marsh area and this perched stream flows into Port Harmon following a small stream or brook that flows along the eastern edge of the old Abitibi mill site and a similar stream that flows along the west side of the old Abitibi mill site. There is no obvious or major surface drainage from the main marsh area and what surface drainage does take place is perched above the deeper water table.

For the purposes of this discussion, four sub-areas (**Figure D5**) within the Noel's Pond or Warm Creek drainage basin have been identified as potential areas that recharge the groundwater aquifer system in this area. These areas include Areas 1 and 3 that are primarily marsh covered, Area 2 that is covered by either surface water, forested areas with ponds and streams with minor areas of pavement that are underlain by thick granular deposits and Area 4 that is covered by forest but underlaid by thin overburden over fractured granitic bedrock. In Areas 1 and 3, the near surface water table is perched with the actual water table from which the wells would draw their water being located some ten to twenty metres or more below the ground surface. In area 2, the water table is also some depth below the ground surface. In Area 4, the water table is relatively shallow and this groundwater then recharges to the area that is underlain by the marsh and the forest covered areas. As noted above, groundwater recharge in the Mine Pond drainage basin, Area 5, discharges primarily to the perched streams that then run along the east side of the marsh area.

In Areas 1, 2 and 3, most of the surface water bodies are perched in that the elevation of the water level in those surface water bodies is above the elevation of the water table in the underlying granular aquifer.

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. Therefore, an assessment of the water balance within the drainage basin in which Noel’s Pond is located was carried out with adjustments made to the normal assessment procedures to reflect that conditions that exist in each of the four sub-areas as defined above.

A water balance can be defined simply as,

$$P = R + E$$

where, P = Mean Annual Precipitation, R = Mean Annual Runoff, and E = Mean Annual Evapotranspiration. Each of these components are defined and discussed separately below.

Determination of the surface runoff at the site is difficult to accurately assess without data collected in on near the drainage basin being studied. Typically, one would analyze hydrographs from gauged streams in the vicinity of the study area. Ideally these streams would have similar catchment areas and surficial geology to the study area. In this area, data are available for the Blanche Brook drainage basin but not for the Noel’s Pond-Warm Creek drainage basin. The other gauged streams in the area are Harry’s River and Little Barachois Brook and these were much too large to obtain reasonable data for comparison purposes. However, the typical response of these rivers has been studied for use in comparison with Blanche Brook drainage basin and for the analysis of the Noel’s Pond-Warm Creek drainage basin.

Preliminary studies conducted by the Newfoundland and Labrador Department of Environment on Little Barachois Brook indicate that groundwater recharge for that drainage basin was approximately 24 percent of the total precipitation (DOE, 1986). For the purposes of this analysis it is assumed that 24% of the precipitation input is contributing to deep and shallow groundwater recharge for areas that are not covered by marsh. The recharge calculated for the area is 294 mm.

Average Generalized Water Budget (Expressed as Depths)

Input = 1226 mm
Output = 1226 mm
Precipitation = 1226 mm
Evapotranspiration = 518 mm (42 %)
Sublimation = 41 mm (3 %)

Recharge* = 294 mm (24 %)
Runoff = 373 mm (30 %)

* Recharge to deep and shallow groundwater systems. Local topography and local hydraulic gradients in the overall area will result in some direct contributions to surface water.

The average generalized water budget presented above is useful in determining approximate volumes of water that will travel through a specific region during any given year. However, when assessing the risk of potential contaminant migrations and assessing concentrations / dilution factors, it is important to have an understanding of the seasonal fluctuations in the water budget. As such, Fracflow split the average generalized water budget into 12 months using average monthly data climate data for the Stephenville Airport from Environment Canada (Table D1).

To complete this analysis, it was necessary to make some assumptions about frozen conditions in the winter months and the spring melt characteristics. To assess this, Fracflow examained the historical flow records that were reported for Harry’s River and historical snowfall and snowpack data for the Stephenville Airport.

Using the flow records of the Harry’s River, it was determined that the river system was typically in a base flow recession from December until the end of March. The size of the Harrys River drainage basin is 640 km^2 and encompasses portions of the Long Range Mountains; as such, portions of this basin will freeze up before, and melt after Stephenville has had its freeze and thaw periods. When analyzing the snow fall and snow pack data from Environment Canada for the Stephenville Airport, one can see a similar trend. These data show that typically there is snow pack recorded at the airport, starting at the end of December through to February or March where it will typically be gone by the end of April. Based on this data it was assumed that other drainage basins and sub-basins in the area would normally have no groundwater recharge or surface water runoff during January and February. Stream flow would be contributed primarily by groundwater discharge during those periods. Recharge would begin to occur again in March and April. The combined precipitation occurring in January and February is assumed to runoff or recharge in March and April with 50% occurring in each of these melt months.

However, as will be discussed later, the marsh covered areas do not freeze to any great depth and the thick marsh area over a large area of the underlying granular aquifer was observed to be saturated with significant volumes of free water when the edge of the marsh was excavated to prepare a drill pad for the drilling of a new test well in February 2018. This free water is available to recharge the underlying aquifer on a daily basis and is not affected by the surface temperatures, sublimination or evapotranspiration.

D3 WATER BALANCE CALCULATIONS

D3.1 Precipitation

It is worthwhile noting, that there are records from a second precipitation station close to the study area that are available from the Atmospheric Environment Service of Environment Canada, in addition to the station located at the Stephenville Airport, which is adjacent to St. George's Bay, at an approximate elevation of 15 m above mean sea level. The other station is/was located in the community of Black Duck, which is approximately 14 km inland of Stephenville and at an approximate elevation of 45 m above mean sea level.

Mean annual precipitation at Stephenville, between 1943 and 1992, ranged from a low of 838 mm (year 1943) to a high of 1661 mm (year 1982). The calculated average mean annual precipitation for the period of record was 1197 mm (Acres, 1994). On average, approximately 365 mm, or 30%, of this precipitation fell as snow between 1951 and 1980 (Environment Canada, 1982). Mean annual precipitation at Black Duck, between 1984 and 1992, ranged from a low of 1374 mm (year 1985) to a high of 1643 mm (year 1984). The calculated average mean annual precipitation for this relatively short period of record was 1507 mm (Acres, 1994).

The 300 mm difference for average precipitation at Stephenville and Black Duck is considered to be significant given the close proximity of these communities and the potential that underlying bedrock aquifers or bedrock units can be recharged in the upland areas of the local drainage basins or areas with higher elevation. An analysis of these and other data for southwestern Newfoundland suggest that an orographic effect may be the cause (Acres, 1994), although other factors such as wind effects may be partly responsible as well. Precipitation gauges will tend to underestimate snow and rain accumulations under windy conditions (Winter, 1981) and this may partly explain the lower precipitation at Stephenville, which appears to be more exposed to incoming weather systems.

Given the length and linear shape of the Blanche Brook drainage basin, the gauged stream, and the more coastal location of the lower part of the Noel's Pond-Warm Creek drainage basin, it is reasonable to accept that there is a real variation in total precipitation within the study area as one moves inland from the coast. The average total precipitation calculated for the weather stations at Stephenville and Black Duck is taken to be the best estimate of precipitation that is available for this analysis. The value of precipitation used in this second analysis for comparative purposes is 1,227 mm and is extracted from the available climatic data from the Stephenville airport.

D3.2 Runoff

Mean annual runoff (R) is defined as the average annual discharge (Q) divided by the surface area (A) of the catchment of interest. The value of R is usually expressed as a depth in millimetres.

In the most recent evaluation of the water resources of Southwestern Newfoundland (Acres, 1994), R was calculated for a number of gauged catchments, including Blanche Brook. The runoff estimates were based on an analysis of streamflow data, supplemented by precipitation data. The analysis involved establishing the best estimates of long-term R for all gauged catchments, relating R from the gauged catchments to physiographic characteristics, and then preparing a runoff map that shows the variation in average annual runoff as a series of contours or isolines. The runoff map enables an estimate of R to be derived for ungauged catchments and sub-catchments.

The average R for Blanche Brook, for the period of record, was reported by Acres to be representative of the long-term R because the record covered the 1980's, which included both wet and dry periods. For smaller sub-catchments in the Blanche Brook Catchment, the runoff map indicates that R will vary from about 1100 mm near the coast to approximately 1300 mm in the headwater area, which is adjacent to the Harry’s River catchment. Obviously, the computed or predicted R value, which includes groundwater discharge during baseflow conditions, exceeds the total precipitation in some years and leaves very little water for evapotranspiration.

A review of the minimum daily discharge records for gauged rivers in southwestern Newfoundland, including Blanche Brook, indicates that annual low flows occur predominantly in late winter (February and March) and summer (July and August) (Acres, 1994). During such periods of low flow or baseflow conditions, groundwater discharge is often the primary contributor to surface water flow. Acres (1994) calculated that in terms of water availability, the average specific runoff for the Stephenville and Port au Port area was 0.037 m^3/s per km^2. This includes groundwater discharge as part of baseflow. For the immediate area of interest for the proposed fish hatchery well field, much of the groundwater is discharged directly in the Port of Stephenville and the coastal area.

D3.3 Evapotranspiration

Evapotranspiration is defined as the combined water loss from evaporating surface water bodies and soil surfaces, and transpiring vegetation. Intuitively, the rate of evaporation from open water bodies should be greatest because of the availability of a constant supply of water. Unsaturated soil conditions limit the amount of moisture available for direct evaporation from soil surfaces and for transpiration by plants.

Average annual lake evaporation in southwestern Newfoundland is reported to be between 450-500 mm, according to adjusted evaporation pan measurements for that area (Environment Canada, 1990). Evaporative water losses in the area that is assumed to contribute recharge to the groundwater system are related to the area of the surface water bodies. For the marsh areas (sub-areas 1 and 3) which overlie the area in which it is planned to develop the well field or part of the assumed recharge area, the surface water bodies at 15% of the area only represent a small portion of the total evapotranspiration. In sub-area 2, the surface water bodies represent 14% of the sub-area. For the marsh areas, the sponge like nature of the marsh area ensures that the total evapotranspiration will be higher but should be less than the range reported for lake evaporation.

Methods for the direct measurement of plant transpiration are not readily available and such data for the study area could not be obtained.

Two methods that are sometimes employed to estimate the total amount of evapotranspiration involve (1) a direct rainfall-runoff comparison and (2) the Thornthwaite evapotranspiration method (Thornthwaite, 1948).

(1) A direct rainfall-runoff comparison requires that the mean runoff value at the centroid of the catchment be equal to the mean actual value and that precipitation data are being collected from a station located at or near that centroid. These requirements are not met in the Noel's Pond-Warm Creek basin, but they are satisfied in the adjoining Harry's River catchment. In the Harry's River catchment, the estimated evapotranspiration is reported to be 170 mm, the difference between the measured precipitation (1461 mm) and the calculated runoff (1291 mm) (Acres, 1994).

(2) Using the Thornthwaite Method, which has established a mathematical correlation between temperature and evapotranspiration, the calculated average annual evapotranspiration for the Stephenville area is 528 mm (Acres, 1994).

The above calculations are in poor agreement, but they are believed to bracket the upper and lower limits for evapotranspiration. Furthermore, since total evapotranspiration should not exceed total evaporation, for the marsh area, even though the area of the surface water bodies is small, the sponge like nature of the ground cover ensures that free water is held close to the surface of the ground cove producing evapotranspiration that is in the upper range of the computed value and close to the 450-500 mm range established for lake evaporation. For the areas that are not covered by marsh and where the water table is some depth below the ground surface it is more likely that the direct rainfall-runoff comparison provides the closest estimate to actual evapotranspiration. However, considering that the measured precipitation may be underestimated due to wind effects, it is expected that a value of 200 mm would be an acceptable lower estimate of the average annual evapotranspiration from the expected recharge area for the proposed well field in areas that are not covered by marsh. Note again, the values for evapotranspiration are estimates that have a great deal of uncertainty.

D3.4 Calculated Recharge

Groundwater recharge rates are typically between 7 to 30% of total precipitation in good ground conditions and the full range of recharge rates can be expected to occur locally in the Noel’s Pond-Warm Creek basin area. Normally, the lowest recharge rates will be associated with barren rock and clay tills while the highest rates will occur through deposits of coarse sands and gravels. Sub-areas 1 and 3 are expected to have the highest recharge rates (approximately 30% of precipitation) since there is little to no runoff from the main marsh areas and there are a number of perched ponds or bodies of surface water. However, evaporative and evapotranspiration losses are expected to be high for part of the year. Since the thick marsh layer is fully saturated due to the high porosity of the bog or peat material and the perched nature of the upper water table the water is this upper layer is available to recharge the granular aquifer system below the marsh areas during the entire year.

The other areas in the drainage basin have forest cover and granular overburden that varies in thickness with a range of depths to the water table. In the section of the drainage basin that is assumed to contribute recharge to the granular aquifer the 3D model indicates that Warm Creek is also perched or recharges the aquifer. For those areas, evapotranspiration losses are expected to be moderate to low and recharge is expected to be in the range of 24% of precipitation.

Tables D1 shows the monthly estimates of recharge for two typical areas within the Noel’s Pond Warm Creek drainage basin.

Table D1 Twelve month average generalized water budget based on the Stephenville airport climatic data for sub-area 1 and 3 of the Noel's Pond and Warm Creek drainage basin.

Month	**Avg. Temp (oC)**	**Avg. Snowfall (cm)**	**Avg. Precip. (mm)**	**Pot. Evapotrans. (mm)**	**Sublimation (mm)**	**Recharge (mm)**	**Runoff (mm)**
January	-5.44	102.08	120.71	0.00	12.10	30.67	0.00
February	-6.42	81.81	98.00	0.00	9.79	30.67	0.00
March	-3.23	52.80	79.27	0.00	8.06	30.67	88.01
April	2.08	19.36	67.60	14.95	0.00	30.67	109.99
May	7.28	3.22	86.30	54.34	0.00	30.67	1.29
June	11.96	0.03	91.88	88.39	0.00	30.67	0.00
July	16.21	0.00	104.90	119.41	0.00	30.67	0.00
August	16.42	0.00	111.03	111.33	0.00	30.67	0.00
September	12.51	0.05	116.77	74.00	0.00	30.67	0.00
October	7.35	2.94	118.04	40.50	0.00	30.67	0.00
November	2.85	23.53	118.46	13.88	0.00	30.67	29.58
December	-2.38	79.82	113.78	0.00	11.50	30.67	71.62
Total	**--**	**365.6**	**1226.8**	**516.8**	**41.5**	**368.0**	**300.5**

D4 NOEL'S POND-WARM CREEK DRAINAGE BASIN, WATER AVAILABILITY

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. Therefore, this assessment of the water balance within the drainage basin in which Noel's Pond/Warm Creek and the existing and proposed well fields are and may be located was carried out with adjustments made to the normal procedure for calculating recharge to reflect the conditions that exist in each of the four sub-areas as defined above.

Based on the analysis and climatic data provided, we assumed that the recharge through the marsh covered areas of the granular aquifer could be assigned at a rate of 368 mm per year. Areas (Areas 2, 4 and 5) that are not predominantly covered by marsh can be assigned a recharge rate of 294 mm per year. The 3D model was then used to obtain a balance between the measured K values, the measured drawdowns during the aquifer test, and the water levels in a representative group of monitoring wells. For these monitoring well measurements, one has to note that the existing production wells in the Norther Harvest Smolt Limited well field were operating at different flowrates at different times of the year based on the hatchery's water needs. The estimated recharge rates were then adjusted to provide the best fit to the measured hydraulic head and aquifer test data.

Water availability can also be assessed using simple balk-park calculations. For example, since monitoring wells were installed across the aquifer with BH3 located up-gradient from the marsh covered area of the granular aquifer, the gradient on the water table aquifer in this area is known to range from 0.005 to 0.0065 m/m. Using a reference cross -section of 1,500 m, an assumed aquifer thickness of 50 m, a gradient or I of 0.006 m/m and a hydraulic conductivity (K) of 0.0002 to 0.0004 m/s, Darcy's Law, Q = KIA, gives a flux of 2.8 to 5.7 million cubic metres per year towards that part of the granular aquifer that is covered by marsh. By comparison, the up-gradient and trans-gradient areas have a combined area of more than 12 km^2. With a recharge estimated at 294 mm for part of this area, the total annual recharge would be 3.56 million cubic metres, 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 marsh layer into the underlying granular aquifer, in area 1, is approximately 1.386 millon cubic metres of water per year. For reference, a production well that is producing 2,000 litres per minute, will extract approximately 1.05 million cubic metres of groundwater 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 marsh in area 1, is estimated at 48 to 58 million cubic metres of groundwater. Again, potential contributions from the bedrock aquifer that is assumed to underlie the granular aquifer have not been considered.

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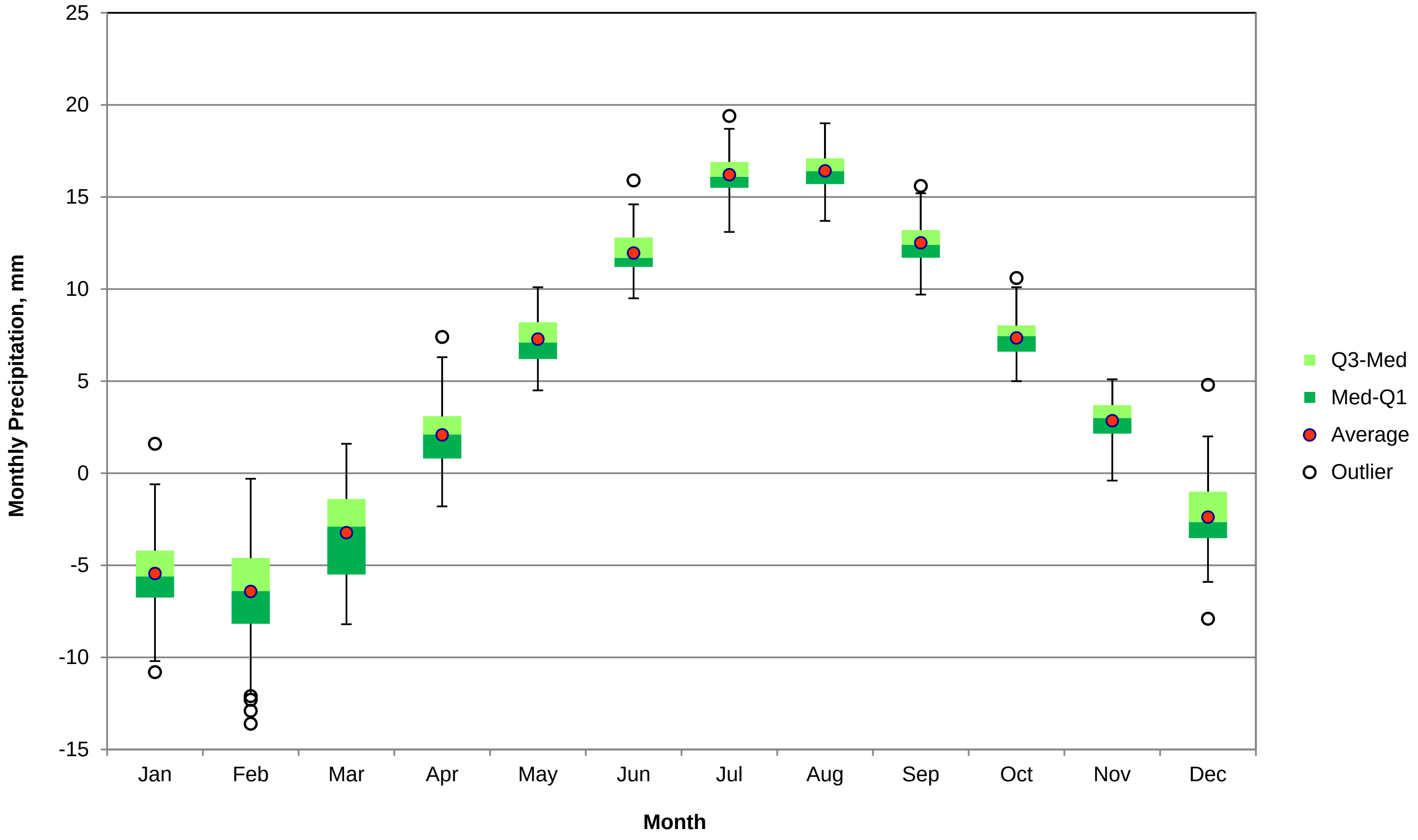


Figure D1 Monthly mean temperature from 1942 to 2014 at STN - Stephenville A, NL (EC, 2017).

Project No.	Document Reference
3113	FFC-NL-3113-007
Location	Date
Stephenville, NL	April 2018

FFC

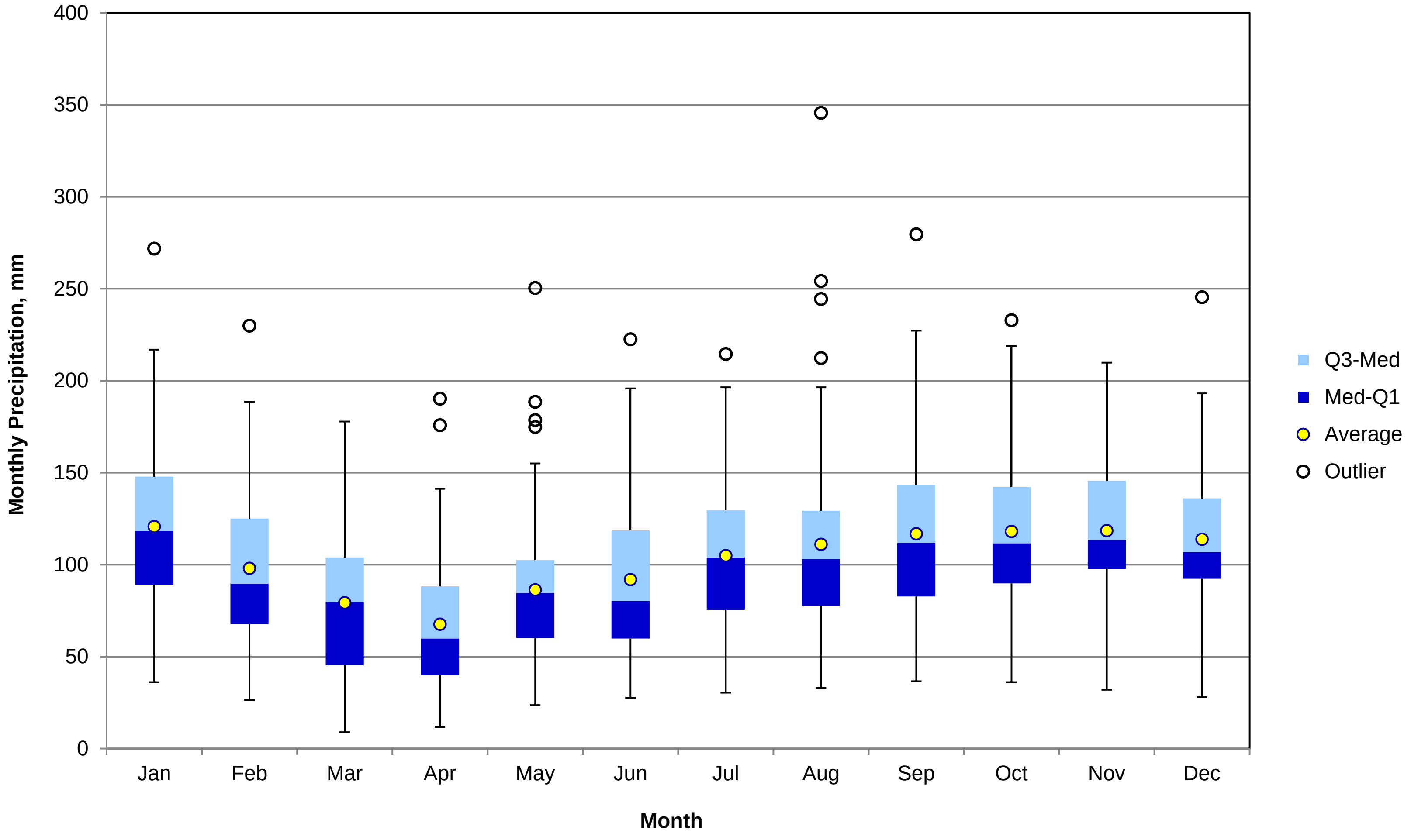


Figure D2 Monthly total precipitation from 1942 to 2014 at STN - Stephenville A, NL (EC, 2017).

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

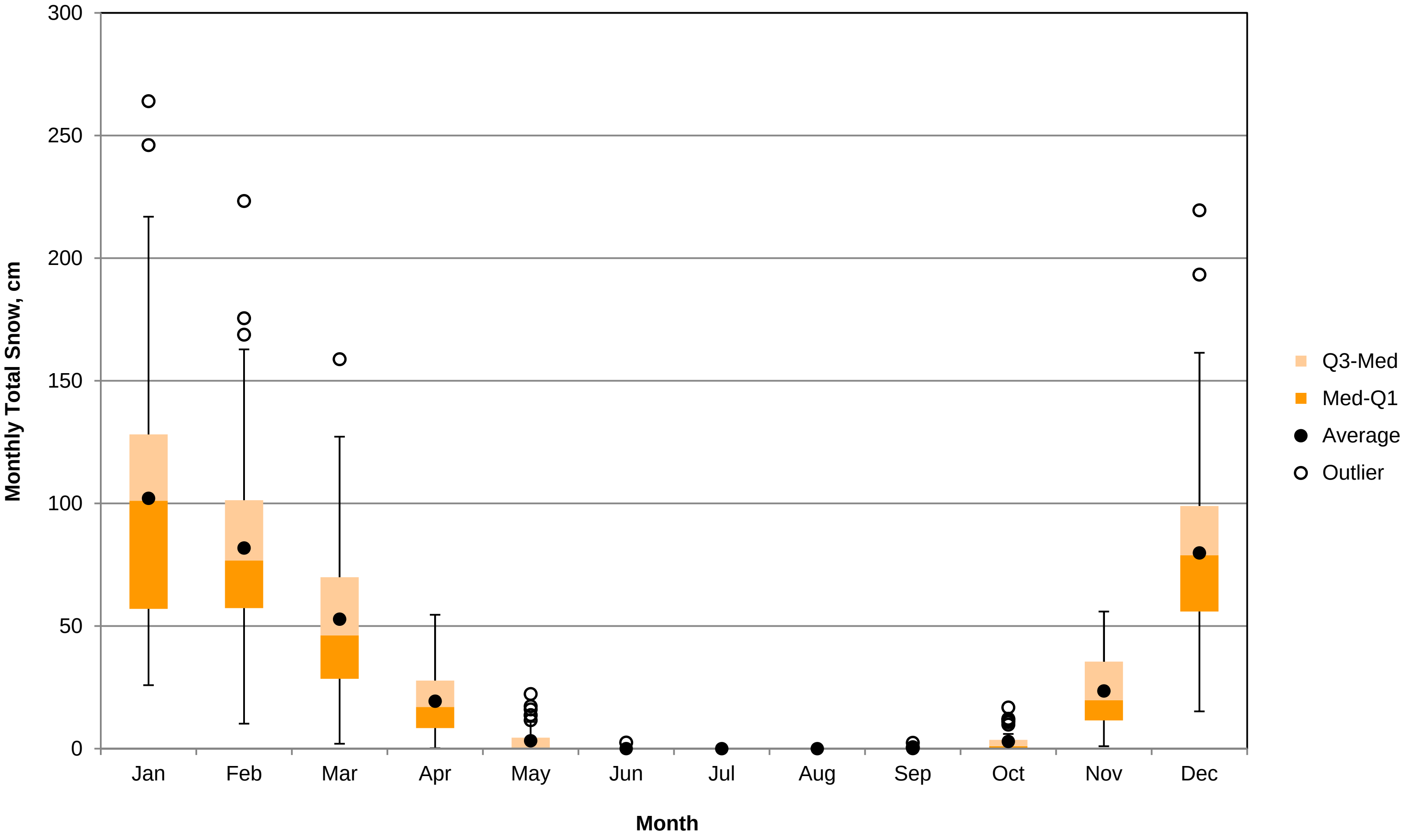


Figure D3 Monthly total snow from 1942 to 2014 at STN - Stephenville A, NL (EC, 2017).

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

FFC

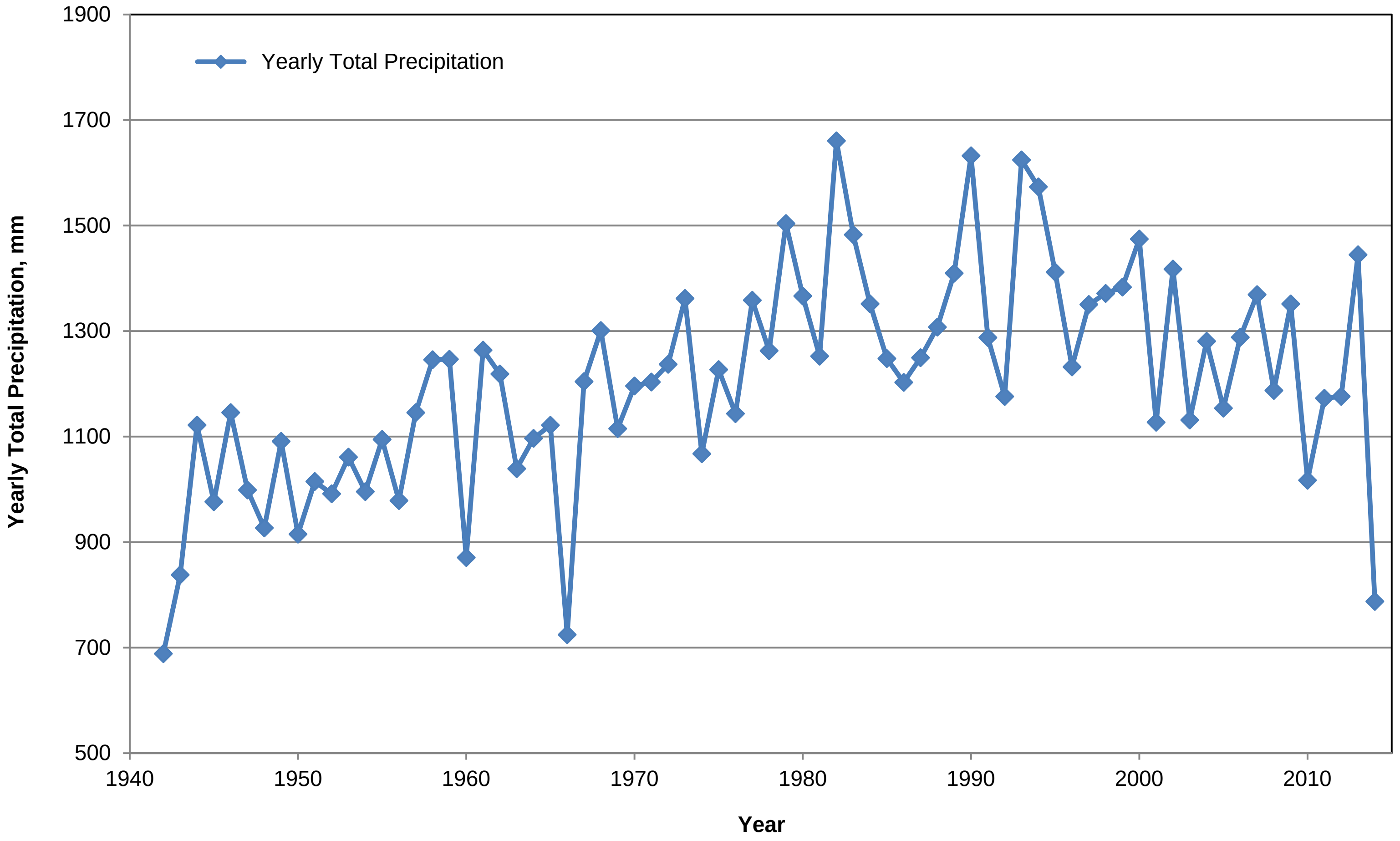
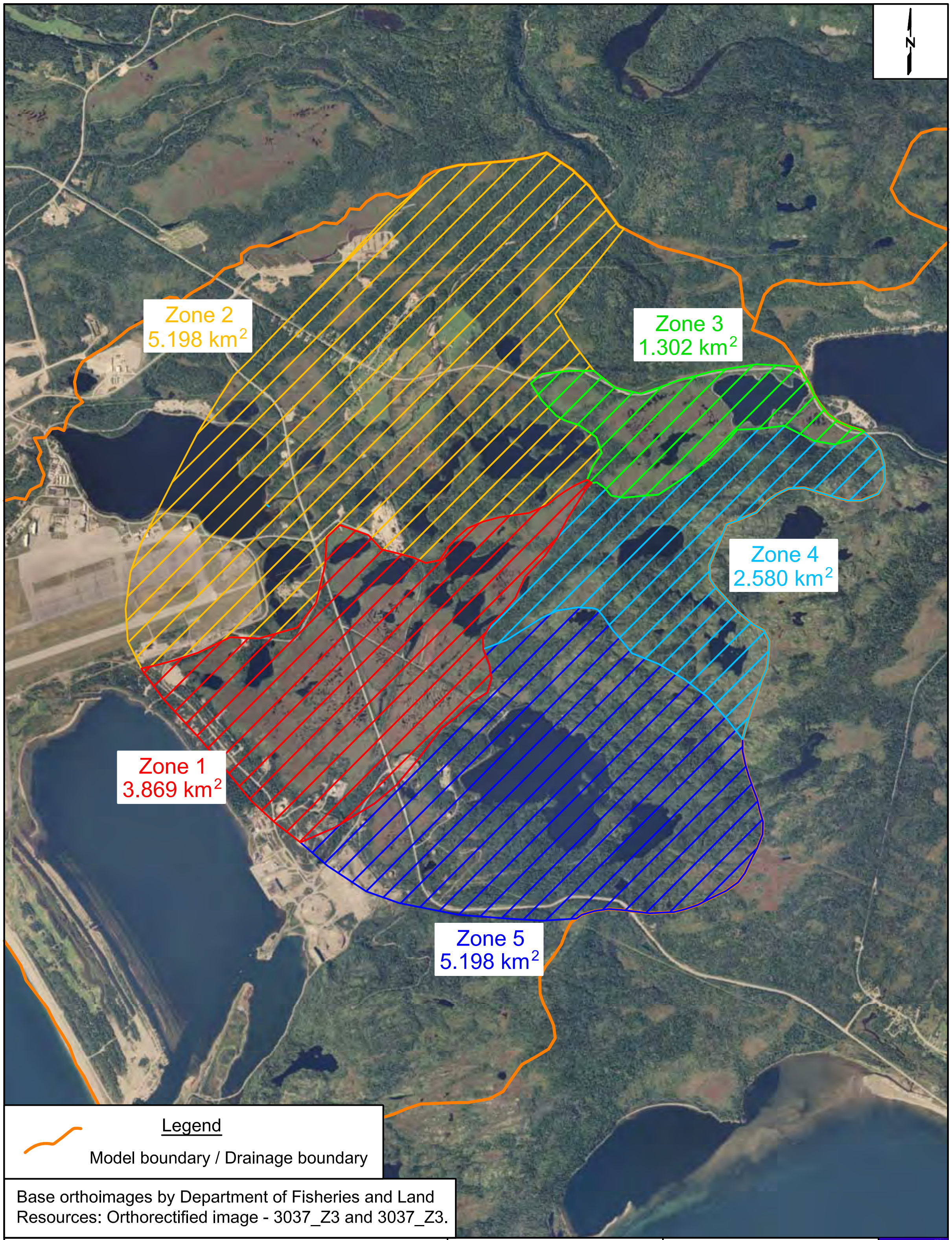


Figure D4 Yearly total precipitation from 1942 to 2014 at STN - Stephenville A, NL (EC, 2017).

Project No. 3113	Document Reference FFC-NL-3113-007
Location Stephenville, NL	Date April 2018

FFC



Base orthoimages by Department of Fisheries and Land Resources: Orthorectified image - 3037_Z3 and 3037_Z3.

Figure D5 Sub-areas of recharge within the Noel's Pond or Warm Creek drainage basin.

Project No. 3113	Document Reference FFC-NL-3113-007	FFC
Location Stephenville, NL	Date April 2018	

APPENDIX D

Inventory of Records Obtained from Government, 2009

PHASE II ENVIRONMENTAL SITE ASSESSMENT
FORMER TRANSMITTER, RECEIVER & EMERGENCY POWER UNIT SITES
STEPHENVILLE, NL

Prepared for:

Public Works and
Government Services
Canada

St. John's, NL

by:

MGI LIMITED
St. John's, NL

November 2003

November 19th, 2003

PUBLIC WORKS AND GOVERNMENT SERVICE CANADA **MGI Project: 40287B**
Environmental Services
10 Barters Hill
St. John’s, NL
A1C 5T2

Attention: Ms. Heather Robbins
Environmental Specialist

Re: Phase II Environmental Site Assessment, Former Transmitter, Receiver Site & Emergency Power Unit Sites, Stephenville, Newfoundland and Labrador

Dear Ms. Robbins:

Please find attached our final report on the above-noted program. On July 30th, 2003, two (2) test pits were excavated at the Receiver site and three (3) test pits were excavated at the Transmitter site, with soil samples collected from all five (5) test pits. One paint sample and two samples of suspected asbestos-containing material were collected from the Receiver site and two samples of suspected asbestos-containing material were collected from the Transmitter site. During the test pitting work, one underground storage tanks was encountered at the Receiver site and one underground storage tank was encountered at the Transmitter site. These tanks were removed from the Transmitter and Receiver sites on September 3rd, 2003. Soil samples were collected from the resulting excavations.

On September 16th, 2003, two (2) test pits were excavated at the Emergency Power Unit site, with associated soil sampling. Soil samples were also collected around the perimeter of the Emergency Power Unit site.

We trust the completed work meets your requirements. Please contact our office should there be questions.

Sincerely,

MGI LIMITED

____
Marion Organ, P.Eng.
Project Manager

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EXECUTIVE SUMMARY

MGI Limited (MGI) was retained by Public Works and Government Services Canada (PWGSC), on behalf of Transport Canada, to complete a Phase II Environmental Site Assessment (ESA) at the Former Transmitter, Receiver and Emergency Power Unit (EPU) Sites in Stephenville, Newfoundland and Labrador (NL). The assessment consisted of a site investigation, the excavation of three (3) test pits at the Transmitter sit, two (2) test pits at the Receiver site and two (2) test pits at the EPU site. One paint sample and two samples of suspected asbestos-containing material (ACM) were collected from the Receiver site and two samples of suspected ACM were collected from the Transmitter site. During the test pitting work, one underground storage tank (UST) was encountered at the Receiver site and one UST was encountered at the Transmitter site. These tanks were removed from the Transmitter and Receiver sites. Soil samples were collected from the resulting excavations. Soil samples were also collected around the perimeter of the EPU site.

The subject sites are located in the Town of Stephenville, NL. The sites exist on property formerly occupied by a United States Air Force Base and are currently part of the Stephenville Airport. There are three (3) separate parcels of land, known as the EPU site, the Transmitter site and the Receiver site. All three parcels of land are significantly overgrown with a mixture of grass and shrubs to the extent that it is difficult to approach the site buildings. Subsurface soil at the sites consist mainly of sand with trace amounts of silt with numerous cobbles and occasional boulders. Bedrock was not encountered during the assessment program.

The soil analytical results reported benzene, toluene, ethylbenzene and xylene (BTEX) concentrations to be within the Atlantic Partnership in RBCA {Risk Based Corrective Action} Implementation (PIRI) Tier I (Version 2.1) 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 3457 mg/kg in the fuel oil range (EPU-TP1-SS1) which is within the Atlantic PIRI Tier I (Version 2.1) Look Up Table values for petroleum hydrocarbons in the fuel oil range (7400 mg/kg).

Two (2) soil samples from the Transmitter site were analysed for concentrations of polycyclic aromatic hydrocarbons (PAHs). PAHs were not detected in either of the samples submitted for analysis.

Two (2) soil samples from the Transmitter site and four (4) soil samples from the EPU site were analysed for polychlorinated biphenyls (PCBs). PCBs were not detected in any of the samples submitted for analysis.

Paint chip samples were collected from the Receiver site building furnace room. One sample, RX-PC1, contained 33,000 mg/kg of lead which exceeded the Hazardous Products Regulation for lead in paint. Based on the initial lab results, 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 (2) samples of suspected ACMs were collected from the Transmitter site and two (2) samples of suspected ACMs were collected at the Receiver site. All four (4) 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.

1.0 INTRODUCTION

On July 30th, 2003 two (2) test pits were excavated at the Receiver site and three (3) test pits were excavated at the Transmitter site. One paint sample and two samples of suspected asbestos-containing material (ACM) were collected from the Receiver site and two samples of suspected ACM were collected from the Transmitter site. During the test pitting work, one underground storage tank (UST) was encountered at the Receiver site and one UST was encountered at the Transmitter site. These tanks were removed from the Transmitter and Receiver sites on September 3rd, 2003. Soil samples were collected from the resulting excavations.

Soil samples were submitted for detailed petroleum hydrocarbon analysis and selected samples were submitted for analysis of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs).

On September 16th, 2003 two (2) test pits were excavated at the Emergency Power Unit (EPU) site. These test pits were excavated at the former location of an above ground storage tank (AST). Soil samples were also collected around the perimeter of the site. Soil samples were submitted for detailed petroleum hydrocarbon analysis and selected samples were submitted for the analysis of PCBs.

The purpose of the Environmental Site Assessment (ESA) was to assess environmental conditions at the sites and compare the results of the ESA with the current Atlantic Partnership in RBCA {Risk Based Corrective Action} RBCA Implementation (PIRI) Tier I Look Up Table values.

2.0 BACKGROUND INFORMATION

2.1 Site Description

The subject sites are located in the Town of Stephenville, Newfoundland and Labrador (see Figure 2.1 – Site Location). The sites exist on property formerly occupied by a United States Air Force Base and are currently part of the Stephenville Airport. There are three (3) separate parcels of land, known as the EPU site, the Transmitter site and the Receiver site. All three (3) parcels of land are significantly overgrown with a mixture of grass and shrubs to the extent that it is difficult to approach the site buildings. The Receiver site (see Figure 3.1 – Receiver Site Plan) occupies an area of approximately 7.0 hectares, and the Transmitter site (see Figure 3.2 – Transmitter Site Plan) occupies approximately 6.67 hectares. The EPU site (see Figure 3.3 – EPU Site Plan) is the smallest in area at 0.37 hectares. Each site contains one site building; however, the former EPU site building now consists of two walls and a roof sitting on a concrete slab, this results in a building that is open on both ends. The Receiver and Transmitter sites each contain a one-storey building constructed of concrete, occupying an area of approximately 118 m^2 and 102 m^2; respectively. The EPU site building is 25 m^2 in area.

The subject property is located in a commercial/industrial area, with commercial and industrial properties located to the northwest and southeast. An AST, that is (or was) used to store petroleum hydrocarbons for the airport is located to the southeast of the Transmitter site. Northwest of the site is an access road, followed by the Stephenville Airport. An aboveground pipeline that provides fuel to the airport is located just west of the subject sites, followed by the waters of Port Harmon. Undeveloped land is located to the east. See Figure 2.2 – Surrounding Properties for more detail.

2.2 Historical Records Review

MGI Limited (MGI) conducted a Phase I ESA on the subject property prior to the site work (see MGI Limited reported entitled: *"Phase I Environmental Site Assessment, Former Transport Canada Transmitter and Receiver Site, Stephenville, NL"* dated March, 2003).

Several environmental concerns were identified in the Phase I ESA:

- Potential asbestos-containing material (ACM) located in the furnace room of both the Transmitter and Receiver site building; and,

- Potential soil contamination due to the presence of creosote-soaked poles located on the ground adjacent to the Transmitter site building.

It was recommended that further assessment work (Phase II ESA) be completed to document existing environmental conditions on the property to more accurately define the environmental conditions at the sites.

2.3 Local Geology

Geology maps were reviewed to obtain information on the geology of the study area. The bedrock is mapped as Carboniferous non-marine and shallow marine siliciclastic sedimentary rocks from Bay St. George Deer Lake Subbasins, which are from the Post-Ordovician age (Geology of the Island of Newfoundland Preliminary Version, Newfoundland and Labrador Department of Mines and Energy, Geological Survey Branch, Map 90-08, 1990).

3.0 ENVIRONMENTAL ASSESSMENT AND SAMPLING PROTOCOL

3.1 Test Pitting Program

The objective of the test pitting program was to determine the current subsurface soil conditions at the subject sites.

Seven (7) test pits were excavated between July 30th and September 16th, 2003 at the three (3) sites.

Two (2) test pits were excavated at the Receiver site, three (3) test pits were excavated at the Transmitter site and two (2) test pits were excavated at the EPU site. The test pits were excavated in areas of probable subsurface contamination from known source points (such as ASTs and USTs). The test pit locations are shown on Figures 3.1, 3.2 and 3.3. The test pits were excavated using a track-mounted excavator supplied by Marine Contractors Inc. of Pasadena, Newfoundland and Labrador.

The test pits were excavated to depths ranging from approximately 3.0 to 5.0 metres below ground level. Bedrock was not encountered during the test pitting program. Soil samples were collected from the various strata in each test pit excavation (number of soil samples ranged from three (3) to seven (7) in each test pit). Surficial groundwater was encountered in one test pit, TM-TP3 (1.0 m below ground level). All test pits were backfilled to grade using existing soil and compacted following the collection of soil samples. Detailed logs were prepared for subsurface conditions encountered during the test pit excavation program and are included in Appendix II.

All soil samples were subjected to a headspace analysis using a portable vapour analyser (Gastechtor Model 1238-me). The results of the headspace analysis, along with odour, appearance, and/or depth of water table were used in selecting soil samples for laboratory analysis at Phillip Analytical Services (PSC) in St. John’s, NL and Bedford, NS.

3.2 Soil Sampling Program

Twenty-three (23) soil samples, including one (1) field duplicate, were submitted for petroleum hydrocarbon analyses at PSC in St. John’s, NL. Soil samples were analysed for petroleum hydrocarbons, including benzene, toluene, ethylbenzene, and xylenes (BTEX) as well as total petroleum hydrocarbons (TPH). Six (6) soil samples were submitted to PSC in Bedford, Nova Scotia for the analysis of PCBs with two (2) of the samples also analysed for PAHs.

3.3 UST Removal Program

On September 16th, 2003, one (1) UST was removed from the Transmitter site and one (1) UST was removed from the Receiver site. See Figures 3.1 and 3.2. The tank removal was completed with the use of a track-mounted excavator, provided by Marine Contractors Inc.

The two (2) USTs, located near the Transmitter and Receiver site buildings, were used to store fuel oil. Both tanks had a capacity of approximately 2000 litres. The UST at the Transmitter site had no obvious holes, no pitting and very little surface rusting. The UST at the Receiver site contained two holes, one located three-quarters of the way from the bottom of the tank and another at the top of the tank. The tank had no pitting and very little surface rusting. Both tanks were properly vacuumed, purged and removed from the site.

Prior to backfilling the UST excavations, five (5) representative soil samples were collected from the walls and floor of each excavation. All samples were forwarded to PSC in St. John’s, NL for analysis of petroleum hydrocarbons. The excavations were then backfilled using native material.

3.4 QA/QC

The quality assurance / quality control (QA/QC) program was designed to ensure that the quality of the samples submitted for analyses are representative of the field conditions without interferences from other sources. The QA/QC program also ensures that analytical results are reported accurately and precisely.

Soil sampling protocols utilized in this investigation included the use of uncontaminated sampling materials and equipment, and a minimum of sample handling. The soil samples were collected in duplicate (where applicable), with the samples intended for laboratory analyses placed in the proper laboratory supplied bottles, and the duplicates placed in plastic, sealed bags for headspace analysis. The soil samples were maintained in cool storage during the sample collection and handling process. One (1) field duplicate (RX-TP2-SS0) for soil was submitted to evaluate the precision of the analysis. In addition, the laboratory routinely conducts their own QA/QC by preparing duplicates of the samples submitted by MGI, analyzing reference samples and laboratory blank samples

4.0 ENVIRONMENTAL ASSESSMENT RESULTS

4.1 Site Geology

Subsurface soil at the sites consisted mainly of sand, with trace amounts of silt and numerous cobbles and occasional boulders. Bedrock was not encountered during the assessment program.

4.2 Selection of Criteria

The former Transmitter, Receiver and EPU sites are classified as commercial property. No signs of existing or former drinking water wells were present on the sites. Based on existing area land, water usage, and overburden geology with surficial and sub-surface sandy soil, this property is classified as a commercial, non-potable site under the Atlantic PIRI Tier I (Version 2.1) protocols for determining risk as a result of petroleum hydrocarbon impacts. The Canadian Council of Ministers of the Environment (CCME) commercial criteria were selected for comparison to PAH and PCB analytical results in soils. The lead and mercury guidelines for paint are based on Health Canada Recommendations, Hazardous Products Regulations, the Transportation of Dangerous Goods Act and the CCME guidelines.

4.3 Soil Sample Analytical Results

Soil samples collected from the test pits were compared to the Atlantic PIRI - Tier I (Version 2.1) commercial, non-potable Look Up Table values.

The soil analytical results reported 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 non-detect to 3457 mg/kg in the fuel oil range in EPU-TP1-SS1 (0.0 – 1.0 m), which is also within the Atlantic PIRI Tier I Look Up Table (Version 2.1) values for petroleum hydrocarbons in the fuel oil range (7400 mg/kg).

The analytical results for petroleum hydrocarbons in soil are presented in Table 4.1and the laboratory certificates are included in Appendix V-1.

Two (2) soil samples, namely TM-TP3-SS1 and TM-TP3-SS1, were analysed for concentrations of PAHs. PAHs were not detected in either of the samples submitted for analysis.

Six (6) soil samples (TM-TP3-SS1, TM-TP3-SS1, EPU-SS1, EPU-SS2, EPU-SS3 and EPU-SS4) were analysed for concentrations of PCBs. PCBs were not detected in any of the samples submitted for analysis.

The analytical results for PAHs and PCBs in soil are presented in Table 4.2 and the laboratory certificates are included in Appendix V-1.

TABLE 4.1: SURFACE SOIL ANALYTICAL RESULTS -- HYDROCARBONS (mg/kg)

Sample Location	Depth (m)	Date Sampled	Benzene	Toluene	Ethyl Benzene	Xylenes	Total Petroleum Hydrocarbons (TPH)					
							TPuH	TExH	TExH	Modified TPH	TPH	Comments
							C_6-C_{10}	C_{10}-C_{21}	C_{21}-C_{32}			
RX-TP1-SS1	0.4-1.4	30-Jul-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	---
RX-TP2-SS1	0.2-1.2	30-Jul-03	nd	nd	nd	nd	nd	nd	nd (20)	nd	nd	---
TM-TP1-SS1	0.2-1.3	30-Jul-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	---
TM-TP2-SS1	0.2-1.3	30-Jul-03	nd	nd	nd	nd	nd	44	21	65	65	---
EPU-TP1-SS1	0.0-1.0	16-Sept-03	nd	nd	0.275	0.637	35	3400	22	3457	3458	F (weathered)
EPU-TP2-SS1	0.0-1.0	16-Sept-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	---
RX-TP1-SS6	3.0-4.0	30-Jul-03	nd	nd	nd	nd	nd	180	63	243	243	F
RX-TP2-SS4	3.0-4.0	30-Jul-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
TM-TP1-SS3	2.4-3.5	30-Jul-03	nd	nd	nd	nd	nd	19	nd	19	19	-
TM-TP2-SS4	3.5-4.5	30-Jul-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
RX-TP2-SS0	3.0-4.0	30-Jul-03	nd	nd	nd	nd	nd	17	nd	17	17	-
RX-TP2-SS0 (Dup)	3.0-4.0	30-Jul-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
EPU-TP1-SS3	2.0-3.0	16-Sep-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
EPU-TP2-SS4	3.0-4.0	16-Sep-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
EX1-SS1	2.5-2.6	3-Sep-03	nd	nd	nd	nd	nd	100	32	132	132	-
EX1-SS2	1.5-2.5	3-Sep-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
EX1-SS3	1.5-2.5	3-Sep-03	nd	nd	nd	nd	nd	120	85	205	205	F
EX1-SS4	1.5-2.5	3-Sep-03	nd	nd	nd	nd	nd	nd(40)	nd(30)	nd	nd	-
EX1-SS5	1.4-2.4	3-Sep-03	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
EX2-SS1	1.3-2.3	3-Sep-03	nd	nd	nd	nd	nd	70	nd	70	70	-
EX2-SS2	2.4-2.5	3-Sep-03	nd	nd	nd	nd	nd	65	17	82	82	-
EX2-SS3	1.2-2.2	3-Sep-03	nd	nd	nd	nd	nd	nd(40)	nd(40)	nd	nd	-
EX2-SS4	1.4-2.4	3-Sep-03	nd	nd	nd	nd	nd	710	88	798	798	F
EX2-SS5	1.3-2.3	3-Sep-03	nd	nd	nd	nd	nd	46	nd	46	46	-
EX2-SS5 (Dup)	1.3-2.3	3-Sep-03	nd	nd	nd	nd	nd	49	16	65	65	-
Atlantic PIRI - Tier I (Version 2.1) - Commercial / Non-Potable / Sandy Surface Soils*			**120**	**4800**	**2400**	**3200**	**na**	**na**	**na**	**450**	**na**	**Gasoline**
										7400	**na**	**Diesel / #2 Fuel Oil**
										10,000	**na**	**# 6 Oil**
Detection Limits			0.025	0.025	0.025	0.050	2.5	15	15	na		

Notes:	**nd**	**Not Detected**
	---	**No Guideline Limit**
	G,F,L	**Gas, Fuel, Lube Oil**
	(#)	**Elevated detection limit value**
	Shading	**Exceedence**

TABLE 4.2: SOIL ANALYTICAL RESULTS – PAHs and PCBs (mg/kg)

Sample ID		**TM-TP3-SS1**	**TM-TP3-SS2**	**EPU-SS1**	**EPU-SS2**	**EPU-SS3**	**EPU-SS4**	**Guideline Criteria***
Parameter	**Detection Limits**							
PCBs	0.05	nd	nd	nd	nd	nd	nd	33
Naphthalene	0.05	nd	nd	-	-	-	-	22
Perylene	0.05	nd	nd	-	-	-	-	na
1-Methylnaphthalene	0.05	nd	nd	-	-	-	-	na
2-Methylnaphthalene	0.05	nd	nd	-	-	-	-	na
Acenaphthylene	0.05	nd	nd	-	-	-	-	na
Acenaphthene	0.05	nd	nd	-	-	-	-	na
Fluorene	0.05	nd	nd	-	-	-	-	na
Phenanthrene	0.05	nd	nd	-	-	-	-	50
Anthracene	0.05	nd	nd	-	-	-	-	na
Fluoranthene	0.05	nd	nd	-	-	-	-	na
Pyrene	0.05	nd	nd	-	-	-	-	100
Benz[a]anthracene	0.05	nd	nd	-	-	-	-	10
Chrysene	0.05	nd	nd	-	-	-	-	na
Benzo[b]fluoranthene	0.05	nd	nd	-	-	-	-	10
Benzo[k]fluoranthene	0.05	nd	nd	-	-	-	-	10
Benzo[a]pyrene	0.05	nd	nd	-	-	-	-	0.7
Indeno[1,2,3-cd]pyrene	0.05	nd	nd	-	-	-	-	10
Dibenz[a,h]anthracene	0.05	nd	nd	-	-	-	-	10

Notes:		
	-	**Parameter Not Requested**
	nd	**Parameter Not Detected**
	na	**No Guideline**

4.4 Lead and Mercury in Paint

During the Phase II ESA, paint was found in a room located between the furnace room and the generator room of the Receiver building. One (1) paint sample (PC1), which was grey in colour, was collected from the interior concrete wall in the room (see Figure 3.1). Paint was not sampled from the Transmitter and EPU site buildings as no painted surfaces were observed during the site visits.

A twelve centimetre by twelve centimetre (12 cm x 12 cm) square sample was collected using a clean chisel, placed in a zip-lock plastic bag and labeled with reference to sample number and location. The spatial extent of the paint was estimated and recorded. The paint sample was forwarded to PSC for analysis of lead and mercury concentrations.

Laboratory analysis indicated that PC1 contained a lead concentration of 33,000 mg/kg, which exceeded the Hazardous Products (Liquid Coating Materials) Regulation, Item 31 of Part II of Schedule 1 (5000 mg/kg). Based on the total lead analytical results for PC1, the paint sample was submitted to a leachable lead analysis. Leachate testing is performed to determine if the paint is a hazardous waste if/when it is removed. The analysis from PC1 indicated the sample contained contained a lead leachate value of 7.59 mg/L, which exceeded the Transportation of Dangerous Goods Act (5 mg/L).

Laboratory analysis indicated that PC1 contained a mercury concentration of 0.86 mg/kg, which was below the commercial CCME Soil Quality Guidelines for mercury (24 mg/kg). The CCME soil guidelines were used as an indicator to aid in the selection of paint samples to undergo a mercury leachate analysis. Based on the total mercury analytical results, the paint sample was not submitted for leachable mercury analysis.

The total sample weight, the laboratory measured lead concentration, and the area sampled, were also used to calculate the milligrams of lead per square centimetre. The primary exposure pathway of lead paint is ingestion, either from dust during renovation, dust and flakes from paint in poor condition or direct ingestion of paint. Contaminated dust is a particular important source of exposure for babies and small children because they can ingest a significant amount of dust through the natural habit of putting objects in their mouths. Health Canada suggests that a lead level greater than 1 mg/cm^2 requires that you take precautions to keep children and pregnant women away from the painted area and that levels greater than 5 mg/cm^2 are considered heavily leaded. The Health Canada guidelines are used for indicating the presence of a health hazard. The recommended lead level of 1 mg/cm^2 was not exceeded by the paint sample (PC1) collected and analyzed. The paint analytical results are presented in Table 4.3 and laboratory certificates are attached in Appendix V-2.

TABLE 4.3: PAINT ANALYTICAL RESULTS – Lead and Mercury

Sample ID	Date Sampled	Location	Lead (mg/kg)	Mercury (mg/kg)	Lead (mg/cm^2)	Lead Leachate (mg/L)	Mercury Leachate (mg/L)	Colour
RX-PC1	30-Jul-03	Interior Wall, Furnace Room of Receiver Site	33000	0.86	0.64	7.59	---	Greenish Blue
Health Canada Recommendations - Lead Paint (1)			-	-	**<1mg/cm^2 <5 mg/cm^2**	-	-	-
Hazardous Products Regulations - Lead (2)			**5000**	-	-	-	-	-
Transportation of Dangerous Goods Act (3)			-	-	-	**5**	**0.1**	-
CCME Guidelines - Mercury (4)			-	**24**	-	-	-	-
EQL			0.5	0.01	-	-	-	-

Notes:

-	**Parameter Not Requested**
---	**No Guideline Limit**
Shading	**Indicates Exceedence**
EQL	**Estimated Quantification Limit**

(1) http://www.hc-sc.gc.ca/chp/ehd/catalogue/iyh/renovate.htm (>1 mg/cm2 = require precautions for children and pregnant women;
>5 mg/cm2 = heavily leaded)
(2) Hazardous Products (Liquid Coating Materials) Regulations, Item 31 of Part 31 of Part II of Schedule 1, Health Canada
(3) Transportation of Dangerous Goods Regulations SOR/2001-286
(4) CCME Recommended Canadian Soil Quality Guidelines (1999) for commercial sites

4.5 Asbestos-Containing Materials

During the Phase I ESA, suspected ACMs were observed in the Receiver building on the furnace room floor, and in ductwork in the furnace room of the Transmitter building (see Figure 3.1 and 3.2). No suspected ACMs were observed in the EPU building. Four (4) potential ACM samples were collected from the site buildings. MGI personnel, wearing Level C personal protective equipment, collected the samples using a protective glove and carefully enclosed the samples in a plastic bag to prevent any possible asbestos fibres from entering the atmosphere. The ACM samples were submitted to PSC in Bedford, Nova Scotia for asbestos analysis, including asbestos type and content using polarized light microscopy (PLM).

Laboratory analysis indicated that all four (4) of the building material samples contained various amounts of chrysotile and amosite asbestos. Sample RX-ABS-1 from the Receiver site contained 20-40% chrysotile and 10-30% amosite, and sample RX-ABS-2 from the Receiver site contained 50-70% chrysotile. Sample TM-ABS-1 from the Transmitter site contained 10-30% chrysotile and 20-40% amosite, and sample TM-ABS-2 from the Transmitter site contained 30-50% cyrysotile.

The estimated quantity of ACM in the Receiver building is 0.2 cubic metres. The estimated quantity of ACM in the Transmitter building is 0.5 cubic metres. The asbestos analytical results are presented in Table 4.5 and the laboratory certificates are attached as Appendix V-2.

TABLE 4.4: ASBESTOS ANALYTICAL RESULTS

Sample I.D.	Description	Asbestos Type and Content	Estimated Quantity
RX-ABS-1	Receiver - Floor of Furnance Room	20-40% chrysotile 10-30% amosite	0.16 m^3
RX-ABS-2		50-70% chrysotile	
TM-ABS-1	Transmitter - Ductwork in Furnance Room	10-30% chrysotile 20-40% amosite	0.36 m^3
TM-ABS-2		30-50% chrysotile	

4.6 QA/QC

One (1) “blind” field duplicate (RX-TP2-SS0 for RX-TP2-SS4) for soil was collected by MGI and submitted to PSC to evaluate the precision of the analysis. The percent difference between the “original” soil sample and its duplicates was as follows: benzene 0%; toluene 0%: ethylbenzene 0%; xylenes 0%; and, Modified TPH 11.8%.

PSC conducted their QA/QC program by preparing two duplicates of the soil samples submitted by MGI for petroleum hydrocarbon analysis. The average difference between the “original” soil samples (RX-TP2-SS0 and EX2-SS5) and the duplicates (RX-TP2-SS0 (Dup) and EX2-SS5 (Dup)) was as follows: benzene 0%; toluene 0%; ethylbenzene 0%; xylenes 0%; and, Modified TPH 26.5%.

4.7 Tier I Assessment of Ecological Receptors

An inspection of the subject site and surrounding properties has identified none of the following Ecological Receptors to be within 150 metres of the site:

- Aquatic habitats such as rivers, lakes or streams;
- Forested habitats (50 acres or more);

- Grassland habitats;
- Provincial/National parks or ecological reserve;
- Rare, threatened or endangered species populations; and,
- Other critical or sensitive habitat for wildlife, migratory species.

The nearest ecological receptor of concern is the waters of Port Harmon, which is approximately 400 metres downgradient from the site.

5.0 SUMMARY

MGI Limited (MGI) was retained by Public Works and Government Services Canada (PWGSC), on behalf of Transport Canada, to complete a Phase II Environmental Site Assessment (ESA) at the Former Transmitter, Receiver and Emergency Power Unit (EPU) Sites in Stephenville, Newfoundland and Labrador (NL). The assessment consisted of a site investigation, the excavation of two (2) test pits at the Receiver site, three (3) test pits at the Transmitter site and two (2) test pits at the EPU site. One paint sample and two samples of suspected ACM were collected from the Receiver site and two samples of suspected ACM were collected from the Transmitter site. During the test pitting work, one UST was encountered at the Receiver site and one UST was encountered at the Transmitter site. These tanks were removed from the Transmitter and Receiver sites. Soil samples were collected from the resulting excavations. Soil samples were also collected around the perimeter of the EPU site. The work was completed between July 30th and September 16th, 2003.

The subject sites are located in the Town of Stephenville, Newfoundland and Labrador. The sites exist on property formerly occupied by a United States Air Force Base and currently form part of the Stephenville Airport property. These three (3) separate parcels of land, are known as the EPU site, the Transmitter site and the Receiver site. All three (3) parcels of land are significantly overgrown with a mixture of grass and shrubs to the extent that it is difficult to approach the site buildings.

Subsurface soils at the sites consist mainly of sand with trace amounts of silt with numerous cobbles and occasional boulders. Bedrock was not encountered during the assessment program.

Between three (3) and seven (7) soil samples were collected from each test pit. Based on results of the headspace analysis, along with odour, appearance, and/or depth of water table selected soil samples were submitted for laboratory analysis at PSC in St. John's, NL and Bedford, NS.

The soil analytical results reported BTEX concentrations to be within the Atlantic PIRI Tier I (version 2.1) Look Up Table values in all of the samples submitted for petroleum hydrocarbon analysis. Modified TPH concentrations in the fuel oil range for the soil samples analyzed ranged from non-detect to 3457 mg/kg in the fuel oil range (EPU-TP1-SS1) which is also within the Atlantic PIRI Tier I (version 2.1) Look Up Table values for petroleum hydrocarbons in the fuel oil range (7400 mg/kg).

Two(2) soil samples were analysed for concentration of PAHs. PAHs were not detected in either of the samples submitted for analysis.

Six (6) soil samples were analysed for concentration of PCBs. PCBs were not detected in any of the samples submitted for analysis.

Paint chip samples were also collected from the Receiver building furnace room. Sample RX-PC1 contained 33,000 mg/kg of lead which exceeded the Hazardous Products Regulation for lead in paint. Based on the initial lab results, 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 area of lead paint is estimated to be 10.5 m^2. The CCME guideline for mercury was not exceeded in the paint sample.

Four (4) samples of suspected ACM were sampled from the Transmitter and Receiver sites. All four (4) samples (RX-ABS-1, RX-ABS-2, TM-ABS-1 and TM-ABS-2) were found to contain chrysotile (ranging from 10-70%) and amosite (ranging from 10-40%). The volume of asbestos containing material is estimated to be 0.2 m^3 at the receiver site and 0.5 m^3 at the transmitter site.

6.0 RECOMMENDATIONS

Based on the results of the investigation, the following further actions are recommended for the subject property at this time.

- Due to the open access to the subject site, with the potential of exposure to the ACMs and lead based paint by both authorized and unauthorized visitors, we recommend that the ACMs at the Transmitter site and the Receiver site buildings be removed from these areas. Any ACM removal should be conducted by a licensed, asbestos abatement contractor and any handling or disposal of lead based paint should follow standard practice and regulations.

7.0 STATEMENT OF LIMITATIONS

Limitation of Liability, Scope of Report and Third Party Reliance

This report has been prepared and the work referred to in this report has been undertaken by MGI Limited for the Public Works and Government Services Canada, on behalf of Transport Canada.

The investigation undertaken by MGI Limited with respect to this report and any conclusions or recommendations made in this report reflect MGI's judgement based on the site conditions observed at the time of the site inspection on the date(s) set out in this report and on information available at the time of preparation of this report. This report has been prepared for specific application to this site and it is based, in part, upon visual observation of the site, subsurface investigation at discrete locations and depths, and specific analysis of specific chemical parameters and materials during a specific time interval, all as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, portions of the site which were unavailable for direct investigation, sub-surface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed.

Substances other than those addressed by the investigation described in this report may exist within the site, substances addressed by the investigation may exist in areas of the site not investigated and concentrations of substances addressed which are different than those reported may exist in areas other than the locations from which samples were taken.
If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

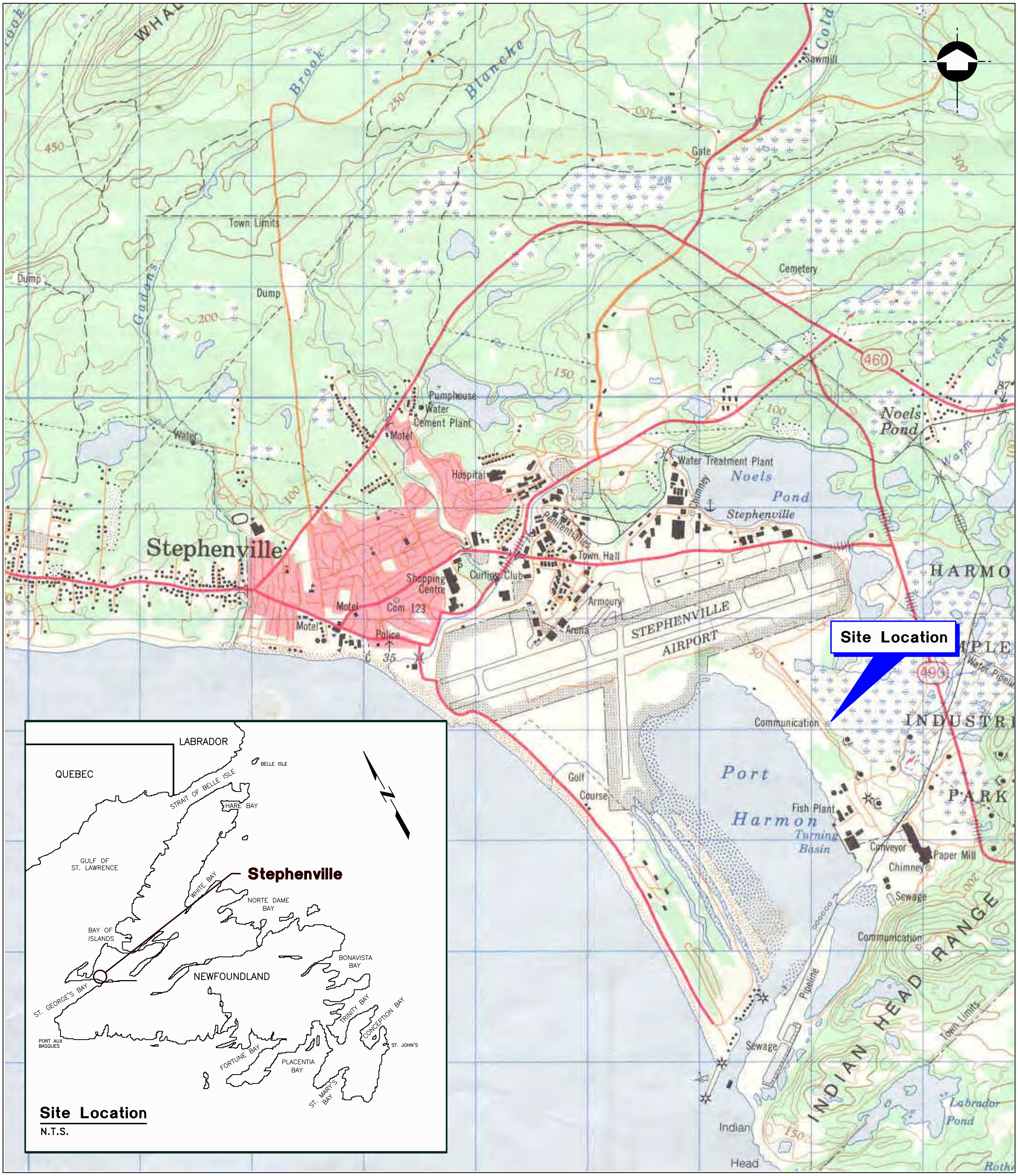
Other than by PWGSC, copying or distribution of this report or use of or reliance on the information contained herein in whole or in part, is not permitted without the express written permission of PWGSC. Nothing in this report is intended to constitute or provide a legal opinion.

We trust this report meets with your requirements. Please do not hesitate to contact our office should you have any questions.

Sincerely,

MGI LIMITED

Marion E. Organ, P.Eng.
Project Manager



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TITLE

Site Location

PROJECT

Phase II Env. Site Assessment
Former Transmitter and Receiver Site
Stephenville, Newfoundland & Labrador

PROJECT NO. 40287B

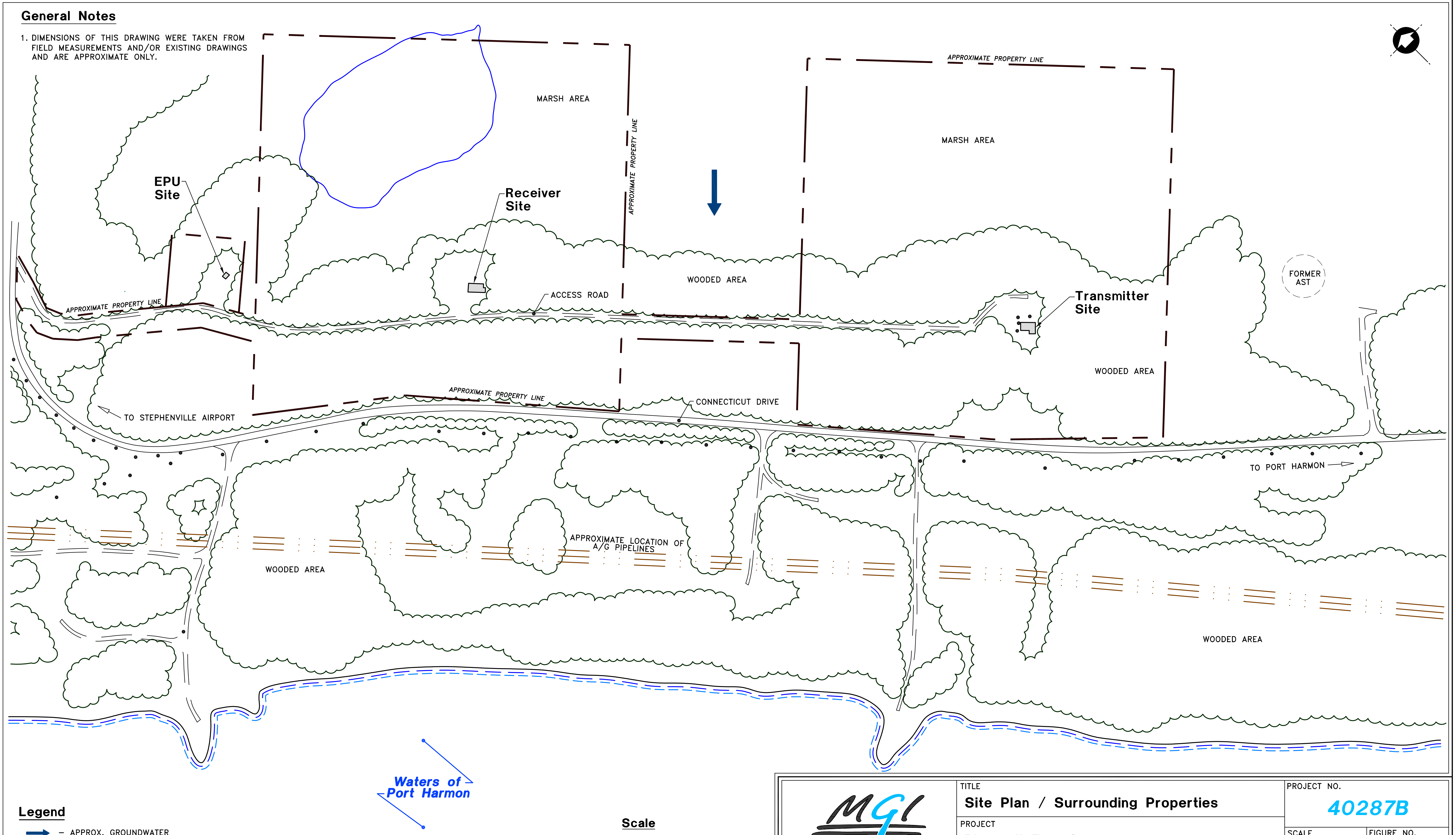
SCALE 1:50 000

DATE Oct. 2003

FIGURE NO. 2.1

General Notes

1. DIMENSIONS OF THIS DRAWING WERE TAKEN FROM FIELD MEASUREMENTS AND/OR EXISTING DRAWINGS AND ARE APPROXIMATE ONLY.



Legend

- ➡ – APPROX. GROUNDWATER FLOW DIRECTION
- • – UTILITY POLES

Scale

100 80 60 40 20 0 m

1:3000

MGI
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TITLE
Site Plan / Surrounding Properties

PROJECT
Phase II Env. Site Assessment
Former Transmitter, Receiver and EPU Site
Stephenville, Newfoundland & Labrador

PROJECT NO.
40287B

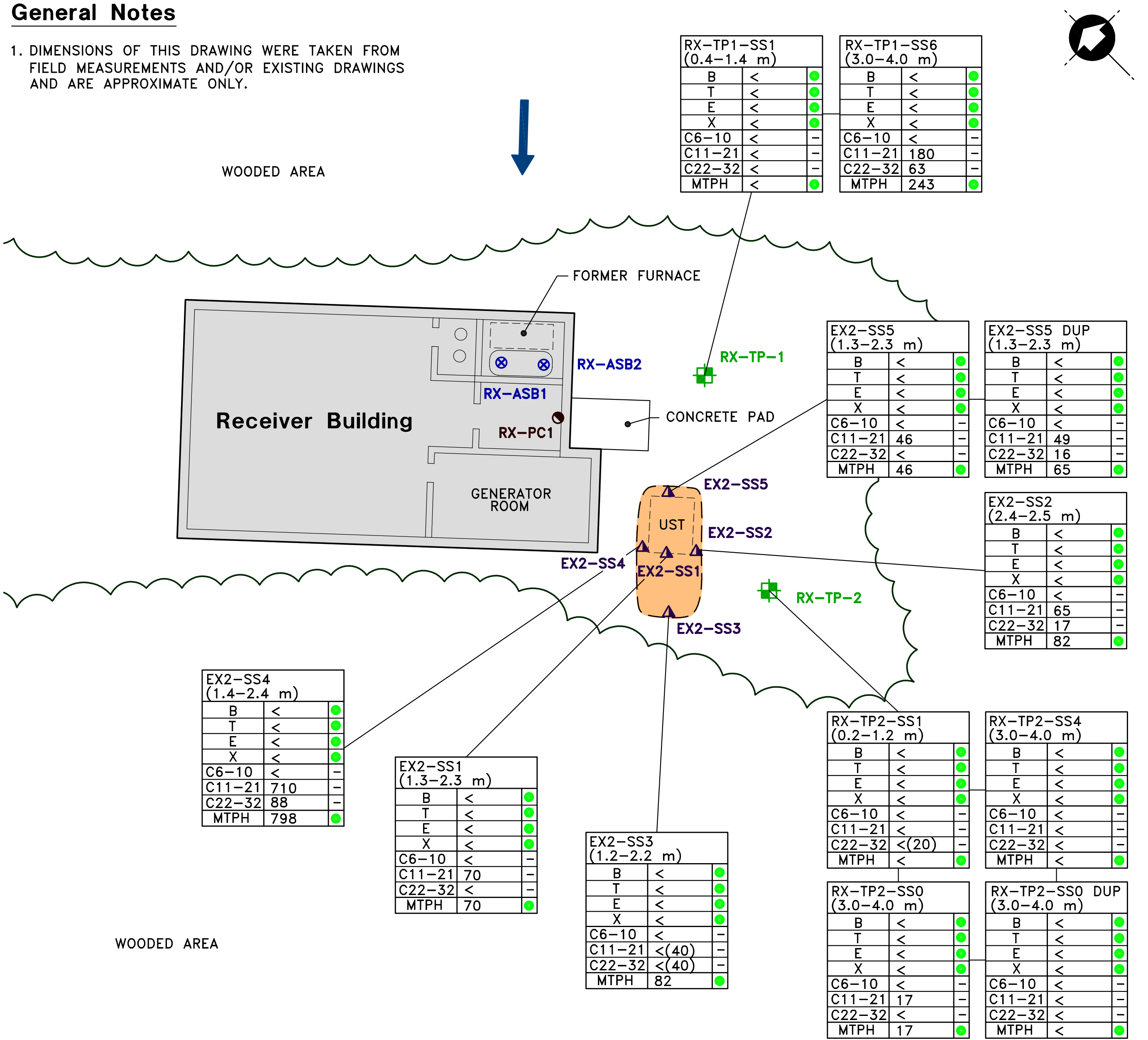
SCALE
1:3000

FIGURE NO.
2.2

DATE
Oct. 2003

General Notes

1. DIMENSIONS OF THIS DRAWING WERE TAKEN FROM FIELD MEASUREMENTS AND/OR EXISTING DRAWINGS AND ARE APPROXIMATE ONLY.



RX-TP1-SS1 (0.4-1.4 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<	–
C22-32	<	–
MTPH	<	●

RX-TP1-SS6 (3.0-4.0 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	180	–
C22-32	63	–
MTPH	243	●

EX2-SS5 (1.3-2.3 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	46	–
C22-32	<	–
MTPH	46	●

EX2-SS5 DUP (1.3-2.3 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	49	–
C22-32	16	–
MTPH	65	●

EX2-SS2 (2.4-2.5 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	65	–
C22-32	17	–
MTPH	82	●

EX2-SS4 (1.4-2.4 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	710	–
C22-32	88	–
MTPH	798	●

EX2-SS1 (1.3-2.3 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	70	–
C22-32	<	–
MTPH	70	●

EX2-SS3 (1.2-2.2 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<(40)	–
C22-32	<(40)	–
MTPH	82	●

RX-TP2-SS1 (0.2-1.2 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<	–
C22-32	<(20)	–
MTPH	<	●

RX-TP2-SS4 (3.0-4.0 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<	–
C22-32	<	–
MTPH	<	●

RX-TP2-SS0 (3.0-4.0 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	17	–
C22-32	<	–
MTPH	17	●

RX-TP2-SS0 DUP (3.0-4.0 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<	–
C22-32	<	–
MTPH	<	●

Analytical Results Legend

B – BENZENE
T – TOLUENE
E – ETHYLBENZENE
X – XYLENE m,p,o
● – BELOW GUIDELINE
🟥 – EXCEEDS GUIDELINE

C6-C32 – PETROLEUM HYDROCARBONS
mTPH – MODIFIED TOTAL PETROLEUM HYDROCARBONS
< – BELOW DETECTION LIMITS

NOTE: CONCENTRATION IN mg/L (ppm)
GUIDELINE = ATLANTIC PIRI TIER I LOOK-UP TABLES (1999)

☐ RESIDENTIAL ☒ SAND ☐ POTABLE
☒ COMMERCIAL ☐ CLAY ☒ NON-POTABLE
☐ GASOLINE ☒ FUEL OIL ☐ LUBE OIL

Scale

5 0 m
1:200

Legend

EX2-SS ▲ – SOIL SAMPLE
RX-TP ✚ – TEST PIT
RX-ASB1 ⊗ – ASBESTOS SAMPLE
RX-PC1 ◐ – PAINT SAMPLE
→ – APPROX. GROUNDWATER FLOW DIRECTION
● – AREA OF EXCAVATION (APPROXIMATE)

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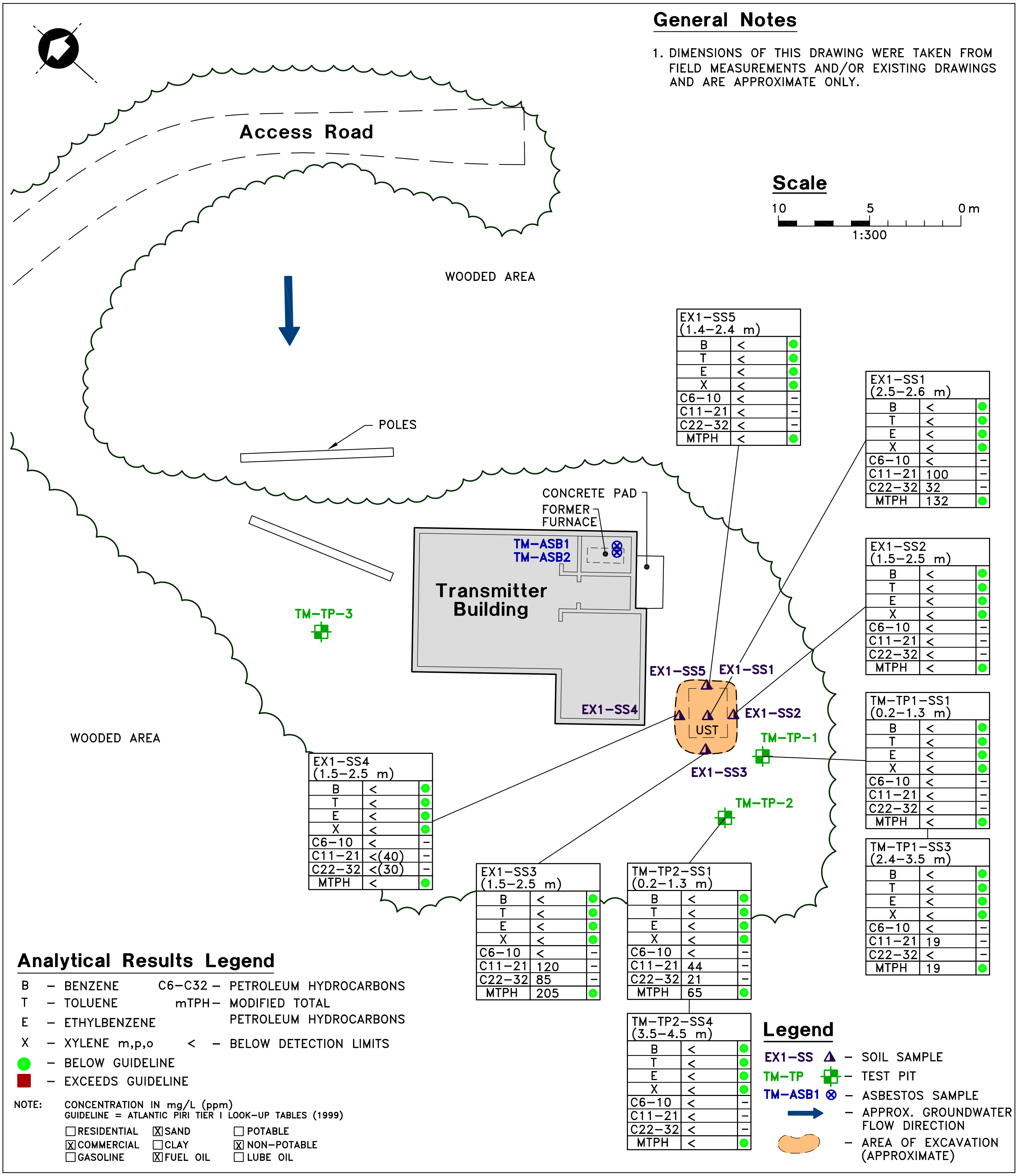
TITLE
Receiver Site Plan

PROJECT
Phase II Env. Site Assessment
Former Transmitter, Receiver and EPU Site
Stephenville, Newfoundland & Labrador

PROJECT NO. **40287B**
SCALE 1:200
DATE Oct. 2003
FIGURE NO. **3.1**



General Notes

1. DIMENSIONS OF THIS DRAWING WERE TAKEN FROM FIELD MEASUREMENTS AND/OR EXISTING DRAWINGS AND ARE APPROXIMATE ONLY.

Scale

10 5 0 m
1:300

EX1-SS5
(1.4-2.4 m)

B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<	–
C22-32	<	–
MTPH	<	●

EX1-SS1
(2.5-2.6 m)

B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	100	–
C22-32	32	–
MTPH	132	●

EX1-SS2
(1.5-2.5 m)

B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<	–
C22-32	<	–
MTPH	<	●

TM-TP1-SS1
(0.2-1.3 m)

B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<	–
C22-32	<	–
MTPH	<	●

TM-TP1-SS3
(2.4-3.5 m)

B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	19	–
C22-32	<	–
MTPH	19	●

EX1-SS4
(1.5-2.5 m)

B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<(40)	–
C22-32	<(30)	–
MTPH	<	●

EX1-SS3
(1.5-2.5 m)

B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	120	–
C22-32	85	–
MTPH	205	●

TM-TP2-SS1
(0.2-1.3 m)

B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	44	–
C22-32	21	–
MTPH	65	●

TM-TP2-SS4
(3.5-4.5 m)

B	<	●
T	<	●
E	<	●
X	<	●
C6-10	<	–
C11-21	<	–
C22-32	<	–
MTPH	<	●

Analytical Results Legend

B – BENZENE
T – TOLUENE
E – ETHYLBENZENE
X – XYLENE m,p,o
● – BELOW GUIDELINE
🟥 – EXCEEDS GUIDELINE

C6-C32 – PETROLEUM HYDROCARBONS
mTPH – MODIFIED TOTAL PETROLEUM HYDROCARBONS
< – BELOW DETECTION LIMITS

NOTE: CONCENTRATION IN mg/L (ppm)
GUIDELINE = ATLANTIC PIRI TIER I LOOK-UP TABLES (1999)

☐ RESIDENTIAL ☒ SAND ☐ POTABLE
☒ COMMERCIAL ☐ CLAY ☒ NON-POTABLE
☐ GASOLINE ☒ FUEL OIL ☐ LUBE OIL

Legend

EX1-SS ▲ – SOIL SAMPLE
TM-TP ✚ – TEST PIT
TM-ASB1 ⊗ – ASBESTOS SAMPLE
➡ – APPROX. GROUNDWATER FLOW DIRECTION
● – AREA OF EXCAVATION (APPROXIMATE)

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TITLE
Transmitter Site Plan

PROJECT
Phase II Env. Site Assessment
Former Transmitter, Receiver and EPU Site
Stephenville, Newfoundland & Labrador

PROJECT NO.
40287B

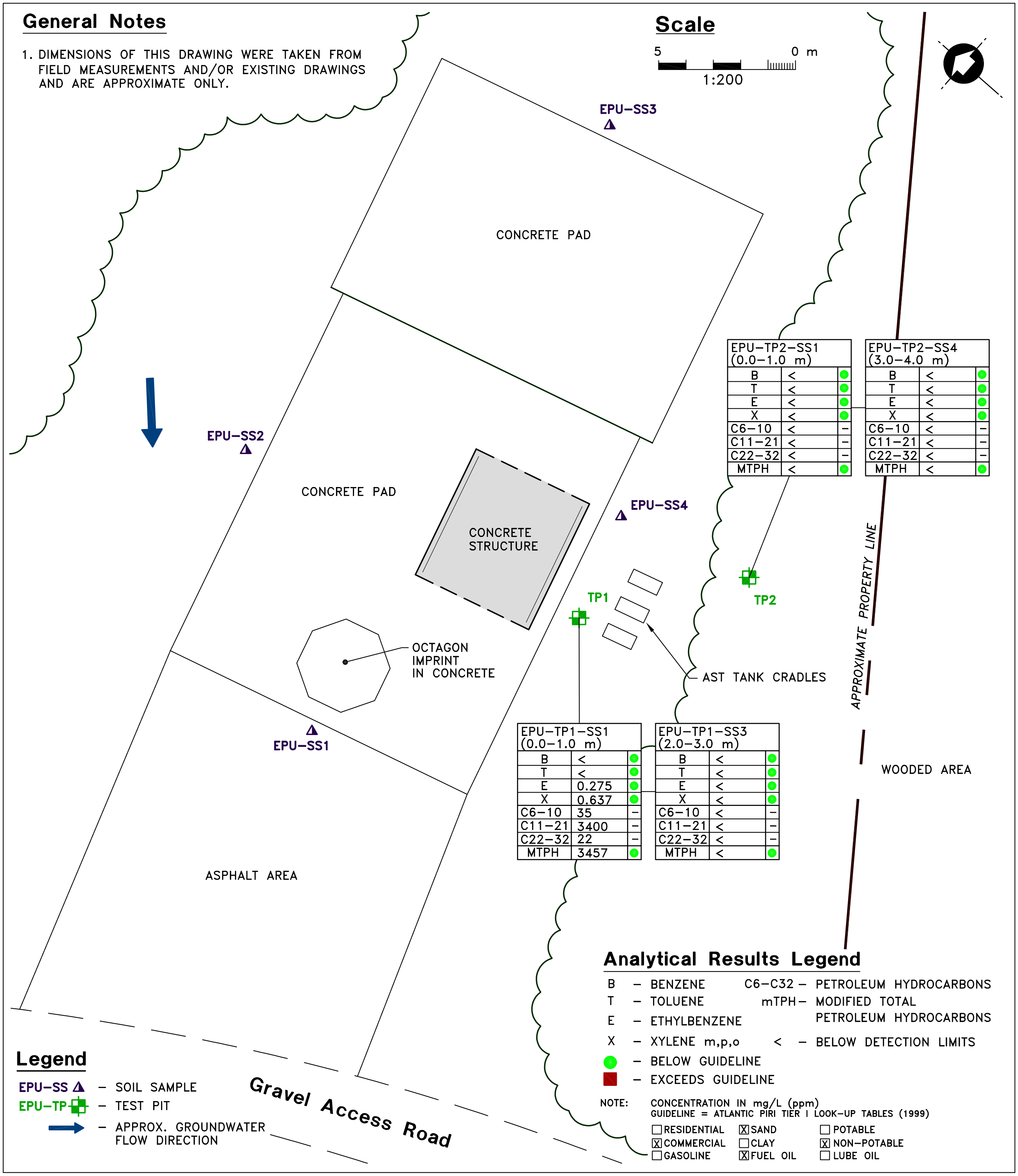
SCALE
1:300

DATE
Oct. 2003

FIGURE NO.
3.2

General Notes

1. DIMENSIONS OF THIS DRAWING WERE TAKEN FROM FIELD MEASUREMENTS AND/OR EXISTING DRAWINGS AND ARE APPROXIMATE ONLY.



EPU–TP2–SS1 (0.0–1.0 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6–10	<	–
C11–21	<	–
C22–32	<	–
MTPH	<	●

EPU–TP2–SS4 (3.0–4.0 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6–10	<	–
C11–21	<	–
C22–32	<	–
MTPH	<	●

EPU–TP1–SS1 (0.0–1.0 m)		
B	<	●
T	<	●
E	0.275	●
X	0.637	●
C6–10	35	–
C11–21	3400	–
C22–32	22	–
MTPH	3457	●

EPU–TP1–SS3 (2.0–3.0 m)		
B	<	●
T	<	●
E	<	●
X	<	●
C6–10	<	–
C11–21	<	–
C22–32	<	–
MTPH	<	●

Legend

EPU–SS ▲ – SOIL SAMPLE
EPU–TP ✚ – TEST PIT
→ – APPROX. GROUNDWATER FLOW DIRECTION

Analytical Results Legend

B – BENZENE
T – TOLUENE
E – ETHYLBENZENE
X – XYLENE m,p,o
● – BELOW GUIDELINE
🟥 – EXCEEDS GUIDELINE
C6–C32 – PETROLEUM HYDROCARBONS
mTPH – MODIFIED TOTAL PETROLEUM HYDROCARBONS
< – BELOW DETECTION LIMITS

NOTE: CONCENTRATION IN mg/L (ppm)
GUIDELINE = ATLANTIC PIRI TIER I LOOK–UP TABLES (1999)

☐ RESIDENTIAL
☒ COMMERCIAL
☐ GASOLINE
☒ SAND
☐ CLAY
☒ FUEL OIL
☐ POTABLE
☒ NON–POTABLE
☐ LUBE OIL

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TITLE
EPU Site Plan

PROJECT
Phase II Env. Site Assessment
Former Transmitter, Receiver and EPU Site
Stephenville, Newfoundland & Labrador

PROJECT NO.
40287B

SCALE
1:200

DATE
Oct. 2003

FIGURE NO.
3.3

APPENDIX I

SITE PHOTOGRAPHS

Photo A: Excavation of RX-TP1.

Photo B: View of TM-TP3 adjacent to creosote poles.

Photo C: View of flaking paint in receiver building.

Photo D: View of asbestos containing material in receiver building.

Photo E: UST adjacent to receiver site after removal.

Photo F: UST adjacent to transmitter site after removal.

Photo G: View of EPU site facing northeast.

Photo H: View of AST cradle location at EPU site.

APPENDIX II
TEST PIT LOGS

MGI Limited
1118 Topsail Road
P.O. Box 8353, Station A
St. John's, NL A1B 3N7

Test Pit: RX-TP1

MGI Project: 40287B

Client: PWGSC

Project: Phase II Environmental Site Assessment
Former Transmitter & Receiver Site
Stephenville, NL

Depth (m)	Strata Plot	Description	Depth/Elev.	Sample No.	Sample Type	Well Data	Remarks	Depth (m)
0		Ground Surface	0					0
		Grassmat/Rootmat	-0.4					
1		Dark brown sand; some silt; numerous cobbles; dry; odourless	-1.4	1	Grab			1
		Light brown sand; some silt; occasional cobbles; moist; odourless	-1.8	2	Grab			
2		Dark grey sand; some silt and organics; occasional cobbles; moist; slight septic odour	-2	3	Grab			2
		Light brown sand; some silt; numerous cobbles; moist; odourless	-2.7	4	Grab			
3		Reddish brown sand; some silt; numerous cobbles; moist; trace hydrocarbon odour	-3	5	Grab			3
4 5		Light brown sand; some silt; numerous cobbles; moist; slight to trace hydrocarbon odour	-5	6 7	Grab Grab		Surficial groundwater not encountered	4 5
6 7		End of Test Pit						6 7

Excavated by: Marine Contractors Inc.

Hole size: 3.0 m x 4.2 m

Excavation method: Track-Mounted Excavator

Logged by: James O'Neill

Excavation date: July 30, 2003

MGI Limited
1118 Topsail Road
P.O. Box 8353, Station A
St. John's, NL A1B 3N7

Test Pit: RX-TP2

MGI Project: 40287B

Client: PWGSC

Project: Phase II Environmental Site Assessment
Former Transmitter & Receiver Site
Stephenville, NL

Depth (m)	Strata Plot	Description	Depth/Elev.	Sample No.	Sample Type	Well Data	Remarks	Depth (m)
0		Ground Surface	0					0
		Grassmat/Rootmat	-0.2					
1		Dark brown sand; some silt; numerous cobbles; moist; odourless	-1.2	1	Grab			1
2		Light brown sand; some silt; occasional cobbles; dry to moist; odourless	-2	2	Grab			2
3		Grey brown sand; some silt; numerous cobbles; moist; slight to trace hydrocarbon odour		3	Grab			3
4				4	Grab			4
5			-5	5	Grab		Surficial groundwater not encountered	5
6		End of Test Pit						6
7								7

Excavated by: Marine Contractors Inc.

Hole size: 3.0 m x 4.0 m

Excavation method: Track-Mounted Excavator

Logged by: James O'Neill

Excavation date: July 30, 2003

MGI Limited
1118 Topsail Road
P.O. Box 8353, Station A
St. John's, NL A1B 3N7

MGI Project: 40287B

Client: PWGSC

Project: Phase II Environmental Site Assessment
Former Transmitter & Receiver Site
Stephenville, NL

Test Pit: TM-TP1

Depth (m)	Strata Plot	Description	Depth/Elev.	Sample No.	Sample Type	Well Data	Remarks	Depth (m)
0		Ground Surface	0					0
		Grassmat/Rootmat	-0.2					
		Dark to light brown sand; some silt; numerous to occasional cobbles; moist; odourless		1	Grab			
			-2.4	2	Grab			
		Greyish brown sand; some silt; numerous cobbles; moist; odourless		3	Grab			
				4	Grab			
			-5	5	Grab		Surficial groundwater not encountered	
5		End of Test Pit						5

Excavated by: Marine Contractors Inc.

Excavation method: Track-Mounted Excavator

Excavation date: July 30, 2003

Hole size: 2.0 m x 3.5 m

Logged by: James O'Neill

MGI Limited
1118 Topsail Road
P.O. Box 8353, Station A
St. John's, NL A1B 3N7

MGI Project: 40287B

Client: PWGSC

Project: Phase II Environmental Site Assessment
Former Transmitter & Receiver Site
Stephenville, NL

Test Pit: TM-TP2

Depth (m)	Strata Plot	Description	Depth/Elev.	Sample No.	Sample Type	Well Data	Remarks	Depth (m)
0		Ground Surface	0					0
		Grassmat/Rootmat	-0.2					
1		Dark to light brown sand; some silt; numerous cobbles; moist; odourless		1	Grab			1
2			-2.4	2	Grab			2
3		Greyish brown sand; some silt; numerous cobbles; moist; odourless		3	Grab			3
4				4	Grab			4
			-5	5	Grab		Surficial groundwater not encountered	
5		End of Test Pit						5
6								6
7								7

Excavated by: Marine Contractors Inc.

Hole size: 2.1 m x 3.8 m

Excavation method: Track-Mounted Excavator

Logged by: James O'Neill

Excavation date: July 30, 2003

MGI Limited
1118 Topsail Road
P.O. Box 8353, Station A
St. John's, NL A1B 3N7

A member of the Family of Companies

Test Pit: TM-TP3

MGI Project: 40287B

Client: PWGSC

Project: Phase II Environmental Site Assessment
Former Transmitter & Receiver Site
Stephenville, NL

Depth (m)	Strata Plot	Description	Depth/Elev.	Sample No.	Sample Type	Well Data	Remarks	Depth (m)
0		Ground Surface	0					0
		Grassmat/Rootmat	-0.2					
1		Dark brown sand; some silt and organics; numerous cobbles; moist; odourless	-1	1	Grab			1
2 3		Grey sand; occasional cobbles; moist to wet (water seeping in at 1.0 mbgl); odourless	-3	2 3	Grab Grab		Surficial groundwater encountered at approximately 1.0 meters below ground level.	2 3
		End of Test Pit						
4								4
5								5
6								6
7								7

Excavated by: Marine Contractors Inc.

Hole size: 1.4 m x 2.8 m

Excavation method: Track-Mounted Excavator

Logged by: James O'Neill

Excavation date: July 30, 2003

MGI Limited
1118 Topsail Road
P.O. Box 8353, Station A
St. John's, NL A1B 3N7

MGI Project: 40287B

Client: PWGSC

Project: Phase II Environmental Site Assessment
Former Transmitter & Receiver Site
Stephenville, NL

Test Pit: EPU-TP1

Depth (m)	Strata Plot	Description	Depth/Elev.	Sample No.	Sample Type	Well Data	Remarks	Depth (m)
0		Ground Surface	0					0
		Brown sand and gravel; dry; trace hydrocarbon odour		1	Grab			
1				2	Grab		Steel 25mm diameter product line encountered at approx. 1.5 meters below ground level.	1
2				3	Grab			2
3			-3					3
		Brown sand and gravel; occasional cobbles; dry; odourless		4	Grab			
4				5	Grab		Surficial groundwater not encountered	4
5			-5					5
		End of Test Pit						
6								6
7								7

Excavated by: Marine Contractors Inc.

Excavation method: Track-Mounted Excavator

Excavation date: September 16, 2003

Hole size: 3.0m x 4.0m

Logged by: Derek AuCoin

MGI Limited
1118 Topsail Road
P.O. Box 8353, Station A
St. John's, NL A1B 3N7

A member of the Family of Companies

Test Pit: EPU-TP2

MGI Project: 40287B

Client: PWGSC

Project: Phase II Environmental Site Assessment
Former Transmitter & Receiver Site
Stephenville, NL

Depth (m)	Strata Plot	Description	Depth/Elev.	Sample No.	Sample Type	Well Data	Remarks	Depth (m)
0		Ground Surface	0					0
0–1		Dark brown sand and gravel; occasional cobbles; moist; trace hydrocarbon odour	-1	1	Grab			1
1–5		Dark brown sand and gravel; occasional cobbles; moist; odourless	-5	2 3 4 5	Grab Grab Grab Grab		Surficial groundwater not encountered	2 3 4 5
5		End of Test Pit						
6								6
7								7

Excavated by: Marine Contractors Inc.

Excavation method: Track-Mounted Excavator

Excavation date: September 16, 2003

Hole size: 3.0m x 4.0m

Logged by: Derek AuCoin

APPENDIX III

HEADSPACE ANALYSIS

Test Pits Headspace Analysis

Monitor Well/Borehole ID	Sample Depth (m)	Headspace (ppm / %LEL)
RX-TP1	0.4-1.4	50 ppm*
	1.4-1.8	40 ppm
	1.8-2.0	25 ppm
	2.0-2.7	25 ppm
	2.7-3.0	24 ppm
	3.0-4.0	35 ppm*
	4.0-5.0	35 ppm
RX-TP2	0.2-1.2	25 ppm*
	1.2-2.0	30 ppm
	2.0-3.0	30 ppm
	3.0-4.0	40 ppm*
	4.0-5.0	40 ppm
TM-TP1	0.2-1.3	45 ppm*
	1.3-2.4	45 ppm
	2.4-3.5	40 ppm*
	3.5-4.5	50 ppm
	4.5-5.0	50 ppm
TM-TP2	0.2-1.3	NR*
	1.3-2.4	60 ppm
	2.4-3.5	60 ppm
	3.5-4.5	60 ppm*
	4.5-5.0	60 ppm
TM-TP3	0.2-1.0	40 ppm*
	1.0-2.0	50 ppm
	2.0-3.0	40 ppm*

* = sample sent for laboratory analysis

NR = not enough recovery for headspace analysis

APPENDIX IV

ATLANTIC PIRI ECOLOGICAL RECEPTORS CHECKLIST

1) ECOLOGICAL HABITAT

Are any of the following within 150 meters of the site:

YES/NO

No Wetland habitats such as marshes, swamps, tidal flats, beaches

No Aquatic habitats such as rivers, lakes or streams

No Forested habitats (50 acres or more)

No Grassland habitats

No Provincial/National parks or ecological reserve

No Rare, threatened or endangered species populations

No Other critical or sensitive habitat for wildlife, migratory species

If the answer is "NO" to all questions, then no habitat of potential concern is identified.

☐ There is no further action required.

If the answer is "YES", then proceed to the next step, Exposure Assessment.

2) EXPOSURE ASSESSMENT

YES/NO

No	Can dissolved hydrocarbons in groundwater reach any receptor habitat identified above now or in the future?
No	Can LNAPL (Light Non-Aqueous Phase Liquids) reach receptor habitat identified above?
No	Can hydrocarbons reach receptor habitat identified above via surface runoffs?

If the site soils or surface water are not accessible due to pavement or other barriers, skip the next two questions.

No	Is there a potential for direct absorption of contaminants through skin?
No	Is there a potential for oral consumption of contaminated soils, water, plants?
No	Have hydrocarbons, associated with the site being investigated, been known to be present in any of the soils, sediments, surface water of the receptor habitats identified above at concentrations greater than CCME ecologically-based guidelines?

If the answer to any questions above is YES, then further assessment is required. Additional data should be gathered to enhance the knowledge of the site-specific situation such as; fate and transport of contaminants, description of the receptor of concerns, preliminary toxicity estimates and mitigation options. (Tiered ERA)

APPENDIX V

LABORATORY CERTIFICATES

V-1

SOIL CHEMICAL ANALYSIS DATA

V-2

PAINT AND ACM ANALYSIS DATA

Analytical Parameters page : 1

Client : MGI Limited ORGAN, MARION
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7 FAX # : 709-364-5368
Philip Project Number : 0300910S Printed : 2003/08/15
Client Project Number : 40287B Reported : 2003/08/15

Matrix			Soil	Soil	Soil	Soil
Philip ID			03-S003419	03-S003420	03-S003421	03-S003422
Client ID			RX-TP1-SS1	RX-TP1-SS6	RX-TP2-SS1	RX-TP2-SS4
Date Sampled (y/m/d)			03/07/30	03/07/30	03/07/30	03/07/30
Date Received (y/m/d)			03/08/05	03/08/05	03/08/05	03/08/05
Analyte	**Units**	**EQL**				
TEH in Soil Event #		-	CI07	CI07	CI07	CI07
VPH in Soil Event #		-	CI06	CI06	CI06	CI06
Benzene	mg/kg	0.025	nd	nd	nd	nd
Toluene	mg/kg	0.025	nd	nd	nd	nd
Ethylbenzene	mg/kg	0.025	nd	nd	nd	nd
Xylenes	mg/kg	0.050	nd	nd	nd	nd
C6 - C10 HC {less BTEX}	mg/kg	2.5	nd	nd	nd	nd
>C10-C21 (Fuel Range)	mg/kg	15.	nd	180	nd	nd
>C21-C32 (Lube Range)	mg/kg	15.	nd	63.	nd(20)	nd
Modified TPH - Tier 1	mg/kg	32.	nd	240	nd	nd
TEH Surrogate (IBB)	% Rec.	-	91.	89.	95.	96.
VPH Surrogate (IBB)	% Rec.	-	91.	110.	137.	96.
TEH Surrogate (C32)	% Rec	-	84.	86.	87.	89.
Moisture	%	-	10.	11.	15.	5.

Note: The product resemblance comments are provided for general guidance only and may not be accurate. Resemblances are based on comparison with available reference standards. Due to chromatographic similarity of certain products, the influence of weathering effects and interference of non-petrogenic compounds, it is not always possible to positively identify products.

Notes: Modified TPH - Tier 1 (C6-C32) does not include BTEX

03-S003420	RX-TP1-SS6	Weathered fuel oil fraction.
03-S003421	RX-TP2-SS1	Elevated TEH EQL(s) due to matrix interference.

Legend:

EQL = Estimated Quantitation Limit for routine analysis
nd = not detected above standard EQL
nd() = not detected at the elevated EQL shown in parenthese
= Parameter not requested in Sample
Note : Soil results are expressed on a dry weight basis.
Biota results are expressed on a wet weight basis.
% rec. = Percent Recovery of added surrogate compound(s)

page verified

Philip Analytical Services
49-55 Elizabeth Ave. Suite 101A
St. John's, NF Canada A1A-1W9
Tel (709) 754-0203
Fax (709) 754-8612

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
Philip Project Number : 0300910S
Client Project Number : 40287B

ORGAN, MARION
FAX # : 709-364-5368
Printed : 2003/08/15
Reported : 2003/08/15

Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Philip ID			**03-S003423**	**03-S003424**	**03-S003425**	**03-S003426**
Client ID			**TM-TP1-SS1**	**TM-TP1-SS3**	**TM-TP2-SS1**	**TM-TP2-SS4**
Date Sampled (y/m/d)			03/07/30	03/07/30	03/07/30	03/07/30
Date Received (y/m/d)			03/08/05	03/08/05	03/08/05	03/08/05
Analyte	**Units**	**EQL**				
TEH in Soil Event #		-	CI07	CI07	CI07	CI07
VPH in Soil Event #		-	CI06	CI06	CI06	CI06
Benzene	mg/kg	0.025	nd	nd	nd	nd
Toluene	mg/kg	0.025	nd	nd	nd	nd
Ethylbenzene	mg/kg	0.025	nd	nd	nd	nd
Xylenes	mg/kg	0.050	nd	nd	nd	nd
C6 - C10 HC {less BTEX}	mg/kg	2.5	nd	nd	nd	nd
>C10-C21 (Fuel Range)	mg/kg	15.	nd	19.	44.	nd
>C21-C32 (Lube Range)	mg/kg	15.	nd	nd	21.	nd
Modified TPH - Tier 1	mg/kg	32.	nd	nd	66.	nd
TEH Surrogate (IBB)	% Rec.	-	93.	93.	94.	94.
VPH Surrogate (IBB)	% Rec.	-	130.	92.	116.	114.
TEH Surrogate (C32)	% Rec	-	84.	84.	87.	87.
Moisture	%	-	8.	11.	10.	12.

Note: The product resemblance comments are provided for general guidance only and may not be accurate. Resemblances are based on comparison with available reference standards. Due to chromatographic similarity of certain products, the influence of weathering effects and interference of non-petrogenic compounds, it is not always possible to positively identify products.

Notes: Modified TPH - Tier 1 (C6-C32) does not include BTEX

Legend:

EQL = Estimated Quantitation Limit for routine analysis
nd = not detected above standard EQL
nd() = not detected at the elevated EQL shown in parenthese
- = Parameter not requested in Sample
Note : Soil results are expressed on a dry weight basis.
Biota results are expressed on a wet weight basis.
% rec. = Percent Recovery of added surrogate compound(s)

page verified

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Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7

ORGAN, MARION
FAX # : 709-364-5368
Printed : 2003/08/15
Reported : 2003/08/15

Philip Project Number : 0300910S
Client Project Number : 40287B

Matrix			Soil	Soil
Philip ID			03-S003427	03-S003428
Client ID			RX-TP2-SS0	RX-TP2-SS0 DUP
Date Sampled (y/m/d)			03/07/30	03/07/30
Date Received (y/m/d)			03/08/05	03/08/05
Analyte	**Units**	**EQL**		
TEH in Soil Event #			CI07	CI07
VPH in Soil Event #		-	CI06	CI06
Benzene	mg/kg	0.025	nd	nd
Toluene	mg/kg	0.025	nd	nd
Ethylbenzene	mg/kg	0.025	nd	nd
Xylenes	mg/kg	0.050	nd	nd
C6 - C10 HC {less BTEX}	mg/kg	2.5	nd	nd
>C10-C21 (Fuel Range)	mg/kg	15.	17.	nd
>C21-C32 (Lube Range)	mg/kg	15.	nd	nd
Modified TPH - Tier 1	mg/kg	32.	nd	nd
TEH Surrogate (IBB)	% Rec.		91.	91.
VPH Surrogate (IBB)	% Rec.		110.	118.
TEH Surrogate (C32)	% Rec	-	87.	90.
Moisture	%	-	4.	3.

Note: The product resemblance comments are provided for general guidance only and may not be accurate. Resemblances are based on comparison with available reference standards. Due to chromatographic similarity of certain products, the influence of weathering effects and interference of non-petrogenic compounds, it is not always possible to positively identify products.

Notes: Modified TPH Tier 1 (C6-C32) does not include BTEX

Legend:

EQL = Estimated Quantitation Limit for routine analysis
nd = not detected above standard EQL
nd() = not detected at the elevated EQL shown in parenthese
= Parameter not requested in Sample
Note : Soil results are expressed on a dry weight basis.
Biota results are expressed on a wet weight basis.
% rec. = Percent Recovery of added surrogate compound(s)

page verified

Philip Analytical Services
49-55 Elizabeth Ave. Suite 101A
St. John's, NF Canada A1A-1W9
Tel (709) 754-0203
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Client : MGI Limited **ORGAN, MARION**
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7 **FAX # : 709-364-5368**
Philip Project Number : 0300910S **Printed : 2003/08/15**
Client Project Number : 40287B **Reported : 2003/08/15**

Certificate of Analysis

Method Summaries :

- Extractable Hydrocarbons - Soil: Acetone/Hexane extraction. HP5890 GC-FID. Ref: Atlantic PIRI Guidelines for Laboratories, Draft 1.0, 1999.
- Purgeable Hydrocarbons - Soil: Methanol extr'n. Headspace/GC-PID-FID. HP5890 GC. Ref: Atlantic PIRI Guidelines for Laboratories, Draft 1.0, 1999.
- Moisture Content: Heating at 103C. Gravimetric det'n - as received basis. Ref: Ontario MOE Analytical Methods for Env. Samples, Vol.1, Method: ME

All work recorded herein has been done in accordance with normal professional standards using accepted testing technologies, quality assurance and quality control procedures except where otherwise agreed to by the client and testing company in writing. The results relate only to the items tested. Liability for any and all use of these test results shall be limited to the actual cost of the pertinent analysis performed. There is no other warranty expressed or implied. Excess sample will be discarded upon expiry of hold time.

Approval of Analytical Parameters:

Laboratory Manager : ____________________
Robert Whelan

ANALYTICAL SERVICES

Analytical Parameters page : 1

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7

TAITE, BRIAN

FAX # : 709-364-5368
Printed : 2003/09/11 (E
Reported : 2003/09/10

Philip Project Number : 0301082S
Client Project Number : 40287B

Matrix			Soil	Soil	Soil	Soil
Philip ID			03-S004111	03-S004112	03-S004113	03-S004114
Client ID			EX1-SS1	EX1-SS2	EX1-SS3	EX1-SS4
Date Sampled (y/m/d)			03/09/02	03/09/02	03/09/02	03/09/02
Date Received (y/m/d)			03/09/05	03/09/05	03/09/05	03/09/05
Analyte	**Units**	**EQL**				
TEH in Soil Event #		-	CI49	CI49	CI49	CI49
VPH in Soil Event #		-	CI48	CI48	CI48	CI48
Benzene	mg/kg	0.025	nd	nd	nd	nd
Toluene	mg/kg	0.025	nd	nd	nd	nd
Ethylbenzene	mg/kg	0.025	nd	nd	nd	nd
Xylenes	mg/kg	0.050	nd	nd	nd	nd
C6 - C10 HC (less BTEX)	mg/kg	2.5	nd	nd	nd	nd
>C10-C21 (Fuel Range)	mg/kg	15.	100	nd	120	nd(40)
>C21-C32 (Lube Range)	mg/kg	15.	32.	nd	85.	nd(30)
Modified TPH - Tier 1	mg/kg	32.	130	nd	210	nd
TEH Surrogate (IBB)	% Rec.	-	91.	92.	92.	97.
VPH Surrogate (IBB)	% Rec.	-	95.	105.	114.	100.
TEH Surrogate (C32)	% Rec	-	92.	91.	77.	96.
Moisture	%	-	13.	15.	20.	16.

Note: **The product resemblance comments are provided for general guidance only and may not be accurate.** Resemblances are based on comparison with available reference standards. Due to chromatographic similarity of certain products, the influence of weathering effects and interference of non-petrogenic compounds, it is not always possible to positively identify products.

Notes: Modified TPH Tier 1 (C6-C32) does not include BTEX

03-S004113	EX1-SS3	Weathered fuel oil fraction.
03-S004114	EX1-SS4	Elevated TEH EQL(s) due to matrix interference.

Legend:

EQL = Estimated Quantitation Limit for routine analysis
nd = not detected above standard EQL
nd() = not detected at the elevated EQL shown in parenthese
\- = Parameter not requested in Sample
Note : Soil results are expressed on a dry weight basis.
Biota results are expressed on a wet weight basis.
% rec. = Percent Recovery of added surrogate compound(s)

page verified

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Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353, Stn A
St. John's
NL A1B 3N7
Philip Project Number : 03010828
Client Project Number : 40287B

TAITE, BRIAN
FAX # : 709-364-5368
Printed : 2003/09/11
Reported : 2003/09/10

Matrix			Soil	Soil	Soil	Soil
Philip ID			03-S004115	03-S004116	03-S004117	03-S004118
Client ID			EX1-SS5	EX2-SS1	EX2-SS2	EX2-SS3
Date Sampled (y/m/d)			03/09/02	03/09/02	03/09/02	03/09/02
Date Received (y/m/d)			03/09/05	03/09/05	03/09/05	03/09/05
Analyte	Units	EQL				
TEH in Soil Event #		-	CI49	CI49	CI49	CI49
VPH in Soil Event #		-	CI48	CI48	CI48	CI48
Benzene	mg/kg	0.025	nd	nd	nd	nd
Toluene	mg/kg	0.025	nd	nd	nd	nd
Ethylbenzene	mg/kg	0.025	nd	nd	nd	nd
Xylenes	mg/kg	0.050	nd	nd	nd	nd
C6 - C10 HC (less BTEX)	mg/kg	2.5	nd	nd	nd	nd
>C10-C21 (Fuel Range)	mg/kg	15.	nd	70.	65.	nd(40)
>C21-C32 (Lube Range)	mg/kg	15.	nd	nd	17.	nd(40)
Modified TPH - Tier 1	mg/kg	32.	nd	70.	82.	nd
TEH Surrogate (IBB)	% Rec.	-	96.	94.	94.	94.
VPH Surrogate (IBB)	% Rec.	-	104.	104.	96.	123.
TEH Surrogate (C32)	% Rec	-	95.	93.	93.	92.
Moisture	%	-	17.	6.	5.	11.

Note: The product resemblance comments are provided for general guidance only and may not be accurate. Resemblances are based on comparison with available reference standards. Due to chromatographic similarity of certain products, the influence of weathering effects and interference of non-petrogenic compounds, it is not always possible to positively identify products.

Notes: Modified TPH - Tier 1 (C6-C32) does not include BTEX

03-S004118 EX2-SS3 Elevated TEH EQL(s) due to matrix interference.

Legend:
EQL = Estimated Quantitation Limit for routine analysis
nd = not detected above standard EQL
nd() = not detected at the elevated EQL shown in parenthese
\- = Parameter not requested in Sample
Note : Soil results are expressed on a dry weight basis.
Biota results are expressed on a wet weight basis.
% rec. = Percent Recovery of added surrogate compound(s)

page verified

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Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
Philip Project Number : 0301082S
Client Project Number : 40287B

TAITE, BRIAN
FAX # : 709-364-5368
Printed : 2003/09/11
Reported : 2003/09/10

Matrix			Soil	Soil	Soil
Philip ID			03-S004119	03-S004120	03-S004121
Client ID			EX2-SS4	EX2-SS5	EX2-SS5DUP
Date Sampled (y/m/d)			03/09/02	03/09/02	03/09/02
Date Received (y/m/d)			03/09/05	03/09/05	03/09/05
Analyte	**Units**	**EQL**			
TEH in Soil Event #			CI49	CI49	CI49
VPH in Soil Event #		-	CI48	CI48	CI48
Benzene	mg/kg	0.025	nd	nd	nd
Toluene	mg/kg	0.025	nd	nd	nd
Ethylbenzene	mg/kg	0.025	nd	nd	nd
Xylenes	mg/kg	0.050	nd	nd	nd
C6 - C10 HC (less BTEX)	mg/kg	2.5	nd	nd	nd
>C10-C21 (Fuel Range)	mg/kg	15.	710	46.	49.
>C21-C32 (Lube Range)	mg/kg	15.	88.	nd	16.
Modified TPH - Tier 1	mg/kg	32.	800	46.	66.
TEH Surrogate (IBB)	% Rec.	-	95.	89.	90.
VPH Surrogate (IBB)	% Rec.	-	73.	86.	99.
TEH Surrogate (C32)	% Rec	-	94.	87.	88.
Moisture	%	-	16.	9.	9.

Note: The product resemblance comments are provided for general guidance only and may not be accurate. Resemblances are based on comparison with available reference standards. Due to chromatographic similarity of certain products, the influence of weathering effects and interference of non-petrogenic compounds, it is not always possible to positively identify products.

Notes: Modified TPH - Tier 1 (C6-C32) does not include BTEX

03-S004119 EX2-SS4 Weathered fuel oil fraction.

Legend:

EQL = Estimated Quantitation Limit for routine analysis
nd = not detected above standard EQL
nd() = not detected at the elevated EQL shown in parenthese
\- = Parameter not requested in Sample
Note : Soil results are expressed on a dry weight basis.
Biota results are expressed on a wet weight basis.
% rec. = Percent Recovery of added surrogate compound(s)

page verified

Certificate of Analysis

Method Summaries :

- Extractable Hydrocarbons - Soil: Acetone/Hexane extraction. HP5890 GC-FID. Ref: Atlantic PIRI Guidelines for Laboratories, Draft 1.0, 1999.
- Purgeable Hydrocarbons - Soil: Methanol extr'n. Headspace/GC-PID-FID. HP5890 GC. Ref: Atlantic PIRI Guidelines for Laboratories, Draft 1.0, 1999.
- Moisture Content: Heating at 103C. Gravimetric det'n - as received basis. Ref: Ontario MOE Analytical Methods for Env. Samples, Vol.1, Method: ME

All work recorded herein has been done in accordance with normal professional standards using accepted testing technologies, quality assurance and quality control procedures except where otherwise agreed to by the client and testing company in writing. The results relate only to the items tested. Liability for any and all use of these test results shall be limited to the actual cost of the pertinent analysis performed. There is no other warranty expressed or implied. Excess sample will be discarded upon expiry of hold time.

Analyses reviewed by:
Laboratory Manager :
Robert Whelan

PSC
ANALYTICAL SERVICES

Analytical Parameters page : 1

Client : MGI Limited ORGAN, MARION
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7 FAX # : 709-364-5368
Philip Project Number : 03011315 Printed : 2003/09/22 (E
Client Project Number : 40287B Reported : 2003/09/22

Matrix			Soil	Soil	Soil	Soil
Philip ID			03-S004332	03-S004333	03-S004334	03-S004335
Client ID			EPU-TP1-SS 1	EPU-TP1-SS 3	EPU-TP2-SS 1	EPU-TP2-SS 4
Date Sampled (y/m/d)			03/09/16	03/09/16	03/09/16	03/09/16
Date Received (y/m/d)			03/09/18	03/09/18	03/09/18	03/09/18
Analyte	**Units**	**EQL**				
TEH in Soil Event #		-	CI71	CI71	CI71	CI71
VPH in Soil Event #		-	CI70	CI70	CI70	CI70
Benzene	mg/kg	0.025	nd	nd	nd	nd
Toluene	mg/kg	0.025	nd	nd	nd	nd
Ethylbenzene	mg/kg	0.025	0.275	nd	nd	nd
Xylenes	mg/kg	0.050	0.637	nd	nd	nd
C6 - C10 HC (less BTEX)	mg/kg	2.5	35.	nd	nd	nd
>C10-C21 (Fuel Range)	mg/kg	15	3400	nd	nd	nd
>C21-C32 (Lube Range)	mg/kg	15	22.	nd	nd	nd
Modified TPH - Tier 1	mg/kg	32	3400	nd	nd	nd
TEH Surrogate (IBB)	% Rec.	-	124.	99.	101.	101.
VPH Surrogate (IBB)	% Rec.	-	109.	112.	130.	121.
TEH Surrogate (C32)	% Rec	-	93.	96.	97.	96.
Moisture	%	-	8.	6.	14.	7.

Note: The product resemblance comments are provided for general guidance only and may not be accurate. Resemblances are based on comparison with available reference standards. Due to chromatographic similarity of certain products, the influence of weathering effects and interference of non-petrogenic compounds, it is not always possible to positively identify products.

Notes: Modified TPH - Tier 1 (C6-C32) does not include BTEX

03-S004332	EPU-TP1-SS1	Weathered fuel oil fraction.

Legend:

EQL = Estimated Quantitation Limit for routine analysis
nd = not detected above standard EQL
nd() = not detected at the elevated EQL shown in parenthese
\- = Parameter not requested in Sample
Note : Soil results are expressed on a dry weight basis.
Biota results are expressed on a wet weight basis.
% rec. = Percent Recovery of added surrogate compound(s)

page verified

Philip Analytical Services
49-55 Elizabeth Ave. Suite 101A
St. John's, NF Canada A1A-1W9
Tel (709) 754-0203
Fax (709) 754-8612

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7

ORGAN, MARION

FAX # : 709-364-5368

Philip Project Number : 0301131S
Client Project Number : 40287B

Printed : 2003/09/22
Reported : 2003/09/22

Certificate of Analysis

Method Summaries :

- Extractable Hydrocarbons - Soil: Acetone/Hexane extraction. HP5890 GC-FID. Ref: Atlantic PIRI Guidelines for Laboratories, Draft 1.0, 1999.
- Purgeable Hydrocarbons - Soil: Methanol extr'n. Headspace/GC-PID-FID. HP5890 GC. Ref: Atlantic PIRI Guidelines for Laboratories, Draft 1.0, 1999.
- Moisture Content: Heating at 103C. Gravimetric det'n - as received basis. Ref: Ontario MOE Analytical Methods for Env. Samples, Vol.1, Method: ME

All work recorded herein has been done in accordance with normal professional standards using accepted testing technologies, quality assurance and quality control procedures except where otherwise agreed to by the client and testing company in writing. The results relate only to the items tested. Liability for any and all use of these test results shall be limited to the actual cost of the pertinent analysis performed. There is no other warranty expressed or implied. Excess sample will be discarded upon expiry of hold time.

Analyses reviewed by:
Laboratory Manager : RWhelan
Robert Whelan

Organic Parameters **page : 1**

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
PSC Project Number : 0312838H
Client Project Number : 40287B

ORGAN, MARION

FAX # : 709-364-5368
Printed : 2003/08/11
Reported : 2003/08/11

Matrix	Soil	Soil
Philip ID	03-H048759	03-H048760
Client ID	40287B-TM-TP3-SS1	40287B-TM-TP3-SS2
Date Sampled (y/m/d)	03/07/30	03/07/30
Date Received (y/m/d)	03/08/06	03/08/06

Analyte	**Units**	**EQL**		
PCB in Soil Event #		-	HM37	HM37
Polychlorinated Biphenyl	mg/kg	0.05	nd	nd
Decachlorobiphenyl Surr.	% Rec.	-	112.	89.
PAH in Soil Event #		-	HM46	HM46
Naphthalene	mg/kg	0.05	nd	nd
2-Methylnaphthalene	mg/kg	0.05	nd	nd
1-Methylnaphthalene	mg/kg	0.05	nd	nd
Acenaphthylene	mg/kg	0.05	nd	nd
Acenaphthene	mg/kg	0.05	nd	nd
Fluorene	mg/kg	0.05	nd	nd
Phenanthrene	mg/kg	0.05	nd	nd
Anthracene	mg/kg	0.05	nd	nd
Fluoranthene	mg/kg	0.05	nd	nd
Pyrene	mg/kg	0.05	nd	nd
Benz[a]anthracene	mg/kg	0.05	nd	nd
Chrysene	mg/kg	0.05	nd	nd
Benzo[b]fluoranthene	mg/kg	0.05	nd	nd
Benzo[k]fluoranthene	mg/kg	0.05	nd	nd
Benzo[a]pyrene	mg/kg	0.05	nd	nd
Perylene	mg/kg	0.05	nd	nd

EQL = Estimated Quantitation Limit is the minimum concentration that can be reliably reported. It is not a regulatory limit. For soils, zero %moisture is assumed. The moisture corrected EQL = EQL/(1-(%moisture/100))
ND ( ) = Analyte was not detected above the EQL. Raised EQL listed in Parenthesis.
- = Dash is reported when parameter not requested in sample.
Event # = PSC Quality Control Reference number for QC samples run with your sample.
%REC = Surrogate Recovery Values are results of PSC quality control tests.
Note : Soil results are expressed on a dry weight basis.
: Biota results are expressed on a wet weight basis.

page verified

PSC Analytical Services
200 Bluewater Road
Bedford, NS Canada B4B 1G9
Tel (902) 420-0203
Toll free (800) 565-7227
Fax (902) 420-8612

Client : MGI Limited ORGAN, MARION
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
FAX # : 709-364-5368
PSC Project Number : 0312838H
Printed : 2003/08/11
Client Project Number : 40287B
Reported : 2003/08/11

Matrix			Soil	Soil
Philip ID			03-H048759	03-H048760
Client ID			40287B-TM-TP3-SS1	40287B-TM-TP3-SS2
Date Sampled (y/m/d)			03/07/30	03/07/30
Date Received (y/m/d)			03/08/06	03/08/06
Analyte	**Units**	**EQL**	(Continued from previous page)	
Indeno[1,2,3-cd]pyrene	mg/kg	0.05	nd	nd
Dibenz[a,h]anthracene	mg/kg	0.05	nd	nd
Benzo[ghi]perylene	mg/kg	0.05	nd	nd
D8 Acenaphthylene Surr.	% Rec.	-	98.	104.
D10 Anthracene Surr.	% Rec.		104.	104.
D10 Pyrene Surr.	% Rec.		102.	101.
D14 p-Terphenyl Surr.	% Rec.		102.	101.
Moisture	%		10.	24.

EQL = Estimated Quantitation Limit is the minimum concentration that can be reliably reported. It is not a regulatory limit. For soils, zero %moisture is assumed. The moisture corrected EQL = EQL/(1-(%moisture/100))
ND ( ) = Analyte was not detected above the EQL. Raised EQL listed in Parenthesis.
\- = Dash is reported when parameter not requested in sample.
Event # = PSC Quality Control Reference number for QC samples run with your sample.
%REC = Surrogate Recovery Values are results of PSC quality control tests.
Note : Soil results are expressed on a dry weight basis.
: Biota results are expressed on a wet weight basis.

page verified

PSC Analytical Services
200 Bluewater Road
Bedford, NS Canada B4B 1G9
Tel (902) 420-0203
Toll free (800) 565-7227
Fax (902) 420-8612

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
PSC Project Number : 0312838H
Client Project Number : 40287B

ORGAN, MARION
FAX # : 709-364-5368
Printed : 2003/08/11
Reported : 2003/08/11

Certificate of Analysis

Method Summaries :

- Polycyclic Aromatic Hydrocarbons Soil/Sediment: Acetone/Hexane extr'n. HP5890/5971 GC/MS (SIM mode). Ref: EPA 8270A
- PCBs and OC Pesticides - Soil/Sediment: Acetone/hexane extr'n Silica Gel cleanup. HP5890 cap. col. GC-ECD. Ref: EPA 8080, 8081
- Moisture- based upon: Handbook of Analytical Methods for Environmental Samples Gravimetric Metod Vol 1, page ME4, Ontario Ministry of the Environment, Rexdale Ont.1983. Drying temperature 105+- 5 Degrees C.

Approval of Organic Parameters:

Organics Manager : ____________________
James MacDonald

Organic Parameters page : 1

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
PSC Project Number : 0315729H
Client Project Number : 40287B

ORGAN, MARION

FAX # : 709-364-5368
Printed : 2003/09/24 (Event 502)
Reported : 2003/09/24

Matrix	Soil	Soil	Soil	Soil
Philip ID	03-H061586	03-H061587	03-H061588	03-H061589
Client ID	EPU-SS1	EPU-SS2	EPU-SS3	EPU-SS4
Date Sampled (y/m/d)	03/09/16	03/09/16	03/09/16	03/09/16
Date Received (y/m/d)	03/09/19	03/09/19	03/09/19	03/09/19

Analyte	Units	EQL				
PCB in Soil Event #		-	HR96	HR96	HR96	HR96
Polychlorinated Biphenyl	mg/kg	0.05	nd	nd	nd	nd
Decachlorobiphenyl Surr.	% Rec.	-	89.	89.	91.	96.
Moisture	%	-	4.	3.	16.	4.

EQL = Estimated Quantitation Limit is the minimum concentration that can be reliably reported. It is not a regulatory limit. For soils, zero %moisture is assumed. The moisture corrected EQL = EQL/(1-(%moisture/100))
ND ( ) = Analyte was not detected above the EQL. Raised EQL listed in Parenthesis.
- = Dash is reported when parameter not requested in sample.
Event # = PSC Quality Control Reference number for QC samples run with your sample.
%REC = Surrogate Recovery Values are results of PSC quality control tests.
Note : Soil results are expressed on a dry weight basis.
: Biota results are expressed on a wet weight basis.

page verified

Organic Parameters page : 2

PSC Analytical Services
200 Bluewater Road
Bedford, NS Canada B4B 1G9
Tel (902) 420-0203
Toll free (800) 565-7227
Fax (902) 420-8612

Client : MGI Limited ORGAN, MARION
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7 FAX # : 709-364-5368
PSC Project Number : 0315729H Printed : 2003/09/24 E502
Client Project Number : 40287B Reported : 2003/09/24

Certificate of Analysis

Method Summaries :

- PCBs and OC Pesticides - Soil/Sediment: Acetone/hexane extr'n - Silica Gel cleanup. HP5890 cap. col. GC-ECD. Ref: EPA 8080, 8081
- Moisture- based upon: Handbook of Analytical Methods for Environmental Samples Gravimetric Metod Vol 1, page ME4, Ontario Ministry of the Environment, Rexdale Ont.1983. Drying temperature 105+- 5 Degrees C.

All work recorded herein has been done in accordance with normal professional standards using accepted testing technologies, quality assurance and quality control procedures except where otherwise agreed to by the client and testing company in writing. The results relate only to the items tested. Liability for any and all use of these test results shall be limited to the actual cost of the pertinent analysis performed. There is no other warranty expressed or implied. Excess sample will be discarded upon expiry of hold time.

Analyses reviewed by:

Organics Manager : ______________
James MacDonald

V-2

PAINT AND ACM ANALYSIS DATA

Inorganic Parameters

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
PSC Project Number : 0312836H
Client Project Number : 40287B

ORGAN, MARION

FAX # : 709-364-5368
Printed : 2003/08/13
Reported : 2003/08/13

Matrix			**Other**
Philip ID			**03-H048751**
Client ID			**40287B-RX-** **PC 1**
Date Sampled (y/m/d)			**03/07/30**
Date Received (y/m/d)			**03/08/06**
Analyte	**Units**	**EQL**	
HNO3 Peroxide Digestion			20030808-A
Mercury Digestion		-	20030807-A
Mercury	mg/kg	0.01	0.86
Lead	mg/kg	100	33000

Legend **EQL** = Estimated Quantitation Limit is the minimum concentration that can be reliably reported. It is not a regulatory limit.
ND = Not Detected, instrument did not detect anything above standard EQL.
ND ( ) = Not Detected at the elevated EQL specified, due to matrix interferences or sample pre-dilution.
- = Dash is reported when parameter not requested in sample.

Note : Soil results are expressed as air dry weight basis.
: Biota results are expressed on a wet weight basis unless otherwise stated.

page verified

PSC Analytical Services
200 Bluewater Road
Bedford, NS Canada B4B 1G9
Tel (902) 420-0203
Toll free (800) 565-7227
Fax (902) 420-8612

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7

ORGAN, MARION

PSC Project Number : 0312836H
Client Project Number : 40287B

FAX # : 709-364-5368
Printed : 2003/08/13
Reported : 2003/08/13

Certificate of Analysis

Method Summaries:

- Mercury in Solids: Digestion/Cold Vapour Atomic Absorption. Ref: USEPA Method 245.5
- Available Trace Metals in soils/sediments: Nitric/Peroxide Digestion. Ref:USEPA Method #3050B.

All work recorded herein has been done in accordance with normal professional standards using accepted testing technologies, quality assurance and quality control procedures except where otherwise agreed to by the client and testing company in writing. The results relate only to the items tested. Liability for any and all use of these test results shall be limited to the actual cost of the pertinent analysis performed. There is no other warranty expressed or implied. Excess sample will be discarded upon expiry of hold time.

Approval of Inorganic Parameters:

Inorganics Manager : Jerry Arenovich

Analytical Test Results

page : 1

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
PSC Project Number : 0312836H
Client Project Number : 40287B

ORGAN, MARION

FAX # : 709-364-5368
Printed : 2003/08/13
Reported : 2003/08/13

Matrix			Other	Other	Other	Other
Philip ID			03-H048749	03-H048750	03-H048752	03-H048753
Description						
Client ID			40287B-RX-ASB-1	40287B-RX-ASB-2	40287B-TM ASB-1	40287B-TM ASB-2
Date Sampled (y/m/d)			03/07/30	03/07/30	03/07/30	03/07/30
Date Received (y/m/d)			03/08/06	03/08/06	03/08/06	03/08/06
Analyte	**Units**	**EQL**				
Asbestos	%(w)	1.	Present	Present	Present	Present
Chrysotile Asbestos	%(w)	1.	20-40	50-70	10-30	30-50
Amosite Asbestos	%(w)	1.	10-30	nd	20-40	nd
Crocidolite Asbestos	%(w)	1.	nd	nd	nd	nd
Cellulose	%(w)	1.	1-5 cotton	nd	nd	nd
Glass Fibres	%(w)	1.	nd	nd	nd	nd
Hair	%(w)	1.	nd	nd	nd	nd
Miscellaneous	%(w)	1.	nd	nd	nd	nd
Mineral Wool	%(w)	1.	nd	nd	nd	nd

Legend EQL = Estimated Quantitation Limit is the minimum concentration that can be reliably reported. It is not a regulatory limit.
ND ( ) = Not Detected, our instruments did not detect anything above EQL. Raised EQL listed in Parenthesis.
\- = Dash is reported when parameter not requested in sample.
Event # = PSC Quality Control Reference number for QC samples run with your sample.
%REC = Surrogate Recovery Values are results of PSC quality control tests.

Note : Soil results are expressed on a dry weight basis.
: Food results are expressed on a wet weight basis.

page verified

Certificate of Analysis

Method Summaries:

- Examination by stereomicroscope for % composition and tentative identification of fibre type. Confirmation of fibre type by Polarized Light Microscopy with dispersion staining. Procedure is based upon the text, Asbestos Identification, 2nd ed. (1987), Walter C. McCrone, McCrone Research Institute, Chicago, IL.

All work recorded herein has been done in accordance with normal professional standards using accepted testing technologies, quality assurance and quality control procedures except where otherwise agreed to by the client and testing company in writing. The results relate only to the items tested. Liability for any and all use of these test results shall be limited to the actual cost of the pertinent analysis performed. There is no other warranty expressed or implied. Excess sample will be discarded upon expiry of hold time.

Approval of Industrial Chemistry Parameters:
Industrial Chemistry Manager : ______________________
Robert K. Boss

PSC
ANALYTICAL SERVICES

Inorganic Parameters

page : 1

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
PSC Project Number : 0313853H
Client Project Number : 40287B

ORGAN, MARION

FAX # : 709-364-5368
Printed : 2003/08/28
Reported : 2003/08/28

Matrix	Leachate
Philip ID	03-H053203
Client ID	402687B RX PC1
Date Sampled (y/m/d)	03/07/30
Date Received (y/m/d)	03/08/21

Analyte	Units	EQL	
TCLP Extraction		0.00	completed
Total Water Digest		-	20030827-A
Lead	mg/L	0.05	7.59
Dry Weight Used	g	0.01	2.50
Initial pH	Units	1.0	8.4
Final pH	Units	1.0	5.1
Moisture	%	1.	<5 visual

Non-Conformance Comment: Leachate analysis performed using dry equivalent weight of less than 50g due to insufficient sample. All mass:volume ratios adjusted accordingly. However with a smaller sample size, accuracy and precision of analytical data could be reduced due to effects of sample inhomogeniety.

Legend
EQL = Estimated Quantitation Limit is the minimum concentration that can be reliably reported. It is not a regulatory limit.
ND = Not Detected, Instrument did not detect anything above standard EQL.
ND ( ) = Not Detected at the elevated EQL specified, due to matrix interferences or sample pre-dilution.
= Dash is reported when parameter not requested in sample.

Note : Soil results are expressed as air dry weight basis.
: Biota results are expressed on a wet weight basis unless otherwise stated.

page verified

Certificate of Analysis

Method Summaries:

- Total Recoverable Metals Digest: Homogenization/Digestion. Ref: USEPA Method #200.2
- Major Metals in Aqueous Samples: PE Optima 3000 ICP-OES. Ref: USEPA Method #200.7
- Leachate Extraction: Toxicity Characteristic Leachate Procedure. Ref: USEPA SW-846 #1311
- Moisture- based upon: Handbook of Analytical Methods for Environmental Samples Gravimetric Metod Vol 1, page ME4, Ontario Ministry of the Environment, Rexdale Ont.1983. Drying temperature 105+- 5 Degrees C.

Conversions:
1 mg/L = 1000 ug/L = 1 part per million (ppm)
1 ug/L = 0.001 mg/L = 1 part per billion (ppb)

All work recorded herein has been done in accordance with normal professional standards using accepted testing technologies, quality assurance and quality control procedures except where otherwise agreed to by the client and testing company in writing. The results relate only to the items tested. Liability for any and all use of these test results shall be limited to the actual cost of the pertinent analysis performed. There is no other warranty expressed or implied. Excess sample will be discarded upon expiry of hold time.

Analyses reviewed by:

Inorganics Manager : Jerry Arenovich

Analytical Test Results

Client : MGI Limited
1118 Topsail Rd, P.O.Box 8353,Stn A
St. John's
NL A1B 3N7
PSC Project Number : 0313853H
Client Project Number : 40287B

ORGAN, MARION

FAX # : 709-364-5368
Printed : 2003/08/28
Reported : 2003/08/28

Matrix	Leachate
Philip ID	03-H053203
Description	
Client ID	402687B RX PC1
Date Sampled (y/m/d)	03/07/30
Date Received (y/m/d)	03/08/21

Analyte	Units	EQL	
Weight	g	0.02	2.80

Legend EQL = Estimated Quantitation Limit is the minimum concentration that can be reliably reported. It is not a regulatory limit.
ND ( ) = Not Detected, our instruments did not detect anything above EQL. Raised EQL listed in Parenthesis.
= Dash is reported when parameter not requested in sample.
Event # = PSC Quality Control Reference number for QC samples run with your sample.
%REC = Surrogate Recovery Values are results of PSC quality control tests.

Note : Soil results are expressed on a dry weight basis.
: Food results are expressed on a wet weight basis.

page verified

LEAD ABATEMENT
FORMER TRANSMITTER & RECEIVER SITES
STEPHENVILLE, NL
PROJECT NO. 40287D

PROJECT NO. 40287D

REPORT TO

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

ON

LEAD ABATEMENT
FORMER TRANSMITTER & RECEIVER SITES
STEPHENVILLE, NL
PROJECT NO. 40287D

MGI LIMITED
1118 TOPSAIL ROAD
ST. JOHN'S, NL
A1B 3N7

TEL: 709-364-5353
FAX: 709-364-5368

October 2004

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EXECUTIVE SUMMARY

MGI Limited (MGI) was retained by Public Works and Government Services Canada (PWGSC), on behalf of Transport Canada (TC), to carry out a lead abatement program at the Former Transmitter and Receiver Sites in Stephenville, Newfoundland and Labrador (NL). The abatement program consisted of the removal of the lead-based paint by a licensed abatement contractor.

Following the completion of the initial lead and asbestos abatement program, additional painted surfaces were identified throughout the Transmitter and Receiver Sites which had not been identified during the previous assessments conducted by MGI personnel. Ten (10) paint chip samples from these newly identified surfaces were collected and submitted for lead concentration analysis. Based on the initial results of the lead concentration analysis, eight (8) samples required lead leachate analysis. Six (6) of the eight (8) paint chip samples underwent lead leachate analysis; due to insufficient sample weight for testing, two (2) of the paint chip samples were not submitted. Based on the results of the subsequent lead content and leachate analysis, additional surfaces with lead-containing paint were identified at the Transmitter and Receiver Sites, totalling approximately 75 m^2.

In summary, a total of 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.

Based on the above-noted work, there are no further environmental concerns with lead-based paint at the Transmitter and Receiver Sites. No further actions are recommended for the subject property at this time.

The statements made in the executive summary are subject to the same limitations included in the Statement of Limitations and Third Party Reliance (Section 7.0) and are to be read in conjunction with the remainder of the report.

1.0 INTRODUCTION

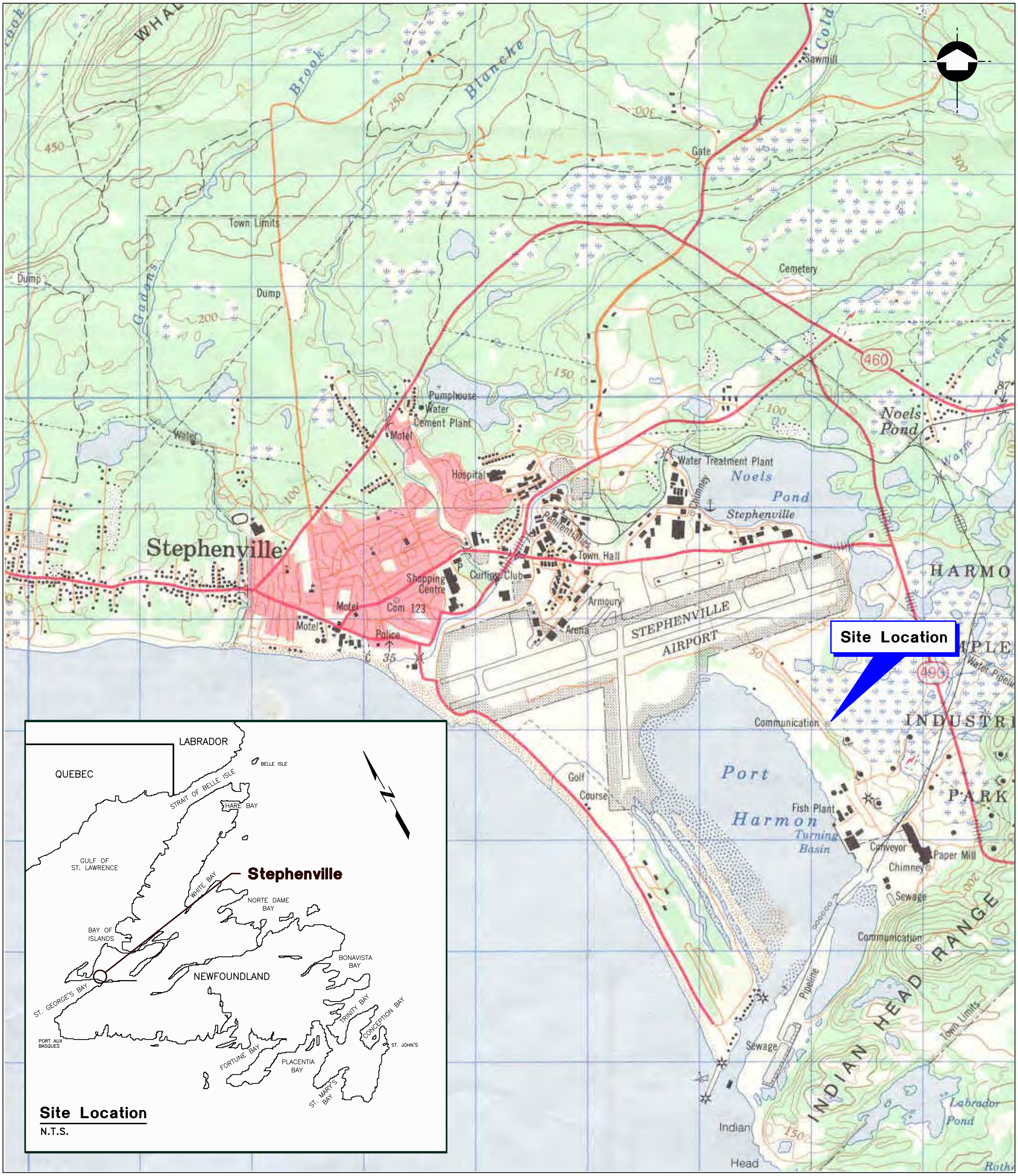
MGI Limited (MGI) was retained by Public Works and Government Services Canada (PWGSC), on behalf of Transport Canada (TC), to carry out a lead abatement program at the Former Transmitter and Receiver Sites in Stephenville, Newfoundland and Labrador (NL). This program was based on information gathered by MGI Limited during the Phase I and II Environmental Site Assessments and an asbestos and lead abatement program, conducted between January 26th and 30th, 2004.

The purpose of the lead abatement program was to remove lead-based paint from the site buildings.

2.0 BACKGROUND INFORMATION

2.1 Site Description

The subject sites are located in the Town of Stephenville, Newfoundland and Labrador (Figure 1). The sites exist on property formerly occupied by a United States Air Force Base and are currently part of the Stephenville Airport. There are two (2) separate parcels of land the Transmitter Site and the Receiver Site (See Figure 2). Both parcels of land are significantly overgrown with a mixture of grass and shrubs to the extent that it is difficult to approach the site buildings. The Receiver Site occupies an area of approximately 7.0 hectares, and the Transmitter Site occupies approximately 6.67 hectares. The Receiver and Transmitter Sites each contain a one-storey building constructed of concrete, occupying an area of approximately 118 m^2 and 102 m^2; respectively.



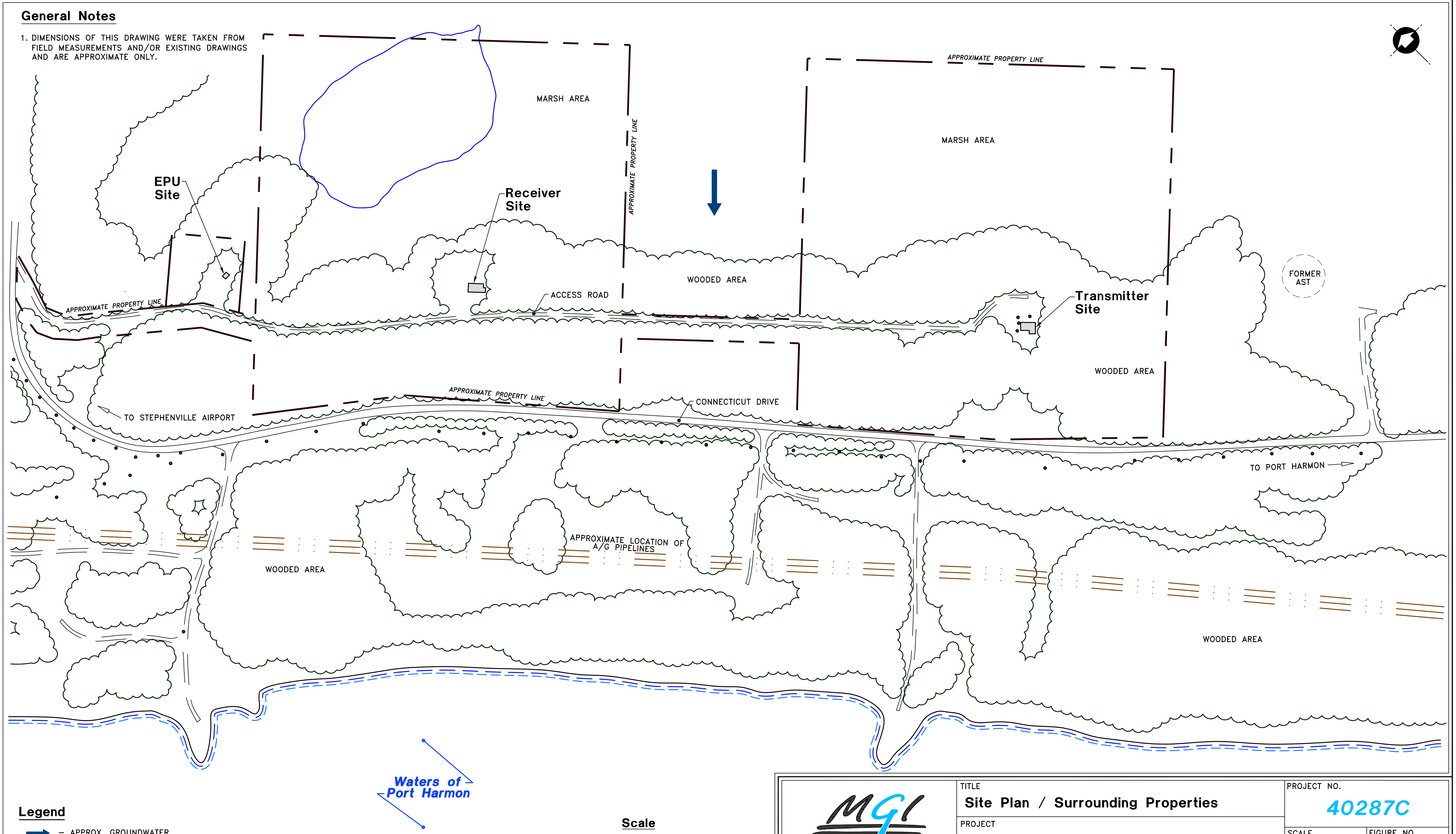
MGI

A member of the CRA Family of Companies

TITLE	Transmitter & Receiver Sites - Location
PROJECT	Lead Abatement Former Transmitter and Receiver Site Stephenville, Newfoundland & Labrador
PROJECT NO.	40287D
SCALE	1:50 000
DATE	October 2004
FIGURE NO.	1

General Notes

1. DIMENSIONS OF THIS DRAWING WERE TAKEN FROM FIELD MEASUREMENTS AND/OR EXISTING DRAWINGS AND ARE APPROXIMATE ONLY.



Legend

- APPROX. GROUNDWATER FLOW DIRECTION

• – UTILITY POLES

Scale

100 80 60 40 20 0 m

1:3000

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TITLE Site Plan / Surrounding Properties	PROJECT NO. 40287C
PROJECT Lead Abatement Former Transmitter, Receiver and EPU Site Stephenville, Newfoundland & Labrador	SCALE 1:3000
	DATE October 2004
	FIGURE NO. 2

The subject properties are located in a commercial/industrial area, with commercial and industrial properties located to the northwest and southeast. The waters of Port Harmon are located to the west and undeveloped land is located to the east.

2.2 Historical Records Review

MGI Limited (MGI) conducted a Phase I ESA on the subject property (see MGI Limited report entitled: *"Phase I Environmental Site Assessment, Former Transport Canada Transmitter and Receiver Site, Stephenville, NL"*, dated March, 2003).

Several environmental concerns were identified in the Phase I ESA:

- Potential asbestos-containing material (ACM) located in the furnace room of both the Transmitter and Receiver Site buildings; and,
- Potential soil contamination due to the presence of creosote-soaked poles located on the ground adjacent to the Transmitter Site building.

It was recommended that further assessment work (Phase II ESA) be completed to document existing environmental conditions on the property to more accurately define the environmental conditions at the sites.

In 2003, MGI conducted a Phase II ESA on the subject property (see MGI Limited reported entitled: *"Phase II Environmental Site Assessment, Former Transport Canada Transmitter, Receiver and EPU Sites Stephenville, NL"*, dated November, 2003).

- The assessment consisted of a site investigation, the excavation of three (3) test pits at the Transmitter Site, two (2) test pits at the Receiver Site and two (2) test pits at the Emergency Power Unit (EPU) site. One (1) paint sample and two (2) samples of suspected ACMs were collected from the Receiver Site and two (2) samples of suspected ACM were collected from the Transmitter Site. During the test pitting work, one underground storage tank (UST) was encountered at the Receiver Site and one UST was encountered at the Transmitter Site. These tanks were removed from the Transmitter and Receiver Sites. Soil samples were collected from the resulting excavations. Soil samples were also collected around the perimeter of the EPU site.

- During the Phase II ESA, a surface with flaking paint was identified in the Receiver Building. One (1) paint sample was collected from a section of an interior concrete wall. Laboratory analysis indicated that sample exceeded the Hazardous Products Regulation for lead in paint and exceeded the Transportation of Dangerous Goods Act for lead leachate.

- All four (4) ACM samples were found to contain chrysotile and amosite.

Based on the results of the Phase I and Phase II ESA investigations, the following further actions were recommended for the subject property:

- Due to the open access to the subject site, with the potential of exposure to the ACMs and lead-based paint by both authorized and unauthorized visitors, ACMs at the Transmitter Site and the Receiver Site buildings should be removed from these areas. Any ACM removal should be conducted by a licensed, asbestos abatement contractor and any handling or disposal of lead based paint should follow standard practice and regulations.

In January 2004, MGI conducted a lead and asbestos abatement program on the subject property (see MGI Limited reported entitled: *"Lead and Asbestos Abatement Program, Former Transmitter, Receiver and EPU Sites Stephenville, NL"*, dated May 2004). During the lead and asbestos abatement 10.5 m^2 of lead-containing paint was removed from the receiver building and a total of 0.52 m^3 of asbestos was removed from the transmitter and receiver buildings.

Following the completion of the initial lead and asbestos abatement, additional painted surfaces were identified throughout the Transmitter and Receiver Sites which had not been identified during the previous assessments conducted by MGI personnel. Ten (10) paint chip samples from these newly identified surfaces were collected and submitted for lead concentration analysis. Based on the results of the subsequent lead content and leachate analysis, additional surfaces with lead-containing paint were identified at the Transmitter and Receiver Sites, totalling approximately 75 m^2.

It was recommended that the remaining 75 m^2 of lead-based paint (30 m^2 from the transmitter building and approximately 45 m^2 from the receiver building) be removed from the concrete walls, as per Newfoundland Occupational Health and Safety regulations which should include the disposal of paint debris in approved drums, and shipping by an approved carrier complete with necessary shipping and disposal documents.

3.0 LEAD ABATEMENT PROGRAM

3.1 Site Preparation Program

The lead abatement program was carried out by EFCO Enterprises Limited (EFCO), a licensed asbestos abatement contractor. On July 21st and 22nd, 2004 site preparation was begun and completed for the removal program.

The immediate work area was enclosed and cleared of all objects, materials and equipment other than that required for the removal of lead-based paint. All interior openings were sealed to prevent escape of lead-containing materials from the work area and signs were posted outside the enclosure warning persons of the hazard of entering the enclosure without suitable respiratory protection and protective clothing.

3.2 Lead-Based Paint Removal and Disposal Program

On July 23rd, 2004 EFCO began the removal of lead-based paint in the Receiver and Transmitter buildings. During the removal program, workers removed sections of lead-based paint (approximately 75 m^2 in area) using grinding methods and various lead removal solvents. OHAS guidelines for asbestos removal were applied to the lead removal program, as per OHAS instructions.

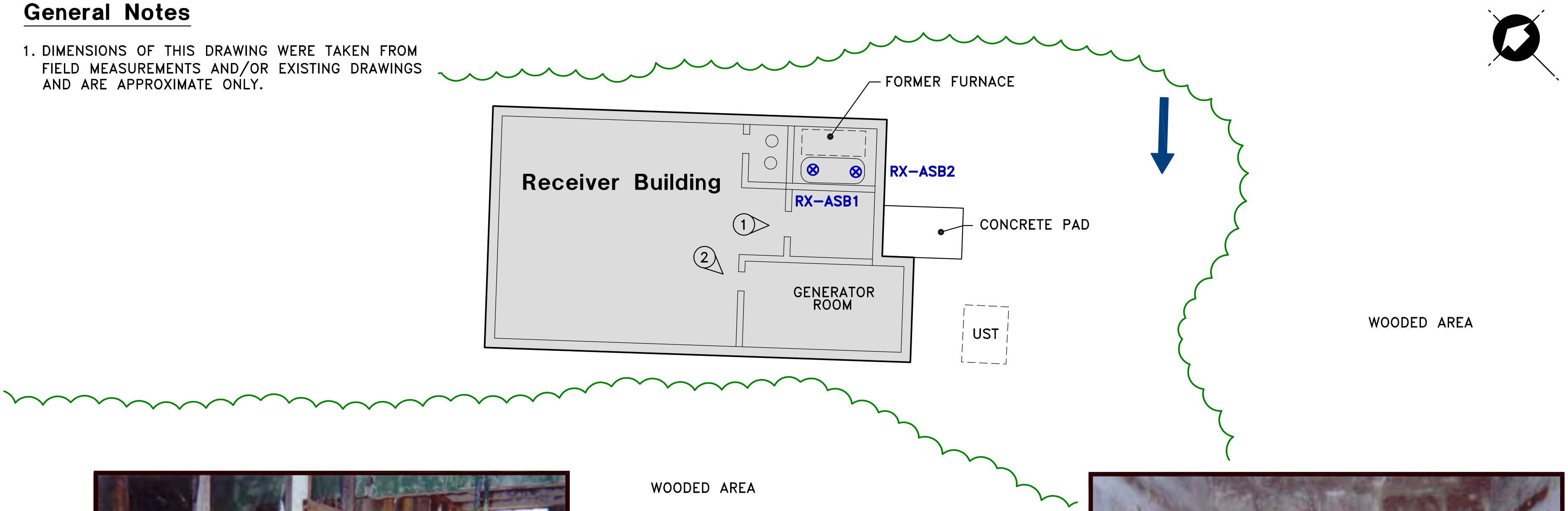
The paint chips removed were stored in an open head metal barrel with a lid, ring and bolt and will be disposed of with Island Waste Management. The paint chips will be collected at a later date. The appropriate documentation for this program is provided in Appendix A.

3.3 Air Quality Monitoring Program

The air quality monitoring program was conducted by All Tech Environmental Services Limited (All Tech). During the removal of the lead-based paint, five (5) personal air samples were collected for lead analysis. The air sampling pump used to collect the sample was a Gastec Medium volume sampling pump and was attached to the belt of the worker while within the enclosed area. The sample was collected on a 37 mm canister through a tube near the individual's respirator air intake area. These samples were sent to PSC Analytical Services (PSC) for analysis. The results for the monitoring program are included in Appendix B and discussed in section 4.2.

General Notes

1. DIMENSIONS OF THIS DRAWING WERE TAKEN FROM FIELD MEASUREMENTS AND/OR EXISTING DRAWINGS AND ARE APPROXIMATE ONLY.



WOODED AREA

PHOTO 1: VIEW OF ENCLOSURE IN RECEIVER BUILDING.

PHOTO 2: VIEW OF WALLS IN RECIEVER BUILDING FOLLOWING LEAD ABATMENT.

Legend

③▶ – PHOTOGRAPH VIEW

➡ – APPROX. GROUNDWATER FLOW DIRECTION

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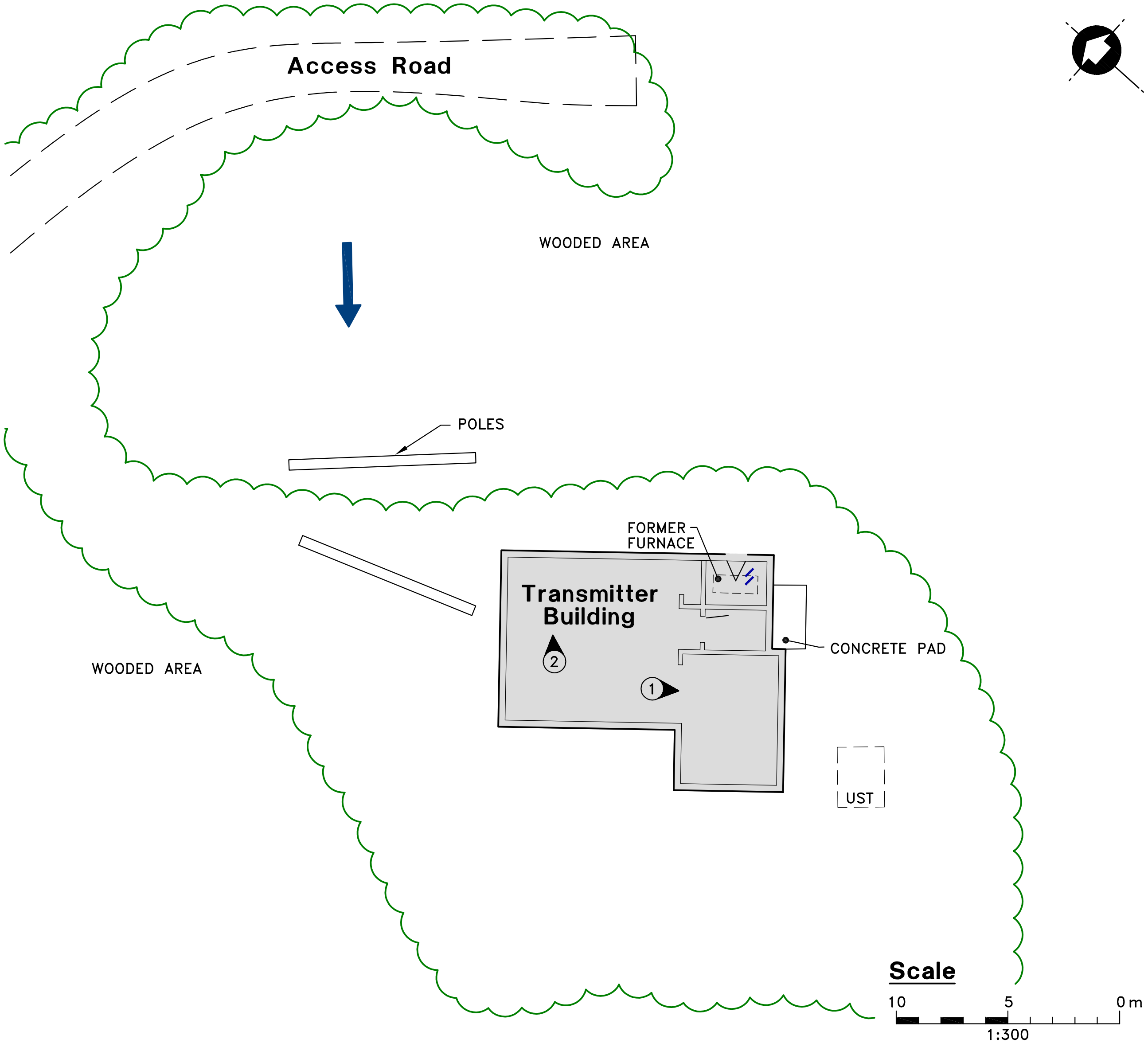
TITLE	Receiver Site Plan w/ Photographs
PROJECT	Lead Abatement Former Transmitter & Receiver Site Stephenville, Newfoundland & Labrador
PROJECT NO.	40287D
SCALE	1:200
DATE	October 2004
FIGURE NO.	3

General Notes

1. DIMENSIONS OF THIS DRAWING WERE TAKEN FROM FIELD MEASUREMENTS AND/OR EXISTING DRAWINGS AND ARE APPROXIMATE ONLY.

PHOTO 1: VIEW OF ENCLOSURE IN TRANSMITTER BUILDING

PHOTO 2: VIEW OF WALLS IN TRANSMITTER BUILDING FOLLOWING LEAD ABATEMENT



Legend

① – PHOTOGRAPH VIEW

→ – APPROX. GROUNDWATER FLOW DIRECTION

MGI

A member of the CRA Family of Companies

TITLE	Transmitter Site Plan w/ Photographs
PROJECT	Lead Abatement Former Transmitter & Receiver Site Stephenville, Newfoundland & Labrador
PROJECT NO.	40287D
SCALE	1:300
FIGURE NO.	4
DATE	October 2004

3.4 Lead Swab Sampling Program

Following the completion of the lead removal and disposal, lead swabs were collected from the surface to determine remaining lead concentrations. These samples were sent to PSC for analysis.

4.0 LABORATORY RESULTS

4.1 Selection of Criteria

Air quality results were compared American Conference of Governmental Industrial Hygienist (ACGIH) Exposure Limits. No Canadian standards are available.

Concentrations of lead in the lead swabs collected from the walls of the Receiver Building following the completion of the lead-based paint abatement program were compared to Health Canada Recommendations for lead-based paint.

4.2 Air Quality Results

Due to a laboratory incident during the sample analysis, only two (2) of the five (5) samples collected could be analyzed. Both air samples proved to be above the ACGIH lead exposure limits of 0.05 mg/m^3 during the time of sampling. Due to the high levels of lead workers wore Powered Air Purifying Respirators (PAPRs) during the abatement work and sufficient personnel protection was achieved.

The lead air quality analytical results are presented in Table 1 and documentation is attached in Appendix B.

Table 1: Lead Air Quality Analytical Results

Sample Number	Date of Collection	Sample Volume (litres)	Sample Location/Description	Results (mg/m^3)	ACGIH Exposure Limits (mg/m^3)
L-087	July 23, 2004	781.1	Building 2-Storage Bunker	Unavailable	0.05
L-088	July 22, 2004	453.3	Building 1-Storage Bunker	Unavailable	
L-090	July 22, 2004	439.8	Building 1-Storage Bunker	Unavailable	
L-091	July 24, 2004	366.3	Building 2-Storage Bunker	0.36	
L-093	July 24,2004	844.2	Building 2-Storage Bunker	0.14	

Notes:
Lpm=litres/minute

4.3 Lead Swab Results

On July 25th, 2004, upon completion of the paint removal work, All-Tech conducted a visual inspection of the work area and collected two (2) swab samples to determine lead concentrations. The total sample weight, the laboratory measured lead concentration, and the area sampled, were used to calculate the milligrams of lead per square centimetre.

The primary exposure pathway of lead paint is ingestion, either from dust during renovation, dust and flakes from paint in poor condition, or direct ingestion of paint. Contaminated dust is a particular important source of exposure for babies and small children because they can ingest a significant amount of dust through the natural habit of putting objects in their mouths. Health Canada suggests that a lead level greater than 1 mg/cm^2 requires that you take precautions to keep children and pregnant women away from the painted area and that levels greater than 5 mg/cm^2 are considered heavily leaded. The Health Canada guidelines are used for indicating the presence of a health hazard.

The recommended lead level of 1 mg/cm^2 was not exceeded by the swab samples (Swab #1 and Swab #2) collected and analyzed. The swab analytical results are presented in Table 2 and documentation is attached in Appendix C.

Table 2: Swab Analytical Results - Lead

Sample ID	Date Sampled	Location	Area Swabbed (cm^2)	Lead (mg/cm^2)
Swab #1	25-Jul-04	Building #1 - Storage Bunker	930	not detected
Swab #2	25-Jul-04	Building #2 - Storage Bunker	930	not detected
Health Canada Recommendations - Lead Paint			---	<1 mg/cm^2 <5 mg/cm^2

5.0 CONCLUSIONS

MGI was retained by PWGSC, on behalf of Transport Canada, to complete lead abatement at the Former Transmitter and Receiver Sites in Stephenville, NL. The abatement program consisted of the removal of the lead-based paint by a licensed abatement contractor.

Paint was removed from the interior walls of the Receiver Building and totalled approximately 30 m^2 in area. In the Transmitter Building, paint was removed from the interior walls and totalled approximately 45 m^2.

Based on the above work, there are no further environmental concerns with lead-based paint at the Transmitter and Receiver Sites.

6.0 RECOMMENDATIONS

No further actions are recommended for the subject property at this time.

7.0 STATEMENT OF LIMITATIONS AND THIRD PARTY RELIANCE

The investigation undertaken by MGI Limited with respect to this report and any conclusions or recommendations made in this report reflect MGI's judgment based on the site conditions observed at the time of the site inspection on the date(s) set out in this report and on information available at the time of preparation of this report. This report has been prepared for specific application to this site and it is based, in part, upon visual observation of the site, subsurface investigation at discrete locations and depths, and specific analysis of specific chemical parameters and materials during a specific time interval, all as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, portions of the site which were unavailable for direct investigation, sub-surface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed.

Substances other than those addressed by the investigation described in this report may exist within the site, substances addressed by the investigation may exist in areas of the site not investigated and concentrations of substances addressed which are different than those reported may exist in areas other than the locations from which samples were taken.

If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

This report has been prepared and the work referred to in this report has been undertaken by MGI Limited for the Public Works and Government Services Canada, on behalf of Transport Canada. Other than by PWGSC or Transport Canada, copying or distribution of this report or use of or reliance on the information contained herein in whole or in part, is not permitted without the express written permission of PWGSC or Transport Canada. Nothing in this report is intended to constitute or provide a legal opinion.

We trust this report meets with your requirements. Please do not hesitate to contact our office should you have any questions.

Sincerely,

MGI LIMITED

David Bourden, M.A.Sc., P.Eng Vice President	Marion Organ, P. Eng. Project Manager

APPENDIX A
LEAD-CONTAINING PAINT DISPOSAL DOCUMENTS

MANIFEST - MANIFESTE

This Manifest conforms to all Federal and Provincial transport and environmental legislation requiring manifesting.
Ce manifeste est conforme aux législations fédérale et provinciale sur l'environnement et le transport, requérant un manifeste.

Manifest Reference No.
Nº de référence du manifeste **9162281-1**

A Consignor (Generator) / Expéditeur (Producteur)

Provincial ID No. / Nº d'id. provincial: NFG000029

Company name / Nom de l'entreprise: Public Works Canada

Mailing address / Adresse postale: 10 Barter's Hill | City / Ville: St. John's | Province: NL | Postal code / Code postal: A1C 5T6

Shipping site address / Origine de l'expédition: Efco Enterprises Ltd.

City / Ville: Stephenville | Province: NL | Postal code / Code postal: A2N 2Z5

Intended consignee / Destinataire prévu: Island Waste Management

Provincial ID No. / No d'id. provincial: NFG 000 398

Address / Adresse: 137 LeMarchant Rd | City / Ville: St. John's | Province: NL | Postal code / Code postal: A1C 2H3

Receiving site address / Destination de l'expédition: Incinerator Rd

City / Ville: 4 Ways. | Province: NL | Postal code / Code postal:

B Carrier / Transporteur

Provincial ID No. / Nº d'id. provincial: NFG 000 398

Company name / Nom de l'entreprise: Island Waste Management

Address / Adresse: 134 LeMarchant Rd

City / Ville: St. John's | Prov.: NL | Postal code / Code postal: A1C 2H3

	Registration No. / Nº d'immatriculation	Prov.
Vehicle / Véhicule	PAY 734	NL
Trailer/Rail Car No. 1 1er remorque - wagon	TWO 764	NL
Trailer/Rail Car No. 2 2e remorque - wagon		

Point of entry / Point d'entrée: S'VILLE | Point of exit / Point de sortie: ST. JOHN'S

Carrier Certification: I declare that I have received waste as offered by the consignor in Part A for delivery to the intended consignee and that the information contained in Part B is complete and correct. / Déclaration du transporteur : J'atteste avoir reçu les déchets offerts par l'expéditeur dans la partie A en vue de leur livraison au destinataire choisi et que les renseignements inscrits à la partie B sont exacts et complets.

Year / Année: 04 | Month / Mois: 08 | Day / Jour: 13 | Name of authorized person (print) / Nom de l'agent autorisé (caractères d'imprimerie): G. MORGAN

Signature: G. | Tel. No. / Nº de tél.: 709) 834-7350

Reference nos. of other Manifest(s) used / Nºs de références des autres manifestes utilisés:

C Consignee (Receiver) / Destinataire (Réceptionnaire)

Provincial ID No. / Nº d'id. provincial:

Consignee information same as Intended Consignee in Part A
L'information à fournir par le destinataire est la même qu'en A
☐ Yes / Oui ☐ No, complete the boxed area below / Non, compléter la boîte ci-dessous

Company name / Nom de l'entreprise:

Address / Adresse:

City / Ville: | Province: | Postal code / Code postal:

Receiving site address / Destination de l'expédition:

City / Ville: | Province: | Postal code / Code postal:

Date received / Date de réception: Year / Année | Month / Mois | Day / Jour
Time / Heure: ☐ A.M. ☐ P.M.

Physical state / État physique	Shipping name of waste / Appellation réglementaire du déchet	Waste identification / Identification du déchet: Provincial No. / Nº (Quebec-Ontario only) (Québec-Ontario seul)	TDGA/PIN LTMD/NIP	Quantity shipped / Quantité expédiée	Units L or kg / unités	Classification	Packing group / Groupe d'emballage	Packaging / Contenants: No. / Nbre	Codes int.-ext.	Quantity received / Quantité reçu	Units L or kg / unités	Identify any shipment discrepancy problems. Attach addendum if necessary. / Indiquer toute différence relative à l'expédition. Annexer une feuille au besoin.	Handling code / Code de manutention	Decontamination / Décontamination: Packaging / Contenants: Yes / Oui	No / Non	Vehicle / Véhicule: Yes / Oui	No / Non
S	NON-REGULATED LEAD PAINT CHIPS		—	205	L	—	—	1	01								

Special handling/Emergency instructions / Manutention spéciale/Instructions d'urgence ☐ Attached / Ci-jointes ☑ Below / Ci-dessous

IN CASE OF DANGEROUS GOODS EMERGENCY CALL CANUTEC 613-996-6666 (24 HRS).

Circulation no. - Quebec only / Nº de circulation - Réservée au Québec:

Date shipped / Date d'expédition: Year / Année: 04 | Month / Mois: 08 | Day / Jour: 13 | Time / Heure: 9:30 ☑ A.M. ☐ P.M.

Scheduled arrival date / Date d'arrivée prévue: Year / Année: 04 | Month / Mois: 08 | Day / Jour: 13

Consignor Certification: *I declare that the information contained in Part A is correct and complete.*
Déclaration de l'expéditeur : *Je déclare que tous les renseignements à la partie A sont véridiques et complets.*

Name of authorized person (print) / Nom de l'agent autorisé (caractères d'imprimerie): Robert Bennett.

Signature: Robert Bennett

Tel. no. / Nº de tél.: 709) 643-5001

If handling code "Other" (specify) / Si code de manutention "divers", spécifier:

If waste to be transferred, specify intended company name / Si les déchets doivent être transférés, préciser le nom du destinataire:

Provincial ID No. / Nº d'id. provincial:

Address / Adresse: | City / Ville: | Prov.:

Consignee Certification: I declare that the information contained in Part C is correct and complete. Déclaration de l'expéditeur : Je déclare que tous les renseignements à la partie C sont véridiques et complets.

Name of authorized person (print) / Nom de l'agent autorisé (caractères d'imprimerie):

Signature: | Tel. no. / Nº de tél.: ( )

MOE 04-1917 (12/01)

Retained by Consignor (Generator) - Gardée par l'expéditeur

Copy / Copie 2 (green / verte

APPENDIX B

ANALYTICAL RESULTS - AIR QUALITY

Lead Abatement Report

Client:
Mr. Steve Menna
EFCO Enterprises
P.O. Box 318
Stephenville, NL
A2N 2Z5

Date: July 30, 2004
Location: Transmitter and Receiver Site
Project #: 3583

---

1. **Details to be noted:**

On July 22-25, 2004, EFCO Enterprises workers began lead paint removal in the Transmitter and Receiver Bunkers located in Stephenville, NL. During the abatement workers removed approximately 75 m^2 of lead paint from a concrete substrate using various lead removal solvents and techniques. A total of (5) air samples were collected and analysed for airborne lead concentrations during this work. Due to a laboratory incident during analysis only two (2) of the five (5) samples collected could be analysed. Both air samples analysed proved to be above the ACGIH lead exposure limits of 0.05 mg/m^3 during the time of sampling. Since workers wore PAPR's (Powered Air Purifying Respirators) during this abatement work, sufficient personnel protection was achieved.

On July 25, 2004 All-Tech Environmental Services Ltd. arrived on site and conducted a visual inspection of both Storage Bunkers and collected two (2) swab samples to determine lead concentrations on surfaces within each structure. Both swab samples collected proved to be below the recommended HUD guidelines of 800 ug/ft^2 (exterior concrete) during the time of sampling.

All samples collected were sent to the PSC Analytical in Bedford, NS, for lead analysis. Listed below are the results of the testing.

2. **Air Sampling Results:**

Sample #	Date	Air Sample Volume (L)	Location	Results (mg/m^3)	ACGIH Exposure Limits (mg/m^3)
L-087 (04-H049199)	July 23, 2004	781.1	Building #2 Storage Bunker	unavailable	0.05
L-088 (04-H049200)	July 22, 2004	455.3	Building #1 Storage Bunker	unavailable	0.05
L-090 (04-H049201)	July 22, 2004	439.6	Building #1 Storage Bunker	unavailable	0.05
L-091 (04-H049202)	July 24, 2004	386.3	Building #2 Storage Bunker	0.86	0.05
L-093 (04-H049203)	July 24, 2004	844.2	Building #2 Storage Bunker	0.14	0.05

3. **Swab Sampling Results:**

Sample #	Date	Area Swabbed (ft^2)	Location	Results (ug/ft^2)	HUD Guidelines (ug/ft^2)
Swab #1 (04-H049204)	July 25, 2004	1	Building #1 Storage Bunker	None Detected	800
Swab #2 (04-H049205)	July 25, 2004	1	Building #2 Storage Bunker	None Detected	800

If you have any questions or concerns regarding the above noted results, I may be contacted at (709) 754-4146 or via email at dbutt@toalltech.com.

Thank you,

Sean Hynes
Environmental Consultant
ALL-TECH Environmental Services Limited

Enc. 2

APPENDIX C

ANALYTICAL RESULTS – LEAD SWABS